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NHMRC SUPPORTED RESEARCH:

the impact of journal publication output 1999-2003

INVESTING IN AUSTRALIA'S HEALTH



Australian Government

National Health and Medical Research Council

**NHMRC - supported research:
the impact of journal publication output 1999-2003**

Linda Butler, Bev Biglia and Kumara Henadeera
Research Evaluation and Policy Project
Research School of Social Sciences
The Australian National University

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Paper-based publications

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EXECUTIVE SUMMARY

Background

The Research Evaluation and Policy Project (REPP) was commissioned by the National Health and Medical Research Council (NHMRC) to update its previous analyses of the impact of publications resulting from the research it funded. The NHMRC has many diverse schemes for funding research, targeting different aggregations of effort – the institution, the unit, the research group, cross institutional programs, and the individual researcher. This current analysis, like those in the 2001 and 2003 studies, creates a series of publication sets that enable each of the NHMRC's main research grants schemes to be evaluated on the basis of citation impact.

Database

The analysis is based primarily on the REPP database. It contains all Australian publications indexed in the Institute for Scientific Information's (ISI) three main indices: the Science Citation Index, the Social Sciences Citation Index, and the Arts and Humanities Citation Index. Additional information on grant and researcher characteristics provided by the NHMRC is incorporated into the analysis.

Sectors analysed

The report identifies eleven sectors. Six equate to NHMRC research grants schemes – Project Grants; Program Grants; Block-funded research institutes; research Unit grants; and research fellowship awards (Institute and Project). The remaining five represent other sites of activity in Australian medical research – Other Research Institutes; Cooperative Research Centres; universities; hospitals; and government departments and agencies. The methodology used created sectors with quite distinct characteristics, and minimised the overlap between NHMRC sectors and their comparators.

Changes to NHMRC funding schemes

A number of NHMRC grants schemes were superseded by new funding arrangements during the period covered by this analysis, however it was necessary to combine old and new schemes in this study. Otherwise publication distributions would have been severely skewed across the five year window of the study, and hence had a significant effect on citation rates.

Identifying the publications from Project Grants

Publications attributable to most NHMRC funding schemes could be confidently identified. The exception was the Project Grants scheme. The methodology used relied on the accuracy with which applicants for new grants completed their forms. It became apparent that in a number of instances, fellowship holders ascribed some publications to their fellowship rather than to the Project Grant with which they were associated. In aggregate, NHMRC data is accurate, but there is some 'blurring at the edges' between the data for Project Grants and the 'old' Project Fellowships scheme.

Field of research

The study focuses on the biomedical fields and sub-fields of research. Most analyses are undertaken using journal sets to delineate fields. For Project Grants publications, a field analysis is also carried out using the NHMRC discipline codes.

Measures used

The analyses focus on publications that appeared between 1999 and 2003 and the citations they attracted in the same five year period. The three standard bibliometric measures used are:

- citations per publication
- most highly cited publications
- comparison of actual and expected citations

Using bibliometrics

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 that is being analysed. The efficacy of bibliometric measures for the evaluation of various NHMRC schemes varies, not between schemes, but in relation to the different fields of research covered by each scheme.

Main findings

- ⇒ Publications linked to NHMRC demonstrate, in aggregate, a very strong citation performance, with a citation rate 50 percent above the world rate for biomedicine.
- ⇒ NHMRC publications have citation rates above the Australian average in all fields and sub-fields, and account for a significant number of the country's most highly cited publications. In only one case does its citation rate fall below the world benchmark.
- ⇒ The most significant improvement in citation outcomes since the 2003 study has been in medical physiology, where the relative citation impact of NHMRC-linked publications rose from 5% below the world benchmark to 21% above it. At the same time, this discipline had the largest percentage decline in publication numbers.
- ⇒ As in previous REPP studies, researchers on fellowships who are attached to the six medical research institutes formerly receiving Block-funding from NHMRC are most prominent in the citation analyses.
- ⇒ Following on from this, the former Block-funded institutes also exhibit particularly strong citation performance. All other schemes, with the exception of the NHMRC-funded Units, display impact in line with aggregate NHMRC performance.
- ⇒ The Units sector has a distinct discipline mix, with a focus primarily on clinical sciences and public health and health services research. Taking into account its profile, it also exhibits a strong citation performance.
- ⇒ As in the previous study, NHMRC-funded output in biotechnology is the only subfield which falls significantly below the line of convergence between actual and expected citations.
- ⇒ The NHMRC accounts for one-quarter of all Australian biomedical research. In four biomedical sub-fields, the NHMRC is linked to more than one-third of the total Australian output:

- Immunology (42%)
 - Neurosciences (41%)
 - Biochemistry and cell biology (37%)
 - Medical Physiology (34%)
- ⇒ Though accounting for a relatively small number of publications, grants classified into the broad area of preventative medicine exhibited an exceptionally strong performance, attracting citations at a rate more than double that expected for its journals, and significantly higher than publications linked to other broad areas of research.
- ⇒ When classifying publications on the basis of the category 'b' code of the Project Grants to which they were linked, the disciplines showing the strongest improvement in the three years since the last study were oncology, biochemistry and clinical chemistry, and cardiovascular diseases and sciences. The performance of publications linked to haematology and vision and ophthalmology grants declined noticeably over the period. Grants from epidemiology, developmental biology and physiology, and public health had sufficient publications to be separately analysed for the first time, and all demonstrated strong citation performances.
- ⇒ In contrast to the previous REPP analysis, there was a more noticeable difference in citation performance between male and female Institute Fellows, though both cohorts demonstrated exceptionally strong citation impact. Initial investigations suggest it may be worth exploring further additional characteristics such as discipline focus.

Comparison to previous study

The study undertaken by REPP for the NHMRC in 2003 used an identical methodology, thus enabling a comparative analysis to be undertaken. Citation rates world-wide are increasing over time, so a direct comparison of citation per publication data is not helpful. Instead the comparison focused on two key indicators for each biomedical sub-field – the number of publications and the relative citation impact of that output (i.e. the NHMRC rate compared to the world rate). Data is presented in Table 1 for the NHMRC as a whole.

Table 1: Changes in output and impact between the current study and the 2003 study

| | Publications | | | Relative Citation Impact | | |
|--------------------------------------|--------------|--------------|----------|--------------------------|-------------|-----------|
| | 1996-00 | 1999-03 | % Change | 1996-00 | 1999-03 | % Change |
| Biological Sciences | | | | | | |
| Biochemistry & Cell Biology | 2449 | 2634 | 8 | 1.05 | 1.27 | 21 |
| Genetics | 644 | 650 | 1 | 1.10 | 1.18 | 7 |
| Microbiology | 204 | 194 | -5 | 1.59 | 1.42 | -11 |
| Biotechnology | 404 | 386 | -4 | 1.11 | 1.26 | 13 |
| Medical and Health Sciences | 7863 | 8414 | 7 | 1.41 | 1.54 | 9 |
| Immunology | 1206 | 1200 | 0 | 1.45 | 1.49 | 3 |
| Pharmacology & Pharmaceutical Sci | 838 | 769 | -8 | 1.24 | 1.32 | 7 |
| Medical Physiology | 852 | 768 | -10 | 0.95 | 1.21 | 27 |
| Neurosciences | 1236 | 1387 | 12 | 1.01 | 0.98 | -3 |
| Clinical Sciences | 4373 | 5102 | 17 | 1.45 | 1.59 | 9 |
| Public Health and Health Services | 402 | 487 | 21 | 1.55 | 1.58 | 2 |
| General Medicine Sciences | 587 | 590 | 1 | 1.75 | 1.52 | -13 |
| Multi-disciplinary Sciences | 237 | 224 | -5 | 2.43 | 2.29 | -6 |
| Total biomedical publications | 10159 | 10813 | 6 | 1.36 | 1.50 | 11 |

There has been an overall increase of six percent in the number of publications linked to NHMRC support in the three years since the last study, however this has not been uniform across all disciplines. Output in clinical sciences, and public health and health services research increased by three times this level, and in neurosciences the increase was double the overall growth. Those areas with the largest decline in the number of publications linked to NHMRC support declined were pharmacology and pharmaceutical sciences, and medical physiology.

In aggregate terms, the relative citation impact of NHMRC-linked publications rose 11 percent in the intervening period. Again the performance at the sub-field level was quite varied. The most noticeable increase in relative citation impact was in medical physiology, which rose by 27 percent from a level below world parity, followed by biochemistry and cell biology (21 percent), and biotechnology (13 percent). Two sub-fields that recorded double-digit declines were general medical sciences (down 13 percent) and microbiology (down 11 percent), but both remained well above the world benchmark in their discipline.

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Certain data included herein are derived from the **Australian National Citation Report** prepared by the Institute for Scientific Information®, Inc. (ISI®), Philadelphia, Pennsylvania, USA: © Copyright Institute for Scientific Information® 2003. All rights reserved.

INTRODUCTION

The Research Evaluation and Policy Project (REPP) was commissioned by the National Health and Medical Research Council (NHMRC) to update its previous analyses of the impact of publications resulting from the research it funded (Butler 2003, Butler and Biglia 2001). The NHMRC has many diverse schemes for funding research, targeting different aggregations of effort – the institution, the unit, the research group, cross institutional programs, and the individual researcher. This current analysis, like those previous studies, creates a series of publication sets that enable each of the NHMRC's main research grants schemes to be evaluated on the basis of citation impact. It links publications from 1999 to 2003, indexed by the Institute for Scientific Information (ISI), to each of the NHMRC's schemes.

The report presents a bibliometric analysis comparing the impact of publications linked to each of the schemes with other Australian medical and health sciences publications. The NHMRC funding mechanisms evaluated are: Block-funded research institute grants; research Unit grants; Program Grants; Project Grants; and research fellowship awards. A number of these schemes were superseded by new funding arrangements during the period covered by this analysis, however it was necessary to combine old and new schemes in this study. Otherwise publication distributions would have been severely skewed across the five year window of the study, and hence had a significant effect on citation rates. This issue is explained more fully in Section 1.3 below.

NHMRC publications are compared to: Other Research Institutes; Other University research; Other Hospital research; Cooperative Research Centres (CRCs); and government departments and agencies.

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 that is being analysed. The efficacy of bibliometric measures for the evaluation of various NHMRC schemes varies, not between schemes, but in relation to the different fields of research covered by each scheme.

This report is presented in four sections, and incorporates a technical annex containing a detailed discussion of the methodology employed. The contents of each section of the report are as follows:

- Section 1: *Methodology* – a brief outline of the project's methodology.
- Section 2: *Sector characteristics and performance* – compares and contrasts the research focus of each of the nine sectors in the study, and analyses the citation performance of their total publication output.
- Section 3: *Selected characteristics and performance of NHMRC schemes* – looks at selected characteristics of Project Grants and fellowships, and analyses the citation performance of publications on the basis of these characteristics.
- Section 4: *RFCD fields and sub-fields of research* – analyses the citation performance of each of the nine sectors in the study on the basis of journal sets using the Research Fields, Courses and Disciplines (RFCD) classification scheme.

1 METHODOLOGY

The publications that resulted from research supported by NHMRC funding were identified either directly from the REPP database using author and/or institutional address information; or from details obtained from Project Grant application forms. Full details of the methodology used to identify the publications for each of the NHMRC funding schemes, and the comparator sectors against which their performance was judged, is given in the Technical Annex.

1.1 Coverage of ISI database

The use of bibliometric analysis as a tool for evaluating research performance cannot be universally applied across all fields of research (Bourke, Butler and Biglia 1996, NBEET 1994). ISI does not comprehensively cover the output of Australian research in:

- most fields in the humanities and social sciences;
- engineering, information sciences, and other fields of research in the applied sciences; or,
- the applied end of the research spectrum, even for those fields well covered by ISI indices.

The implication for the medical and health sciences is that, while the ISI database provides a comprehensive coverage of the major journals in most sub-fields, it is not universal. Where the majority of research has a basic orientation, as in the case of immunology, ISI coverage of the field is extensive. But for those sub-fields or disciplines more focussed on applied research, such as nursing, public health and health services, and complementary/alternative medicine, the interpretation of bibliometric data should be undertaken with extreme caution. In these disciplines ISI coverage is patchy, and much of the output is found in other formats, such as monographs, reports, professional journals, and the like. It is the reason REPP has found very few ISI publications linked to grants classified to these disciplines.

Section T5 of the Technical Annex goes into the issue of coverage in more detail.

1.2 Definition of sectors

It is important to stress that the methodology used in this study was 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.

When comparing sectoral citation rates using five year windows, an underlying assumption is that each sector has a similar, and even, distribution across the five years. A concentration of publications in the earlier years will inflate citation rates (as most publications will have had several years to attract citations), while a concentration in the later years will deflate citation rates (as most publications will have had little time to attract citations). This issue meant that, even though a number of NHMRC grant schemes have undergone significant changes during the five years covered by this study, it was necessary to combine the new and old versions for analytical purposes. This will no longer be necessary for the next update, which is scheduled to cover the period 2002-2006.

The specifications for the study identified eleven sectors for analysis:

NHMRC sectors:**1 Project Grants**

The Project Grants scheme supports research that is likely to be capable of solution within a relatively short time frame. Grants are normally of three years duration, and researchers usually retain teaching and/or clinical duties within their institutions. Publications resulting from this scheme were identified using information contained in Project Grant applications for 2004 and 2005. This data was supplemented with details obtained in the previous 2003 study.

2 Program Grants

Program Grants are awarded to research teams of scientific excellence, working collaboratively on a number of health and medical research projects who are funded for a five year period. This sector covers all the publications of researchers participating in a Program Grant, and covers both the new and the old schemes.

3 Block-funded research institute grants

Six medical research institutes were supported through the NHMRC Block-funded research institute grants scheme for part of the study period, 1999-2003. The sector covers all publications from the six institutions and these were directly identified in the REPP database using their institutional address.

4 Research Unit grants

Research Unit grants were awarded in areas of health and medical research which the NHMRC assessed required special support to develop research and research training programs. This funding scheme is no longer operational, however a number of Units were supported for part of the study period. The sector covers all the publications from the specified Units.

All Fellowship awards

Research fellowship awards provide five year's salary for high-calibre researchers, allowing them to undertake full-time research. In the initial part of the period covered by this analysis, fellows could be funded either through the Project Grants scheme, or via the Block-funded institutes grants scheme. Recent changes in this area saw the two schemes effectively combined.

5 Institute fellowship awards

The sector incorporates all publications from fellows located in the six medical research institutes analysed in sector 3.

6 Project Fellowship awards

The sector incorporates all publications from each of the fellows funded via the Project Grants scheme, and any fellows funded under the new funding regime who were not located in one of the six specified institutes.

NHMRC total

In all analyses, data is presented in aggregate for all sectors funded by NHMRC (sectors 1 to 6). Duplications due to cross-sector collaboration have been removed.

Comparator sectors:**7 Other Research Institutes**

The sector covers fully funded research institutions employing full-time researchers, viz. the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Institute of Advanced Studies (IAS) at the Australian National University (ANU), and those members of the Australian Association of Medical Research Institutes (AAMRI) not included in sector 3 above. It covers all publications from the AAMRI institutions, and from those units within CSIRO and the IAS that were primarily engaged in medical research.

8 Cooperative Research Centres (CRCs)

The sector covers all publications from biomedical CRC's. These are fully funded single focus research centres of six to nine years duration, located within universities and employing full-time researchers.

9 Other University

The sector covers the output of full-time and part-time researchers, most of whom retain teaching and administrative responsibilities, funded principally through university general operating grants and through competitive grants obtained from other funding agencies. It specifically excludes any publications identified as having NHMRC support (i.e. are included in one or more of sectors 1 to 6) or that are collaborative works with either the CRCs or Other Research Institutes (sectors 7 and 8).

10 Other Hospital

This sector covers the output of full-time and part-time researchers, funded principally through hospital general operating grants and through competitive grants obtained from other funding agencies. It specifically excludes any publications identified as having NHMRC support (i.e. are included in one or more of sectors 1 to 6) or that are collaborative works with either the CRCs or Other Research Institutes (sectors 7 and 8).

11 Other Government departments and agencies

This sector covers the output of full-time and part-time researchers located in federal and state government departments and agencies. It specifically excludes any publications identified as having NHMRC support (i.e. are included in one or more of sectors 1 to 6) or that are collaborative works with either the CRCs or Other Research Institutes (sectors 7 and 8).

It is acknowledged that support for the research that leads to a particular publication can come from more than one source. Publications identified with the NHMRC sectors may well have additional funding sources that could see them included in one or more of sectors 9 to 11. It is impossible to identify sets of publications that have discrete funding sources. The aim in this study was to delineate sectors that would enable us to compare NHMRC-funded publications with those that received little support from the agency, and to delineate sectors that had identifiable, distinctive features. The methodology adopted enabled this to be successfully accomplished.

Some concerns need to be noted concerning the difficulty that was experienced in delineating the Project Grants and Project Fellowships sectors (1 and 6). A number of researchers appear to have linked some publications to their fellowship grant id, rather than to a more appropriate Project Grant id. This does not affect the analysis of overall NHMRC performance. Nor in most cases does it have a significant impact on the performance of the two sectors concerned as they tend to exhibit similar performances. Nevertheless, caution should be used when interpreting the relative performance of these two schemes.

1.3 Methodology overview

A full description of the methodology used to identify each sector's publications, and technical issues in relation to the performance measures, are given in the Technical Annex. In this section of the report, a limited number of specific issues are discussed and the more significant aspects of that methodology are highlighted.

- **In-scope** publications

The analysis covered 1999 and 2003 publications, classified as research articles or reviews that appeared in journals indexed in ISI's three main indices – the Science Citation Index (SCI), Social Sciences Citation Index (SSCI) and Arts and Humanities Citation Index (A&HCI). REPP's database covers all three indices, but its SCI coverage is limited to the equivalent of the CD-Rom version of the index.

- **Field of research** classification
Two methods of classifying publications to a field of research have been used in this report:
 - i) publications are classified on the basis of the journal in which they appear according to the *RFCD classification scheme*¹, which allows comparison across sectors at a more aggregated level; and
 - ii) publications are classified on the basis of the code associated with the NHMRC grant to which they are linked. This method is only used for the Project Grants sector. It uses *category 'b' codes*², and has the advantage that publications appearing in multidisciplinary journals (eg *Nature*) can be ascribed to the field most appropriate to the content of the article.
- **Small numbers**
Because of the skewed nature of citation distributions, analyses based on any units with less than 100 publications are too unreliable and have been omitted. Experience suggests that extra caution should also be used for analyses based on units of less than 200 publications.
- **Identification** of each sector's publications
The methodologies used to identify the publications attributable to each of the sectors defined in section 1.2 above were:
 - i) extracting publication details from NHMRC grant applications (sector 1).
 - ii) extracting all publications for specified authors (sectors 2, 5 and 6); and
 - iii) extracting all publications pertaining to specified "standardised addresses" in the REPP database (sectors 3-4, 7-11);
- **Overlap** of sector publication sets
Given the collaborative nature of most research, with multi-authored papers the norm, it is inevitable that there will be some double-counting. Where authors from more than one sector collaborate on a publication, it is fully counted for each sector involved. The methods used to identify the relevant publications for each of the sectors resulted in some overlap within sectors 1 to 8, and sectors 9 to 11, but none between these two groups. Because recipients of the research fellowship awards were commonly associated with Project or Program Grants, or were located in one of the Block-funded institutes, publications identified for the fellows sectors do not represent a distinct set (98% for Institute Fellows and 77% for Project Fellows are also contained in one of the other NHMRC sectors). However, overlap for the Project, Block and Unit sectors is restricted to approximately one-third.
- **Completeness** of publication set for the Project Grants sectors
To identify the publications relevant to this sector, the study initially relied on information contained in applications for new Project Grants made in 2004 or 2005. These were supplemented with publications identified in the 2003 study. These strategies will not have identified all publications that can be linked to this scheme for two reasons. Firstly, not all researchers or groups that received Project Grant funding and were likely to have publications in our target period will have applied for a new grant in the last three years – some may have retired, gone overseas, moved to a non-research position, etc. Secondly, not all applicants are meticulous in their completion of this section of the application form. The exact extent of under-reporting is impossible to calculate, but is likely to be less than 20 percent. This issue must be borne in mind when interpreting the results of the study, but given the large number of publications that were identified, it is unlikely to have a significant effect on the average citation rates that formed the basis of the analysis. It is of most concern when publication numbers drop to fairly low levels.

1 The Research Fields, Courses and Disciplines classification scheme is prepared by the Australian Bureau of Statistics for use in the measurement and analysis of research and experimental development in Australia.

2 The category 'b', or discipline, codes are the second level of NHMRC classification.

1.4 Performance measures

This section gives a general description of the standard bibliometric measures used in the study. Notes relevant to particular points of discussion are included throughout the report as required.

1.4.1 Citations per publication

Publications from 1999 to 2003 were counted and the citations these publications received during the same period were tabulated. A simple citation per publication (cpp) average was then calculated, and the sectors ranked according to the result.

1.4.2 Actual and expected citation rates

In this measure, the term *actual citation rate* refers to the average number of citations actually achieved by the publications of the unit under study. The term *expected citation rate* refers to the average number of citations achieved by all publications in the journals carrying the articles of the unit under study. The REPP database contains data on the average citation rates for ISI journals for each year of publication and for each type of publication. Calculations of actual and expected citation rates are weighted by publication year, article type, and journal. The expected citation rate is a different calculation to ISI's journal impact factor³, though the measures are related.

The graph essentially, therefore, allows a comparison of actual and expected citation rates. The diagonal on the graph indicates the point at which actual and expected citation rates converge so that, where the unit under study appears above this diagonal line, it is achieving a rate of citation higher than the 'world' average for the journals in which it publishes; and where it appears below the line, it is achieving a rate of citation lower than the 'world' average for its publications in those journals. Where a vertical line is drawn on a graph, it indicates the citation per publication figure for all publications in all journals in the field under study, that is, the world average.

In these graphs, the relationship to the diagonal and vertical lines is the salient point to observe. A point above the line and to the right of the ISI average indicates above world performance in high impact journals; a point below the line and to the left indicates below world performance in low impact journals. Between these extremes, there are many possibilities, such as appearing in high impact journals below the world expected rate or appearing in low impact journals but performing at a higher rate of citation than the expected world rate. Judgments about these relationships should be made carefully.

1.4.3 Most highly cited publications

For all RFCD biomedical fields and sub-fields, the number of citations required to rank a publication from 1999 to 2003 in the top 1% and 5% of publications in Australia was calculated. By extracting publications that fell within these bands, it was possible to identify the sectors to which these high impact articles belonged. For each of the sectors, tables show their total number of publications in the field or sub-field for 1999 to 2003, and the percentage of these publications falling within the two percentile clusters. The sectors are ranked by the percentage of their papers in the 5% band.

The majority of publications identified in this analysis are from 1999 and 2000, as few later publications will have had sufficient time to attract the required number of citations.

3 The calculation for ISI's 1999 impact factor is a/b , where:
 a = 1999 citations to articles published in the journal in 1997 and 1998
 b = number of articles published in the journal in 1997 and 1998;

The calculation for the expected values used in this report for a 1999 article is x/y , where:
 x = number of citations received between 1999 and 2003 to all articles of a particular type published in the journal in 1999
 y = number of articles of that type published in the journal in 1999

1.4.4 Level of collaboration

The REPP database enables publications with different types of authorship to be distinguished, viz.:

- Single author* one author only (i.e. no collaboration);
- Group* more than one author from the same AOU4 within an institution;
- Institutional* more than one AOU from the same institution;
- National* more than one Australian institution; and
- International* more than one country.

The classification is not hierarchical and all collaborations present in a publication will be ascribed to it. For instance, if a publication involves collaboration between a number of Australian institutions as well as an overseas institution, it will be classified as both *international* and *national*.

For this report, data are not presented for institutional collaboration as only addresses for universities and the CSIRO are 'cleaned' down to the level of department or equivalent⁵. Addresses for other institutions, in particular hospitals, are generally not disaggregated.

1.5 Underlying data

The analyses presented in this report are principally in the form of figures, or tables showing percentage distributions. The data underlying the tables and figures in the main body of the report are given in the Appendix. In some instances, particularly in the discussion of highly cited publications, data in the Appendix are referred to during discussion of results.

1.6 Comparison to methodologies in previous REPP studies

Two previous studies undertaken by REPP for the NHMRC have analysed the performance of its separate funding schemes. The 2001 study focussed on publications that appeared in 1994 and 1995. Limiting publications to two years, but calculating citations for a full five year window, meant that citation rates are not directly comparable either to this current study, or to the one undertaken in 2003. The 2003 analysis is directly comparable to the current study — the sectors used, the fields of research covered, and the methodology remain unchanged.

4 Academic Organisational Unit or CSIRO division.

5 See sections T1 and T2 of the Technical Annex for an explanation of address 'cleaning' in the REPP database.

2 SECTOR CHARACTERISTICS AND PERFORMANCE

2.1 Sector research profiles

The sectors delineated in this study do not have identical research profiles – their efforts are spread across a wide variety of research fields. Different fields of research have different citation practices so the profile of an institution is an essential piece of knowledge that needs to be taken into consideration when interpreting results.

Table 2 shows, for each sector, its journal output distributed across the RFCD biomedical fields and sub-fields. Sub-fields that account for more than 10% (blue) or 20% (green) of a sector's publication output have been highlighted. In addition, the second column shows the average citation per publication (cpp) rates for each field and subfield, underscoring the differences that can occur, even within one field. For the Other University and Government sectors, the distribution given in the table is based on data limited to biomedical research, thus allowing for a more valid cross-sectoral comparison. In reality, of course, biomedical research only accounts for 32% and 28%, respectively, of the total output of these sectors as defined.

Table 2: Distribution of publications in sectors by RFCD classification

| RFCD Fields/ Subfields | Cpp | NHMRC Sectors | | | | | | | NHMRC TOTAL | Comparator Sectors | | | | |
|--|-------------|---------------|------------|------------|------------------|----------------|--------------|------------|----------------|--------------------|------------|---------------|---------------|---------------|
| | | Project | Block | Unit | Project Fell. | Inst. Fell. | All Fell. | Progr. | | Res. Inst | CRC | Other Univ | Other Hosp | Other Govt |
| Biological Sciences | | | | | | | | | | | | | | |
| Biochemistry & Cell Biology | 8.79 | 24.4 | 23.5 | 9.7 | 25.1 | 26.5 | 25.5 | 19.8 | 22.6 | 26.7 | 26.1 | 15.2 | 4.2 | 8.9 |
| Genetics | 9.37 | 4.4 | 8.7 | 4.1 | 3.8 | 8.1 | 5.0 | 8.8 | 5.6 | 4.8 | 3.1 | 4.7 | 2.6 | 4.2 |
| Microbiology | 5.63 | 2.0 | 1.7 | 0.0 | 0.7 | 0.8 | 0.7 | 0.7 | 1.7 | 1.8 | 3.0 | 5.6 | 2.7 | 8.1 |
| Biotechnology | 5.12 | 3.4 | 3.8 | 1.8 | 2.2 | 3.3 | 2.5 | 3.8 | 3.3 | 3.7 | 7.8 | 6.3 | 1.2 | 7.4 |
| Medical & Health Sciences | 5.50 | 73.7 | 66.9 | 82.2 | 72.8 | 67.7 | 71.5 | 72.6 | 72.3 | 71.3 | 64.8 | 75.4 | 91.6 | 76.0 |
| Immunology | 7.61 | 10.0 | 12.5 | 0.2 | 9.7 | 14.0 | 10.8 | 10.1 | 10.3 | 13.2 | 27.1 | 4.3 | 5.2 | 3.1 |
| Clinical Chemistry | 4.11 | 0.7 | 0.4 | 0.5 | 0.5 | 0.2 | 0.5 | 0.8 | 0.7 | 1.2 | 0.5 | 1.3 | 0.6 | 1.4 |
| Pharmacol & Pharmaceut Sci | 4.60 | 7.2 | 3.9 | 14.4 | 7.5 | 5.0 | 6.8 | 3.3 | 6.6 | 5.2 | 1.7 | 7.0 | 4.0 | 6.7 |
| Medical Physiology | 5.64 | 8.2 | 4.7 | 2.3 | 8.0 | 7.0 | 7.8 | 5.7 | 6.6 | 4.8 | 0.5 | 5.9 | 1.8 | 3.5 |
| Neurosciences | 6.98 | 14.0 | 6.8 | 15.1 | 15.5 | 10.4 | 14.0 | 10.9 | 11.9 | 9.2 | 1.6 | 7.5 | 4.8 | 2.0 |
| Dentistry | 2.33 | 0.7 | 0.4 | 0.0 | 0.4 | 0.0 | 0.3 | 0.1 | 0.5 | 0.1 | 0.2 | 1.8 | 0.7 | 0.6 |
| Clinical Sciences | 5.38 | 42.8 | 43.8 | 51.0 | 40.5 | 38.4 | 40.1 | 48.0 | 43.8 | 44.0 | 39.1 | 46.0 | 78.3 | 46.6 |
| Nursing | 1.46 | 0.1 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 2.0 | 1.2 | 1.9 |
| Public Health & Health Serv | 3.72 | 3.7 | 4.9 | 11.1 | 2.0 | 3.3 | 2.3 | 4.7 | 4.2 | 4.1 | 1.9 | 12.1 | 6.0 | 21.9 |
| Human Movt & Sports Sci | 3.57 | 0.8 | 0.2 | 0.0 | 1.0 | 0.0 | 0.7 | 0.8 | 0.7 | 1.2 | 0.0 | 2.8 | 1.5 | 4.7 |
| Other Medical & Health Sci | 4.17 | 0.5 | 0.5 | 0.5 | 0.4 | 0.1 | 0.3 | 0.9 | 0.6 | 0.5 | 0.2 | 0.5 | 1.2 | 0.5 |
| General Medicine Sciences | 6.52 | 4.6 | 6.3 | 2.5 | 4.7 | 6.3 | 5.1 | 5.3 | 5.1 | 6.0 | 9.5 | 2.5 | 2.5 | 1.6 |
| Multi- disciplinary Sciences | 12.48 | 1.6 | 3.1 | 0.2 | 1.9 | 5.0 | 2.7 | 1.8 | 1.9 | 1.7 | 3.4 | 4.4 | 0.7 | 5.2 |
| TOTAL | 6.47 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

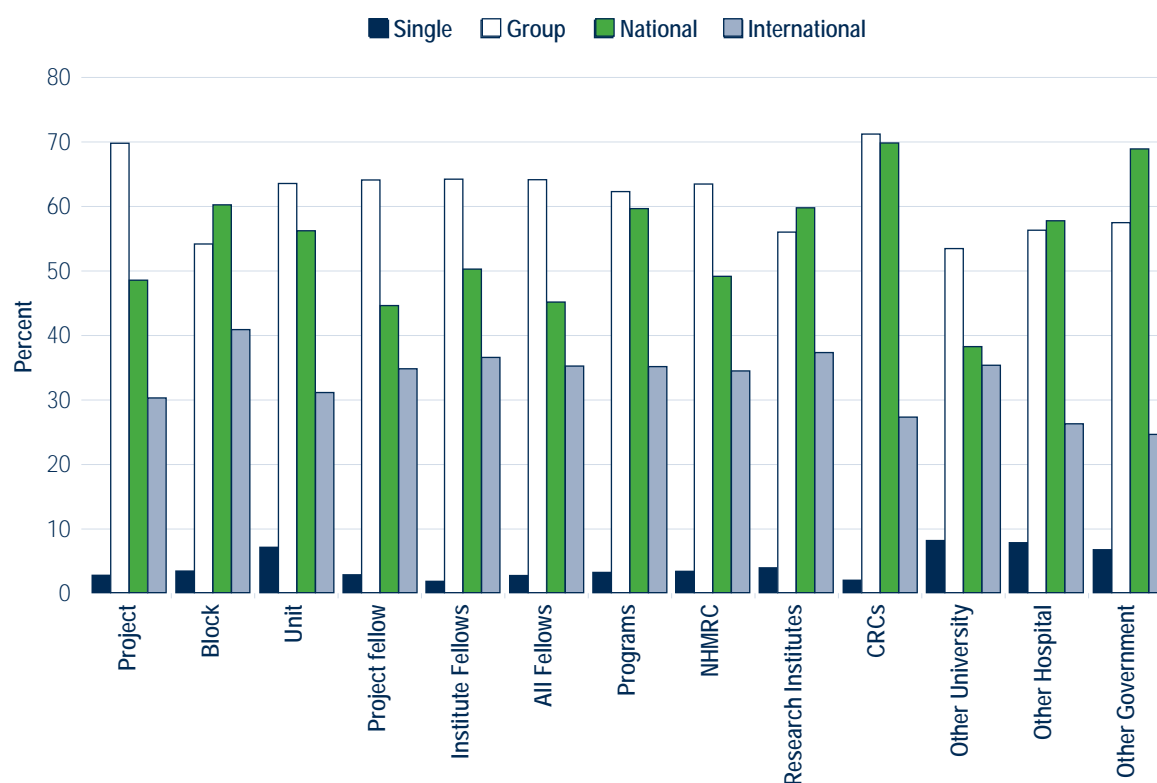
Using the distribution of aggregate NHMRC data as a reference point, it can be seen that three sectors (one NHMRC scheme and two comparators) have a different research focus to the others. The biomedical research output of the Other Hospital sector is, not surprisingly, very heavily concentrated in clinical sciences, with a relatively weak focus on high impact sub-fields such as biochemistry and cell biology, genetics and immunology. The profile of the Other Government sector also differs from that for other sectors in relation to the extent of their activity in public health and health services research.

Within the NHMRC, the Units sector has significantly more output in clinical sciences and public health and health services research. Its unique profile is unsurprising given the targeted nature of funding under this scheme.

2.2 Collaboration

The structure of the REPP database enables the sectors to be described on the basis of their collaboration patterns. These are presented in Figure 1.

Figure 1: Collaboration patterns by sector



Multi-authored papers are the dominant form of publication in the medical and health sciences. Within NHMRC sectors, the single author paper is relatively uncommon, accounting for less than 5% of the total output. At 49%, the extent of national collaboration is much higher in the medical and health sciences than in other fields of science where the average level is only 31%. In contrast, international collaboration is not as strong in this field as for most others (the average for science as a whole is 39% for the period). International collaboration is most prevalent in the Block-funded institutes and Other University sectors, and least common in the CRC, Other Government, and Other Hospital sectors.

The direction of international collaboration for each sector is examined in detail in Table 3.

Table 3: International collaboration by sector and country (percent)

| COUNTRY | NHMRC Sectors | | | | | | | NHMRC TOTAL | Comparator Sectors | | | | |
|-----------------|---------------|-------|------|-----------------|-------------------|-------------|---------|-------------|---------------------|------|------------|------------|------------|
| | Project | Block | Unit | Project Fellows | Institute Fellows | All Fellows | Program | | Research Institutes | CRCs | Other Univ | Other Hosp | Other Govt |
| US | 48 | 51 | 25 | 44 | 50 | 46 | 45 | 46 | 48 | 39 | 35 | 36 | 39 |
| England | 15 | 17 | 17 | 15 | 11 | 14 | 20 | 16 | 17 | 13 | 19 | 29 | 17 |
| Germany | 10 | 9 | 18 | 11 | 11 | 10 | 9 | 10 | 12 | 7 | 9 | 9 | 6 |
| Japan | 9 | 9 | 8 | 8 | 11 | 9 | 6 | 8 | 7 | 3 | 6 | 4 | 5 |
| Canada | 5 | 5 | 6 | 7 | 4 | 6 | 8 | 6 | 5 | 5 | 9 | 12 | 11 |
| France | 5 | 7 | 4 | 6 | 6 | 6 | 7 | 6 | 6 | 6 | 5 | 7 | 5 |
| New Zealand | 5 | 4 | 12 | 7 | 6 | 7 | 5 | 5 | 5 | 5 | 6 | 7 | 11 |
| Sweden | 4 | 4 | 4 | 6 | 3 | 5 | 6 | 5 | 4 | 2 | 5 | 5 | 4 |
| Switzerland | 3 | 6 | 5 | 4 | 4 | 4 | 3 | 4 | 4 | 5 | 3 | 5 | 5 |
| Netherlands | 4 | 4 | 1 | 2 | 3 | 2 | 5 | 4 | 3 | 3 | 4 | 6 | 6 |
| Italy | 3 | 3 | 1 | 3 | 3 | 3 | 4 | 3 | 4 | 1 | 4 | 7 | 5 |
| Peoples R China | 3 | 3 | 6 | 3 | 1 | 2 | 3 | 3 | 2 | 2 | 4 | 4 | 4 |
| Scotland | 2 | 2 | 4 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 4 | 6 |
| Belgium | 1 | 1 | 6 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 2 | 4 | 1 |
| Denmark | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | 3 | 3 | 3 |
| Finland | 2 | 1 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| Spain | 1 | 1 | 1 | 2 | 0 | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 4 |
| Israel | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 0 | 1 | 2 | 1 |
| Singapore | 1 | 1 | 5 | 1 | 1 | 1 | 3 | 1 | 1 | 0 | 2 | 2 | 1 |
| Thailand | 1 | 2 | 2 | 0 | 1 | 0 | 0 | 1 | 1 | 3 | 2 | 1 | 2 |
| Austria | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 2 | 3 | 1 |
| Wales | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| Ireland | 0 | 1 | 6 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| Norway | 0 | 0 | 3 | 1 | 0 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 |
| South Africa | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 2 | 2 |
| Hungary | 0 | 0 | 0 | 2 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| Russia | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| Indonesia | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| Brazil | 1 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| India | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 6 | 1 | 1 | 2 |
| Taiwan | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Vietnam | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Papua N Guinea | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 1 |
| Poland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 |
| Mexico | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Philippines | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| South Korea | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

In the mid-1990s, the focus of Australia's scientific collaborations turned more to continental Europe, with a decreased emphasis on the United States and England as partners in research. For the NHMRC, the extent of collaboration with the United States is stronger than for most other sectors, and well above the overall science average of 36% for the period. NHMRC and the Research Institutes have very similar patterns of international collaboration. In contrast, the Other Government, Hospital and University sectors have stronger links to Canada and England, and a smaller proportion of collaborations with the United States, but the differences are not large.

2.3 Location of Australian research

The importance of the NHMRC and other sectors as sites of basic research can be demonstrated by distributing all Australian publications in RFGD fields and sub-fields across the sectors. The data is presented in Table 4. Sub-fields for which a sector accounts for twenty percent or more of all Australian publications have been highlighted in red.

Table 4: Distribution of Australian publications across sectors by RFGD classification

| RFGD Fields/Subfields | NHMRC Sectors | | | | | | | NHMRC TOTAL | Comparator Sectors | | | | | AUS TOT |
|--|---------------|------------|------------|------------------|----------------|--------------|------------|----------------|--------------------|------------|---------------|---------------|---------------|------------|
| | Project | Block | Unit | Project Fell. | Inst. Fell. | All Fell. | Progr. | | Res. Inst. | CRC | Other Univ | Other Hosp | Other Govt | |
| Biological Sciences | | | | | | | | | | | | | | |
| Biochemistry & Cell Biology | 20.7 | 11.0 | 0.6 | 12.3 | 5.0 | 17.0 | 4.6 | 36.9 | 19.3 | 2.3 | 45.3 | 6.0 | 3.3 | 100 |
| Genetics | 12.8 | 14.0 | 0.9 | 6.5 | 5.3 | 11.5 | 7.1 | 31.5 | 11.9 | 1.0 | 48.1 | 12.6 | 5.3 | 100 |
| Microbiology | 6.8 | 3.2 | 0.0 | 1.4 | 0.6 | 1.9 | 0.6 | 10.8 | 5.3 | 1.1 | 66.2 | 15.4 | 11.8 | 100 |
| Biotechnology | 9.0 | 5.5 | 0.4 | 3.4 | 2.0 | 5.3 | 2.8 | 17.1 | 8.4 | 2.2 | 59.3 | 5.5 | 8.6 | 100 |
| Medical & Health Sciences | | | | | | | | | | | | | | |
| | 13.4 | 6.7 | 1.1 | 7.6 | 2.7 | 10.2 | 3.6 | 25.3 | 11.0 | 1.2 | 48.1 | 27.9 | 6.0 | 100 |
| Immunology | 21.3 | 14.7 | 0.0 | 11.9 | 6.7 | 18.1 | 6.0 | 42.3 | 24.0 | 6.1 | 32.0 | 18.7 | 2.9 | 100 |
| Clin Chemistry | 9.1 | 3.0 | 0.4 | 4.1 | 0.6 | 4.8 | 2.8 | 16.7 | 13.0 | 0.6 | 59.1 | 13.6 | 7.8 | 100 |
| Pharmacol & Pharmac Sci | 15.8 | 4.7 | 2.3 | 9.5 | 2.4 | 11.7 | 2.0 | 27.9 | 9.8 | 0.4 | 53.8 | 14.6 | 6.4 | 100 |
| Medical Physiology | 22.1 | 7.0 | 0.4 | 12.5 | 4.2 | 16.5 | 4.3 | 34.4 | 11.1 | 0.1 | 56.5 | 8.1 | 4.2 | 100 |
| Neurosciences | 24.9 | 6.6 | 2.0 | 15.9 | 4.1 | 19.6 | 5.4 | 40.9 | 14.0 | 0.3 | 47.1 | 14.3 | 1.6 | 100 |
| Dentistry | 8.4 | 2.3 | 0.0 | 2.5 | 0.0 | 2.5 | 0.4 | 11.5 | 0.8 | 0.2 | 72.8 | 13.0 | 3.3 | 100 |
| Clinical Sciences | 11.8 | 6.7 | 1.0 | 6.4 | 2.4 | 8.7 | 3.7 | 23.3 | 10.4 | 1.1 | 44.6 | 36.2 | 5.6 | 100 |
| Nursing | 0.8 | 0.2 | 0.2 | 0.2 | 0.0 | 0.2 | 0.4 | 1.8 | 1.0 | 0.0 | 85.8 | 25.4 | 10.0 | 100 |
| Public Health & Hlth Services | 5.9 | 4.3 | 1.3 | 1.9 | 1.2 | 2.9 | 2.1 | 12.9 | 5.6 | 0.3 | 68.0 | 16.1 | 15.2 | 100 |
| Human Movt & Sports Sci | 5.9 | 0.7 | 0.0 | 4.0 | 0.0 | 4.0 | 1.7 | 9.7 | 7.2 | 0.0 | 70.0 | 17.8 | 14.6 | 100 |
| Other Medical & Health Sci | 11.0 | 5.3 | 0.7 | 4.6 | 0.7 | 5.3 | 5.3 | 23.1 | 10.0 | 0.4 | 40.6 | 42.3 | 4.3 | 100 |
| General Medicine Sci | 19.1 | 14.4 | 0.8 | 11.2 | 5.8 | 16.6 | 6.0 | 40.4 | 21.0 | 4.2 | 36.0 | 17.7 | 2.9 | 100 |
| Multi-disciplinary Sci | 6.9 | 7.2 | 0.1 | 4.7 | 4.8 | 9.1 | 2.1 | 15.7 | 6.2 | 1.5 | 65.0 | 4.8 | 9.6 | 100 |
| TOTAL (Biomed only) | 13.4 | 7.2 | 0.9 | 7.6 | 3.0 | 10.4 | 3.7 | 25.4 | 11.3 | 1.3 | 49.9 | 22.9 | 6.1 | 100 |

The centrality of NHMRC to the Australian biomedical research effort, particularly in those sub-fields at the basic end of the research spectrum, is highlighted in Table 4. Over one-third of Australia's output in biochemistry and cell biology, immunology, medical physiology, and neurosciences can be linked to NHMRC research grants schemes. The Other University sector is a significant site of medical research in all sub-fields, but is particularly important for research in microbiology, dentistry, nursing, public health and health services research, and human movement and sports science, accounting for two-thirds or more of the output for these disciplines. The research institutes have their strongest presence in immunology and biochemistry and cell biology, while for the Other Hospital sectors it is clinical sciences, nursing, and other medical and health sciences. The Other Government sector is most prominent in public health and health services research, and in human movement and sports science.

2.4 Citation performance

The overall citation performance for each sector is shown in Table 5 and Figure 2. As noted above, the analyses for the Other University and Government publications are restricted to the biomedical subfields, which account for less than half their total output. The Australian data is calculated with a similar restriction. For all other sectors, and for each of the NHMRC schemes, all publications are included, irrespective of the subfield. For these sectors, biomedical subfields account for over 90% of their total output.

Table 5: Citations per publication—all publications

| Sector | Pubs ¹ | Cites ¹ | cpp |
|---------------------------|-------------------|--------------------|-------------|
| NHMRC - Institute Fellows | 1347 | 18146 | 13.47 |
| NHMRC - Block-funded | 3330 | 37265 | 11.19 |
| NHMRC - All Fellows | 4740 | 49890 | 10.53 |
| NHMRC - Project Fellows | 3485 | 33073 | 9.49 |
| NHMRC | 11636 | 109843 | 9.44 |
| NHMRC - Programs | 1670 | 15602 | 9.34 |
| Research Institutes | 5154 | 47496 | 9.22 |
| NHMRC - Projects | 6046 | 53724 | 8.89 |
| NHMRC - Units | 443 | 3262 | 7.36 |
| CRCs | 639 | 4520 | 7.07 |
| Other University | 21249 | 111515 | 5.25 |
| Other Hospital | 10140 | 50463 | 4.98 |
| Other Government | 2620 | 10825 | 4.13 |
| Australia | 42621 | 281459 | 6.60 |

¹ Where authors from more than one sector collaborate on a publication, it is counted in full for each sector. This results in double-counting, and totals (Australia and NHMRC) will be less than the sum of component sectors.

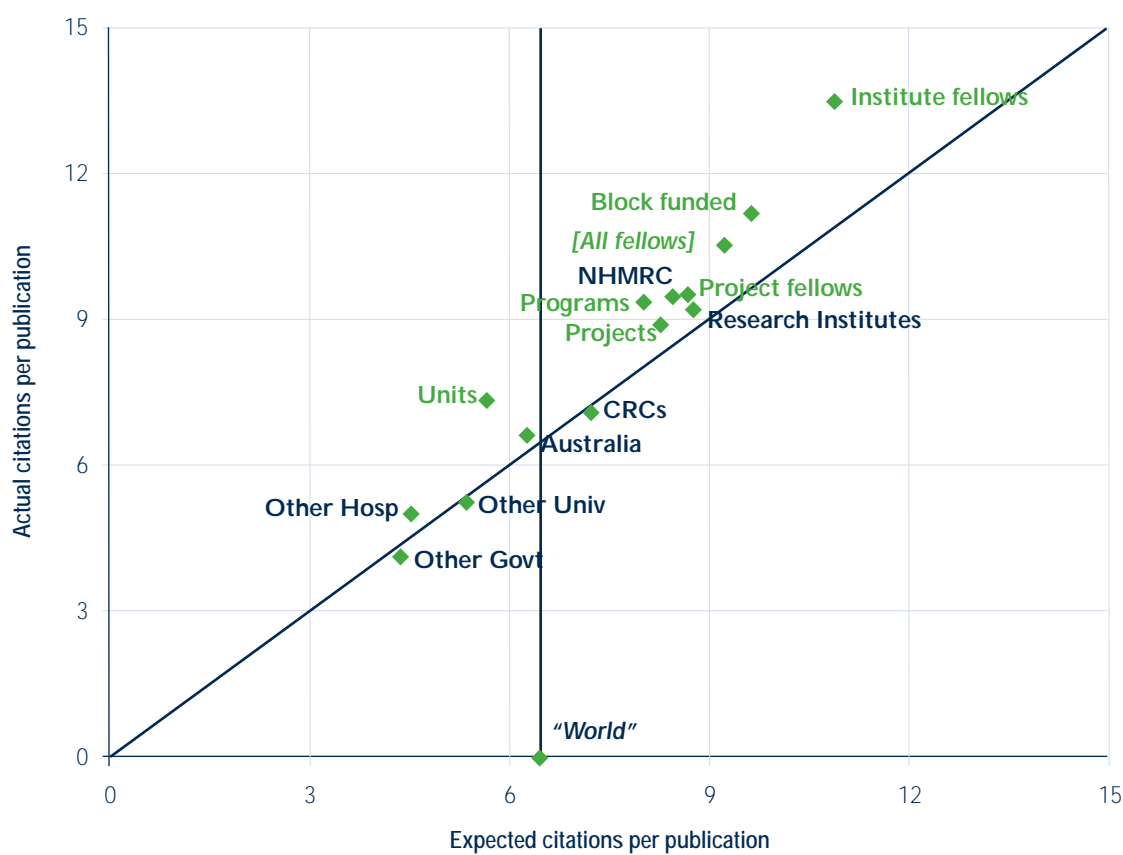
Figure 2: Actual and expected citation rates—all publications

Table 5 and Figure 2: Actual and expected citation rates—all publications highlight the high impact of the publications authored by the 'Institute fellows' – NHMRC fellows located in the Block-funded institutes. They account for 40% of the Block-funded sector's publications. The relative performance of the sectors and the individual NHMRC funding schemes is similar to that identified in the 2001 and 2003 studies conducted for the NHMRC.

To a certain extent, the relative position of the various sectors and schemes in Figure 2 is governed by the orientation of their research – fundamental basic research, such as in immunology, is more highly cited than more applied clinical research. This will become apparent from the detailed analyses contained in Section 3 of this report. However, even allowing for the differences in research orientation between sectors, the performance of NHMRC funded research is notable.

3 SELECTED CHARACTERISTICS AND PERFORMANCE OF NHMRC SCHEMES

An analysis of the performance of two NHMRC Projects Grants Scheme based on selected characteristics is presented in this section. By linking publications back to the grants that funded the research effort, these publications can be analysed on the basis of characteristics attached to the originating grants. These include the broad field of research and detailed disciplines classification of Project Grants, and the gender of fellows.

3.1 Project Grants - Broad research area

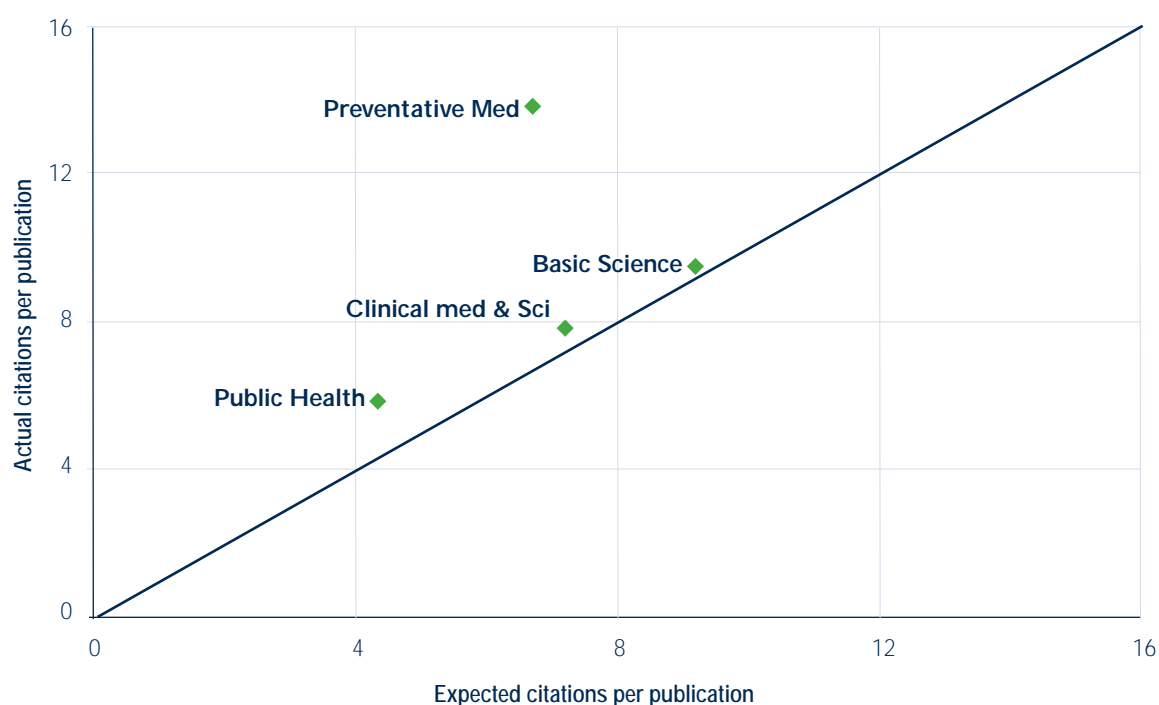
NHMRC Project Grants are classified to one of five broad areas of research (category a codes). Likewise, the publications linked to these grants can be classified in the same way. The distribution of grants to which publications are linked across these five areas is given in Table 6.

Table 6: Broad area of research for Project Grants linked to publications

| Broad Area of Research | Linked grants | | Number of Publications |
|-------------------------------|---------------|----|------------------------|
| | Number | % | |
| Basic science | 1173 | 63 | 4129 |
| Clinical medicine and science | 519 | 28 | 1629 |
| Preventative medicine | 40 | 2 | 156 |
| Health services research | 33 | 2 | 81 |
| Public health | 101 | 5 | 296 |

For this five year period, grants classified to preventative medicine resulted in a surprisingly high number of publications – nearly four per grant compared to just over three in the preceding study, and higher than grants classified to basic science.

Figure 3: Actual and expected citation rates—Project Grants broad area of research



The proportion of total output covered by ISI from all broad areas other than basic science is likely to be quite low. That said, Figure 3 shows that all areas exhibit a strong citation performance, with preventative medicine the stand out. While all areas achieve above expected citation levels for their set of journals, its rate is more than double the expected, and is also further along the x-axis than expected for more applied research.

3.2 Project Grants - Disciplines

Most Project Grants are also classified to one of forty-one research disciplines. The distribution of grants across these disciplines is given in Table 7.

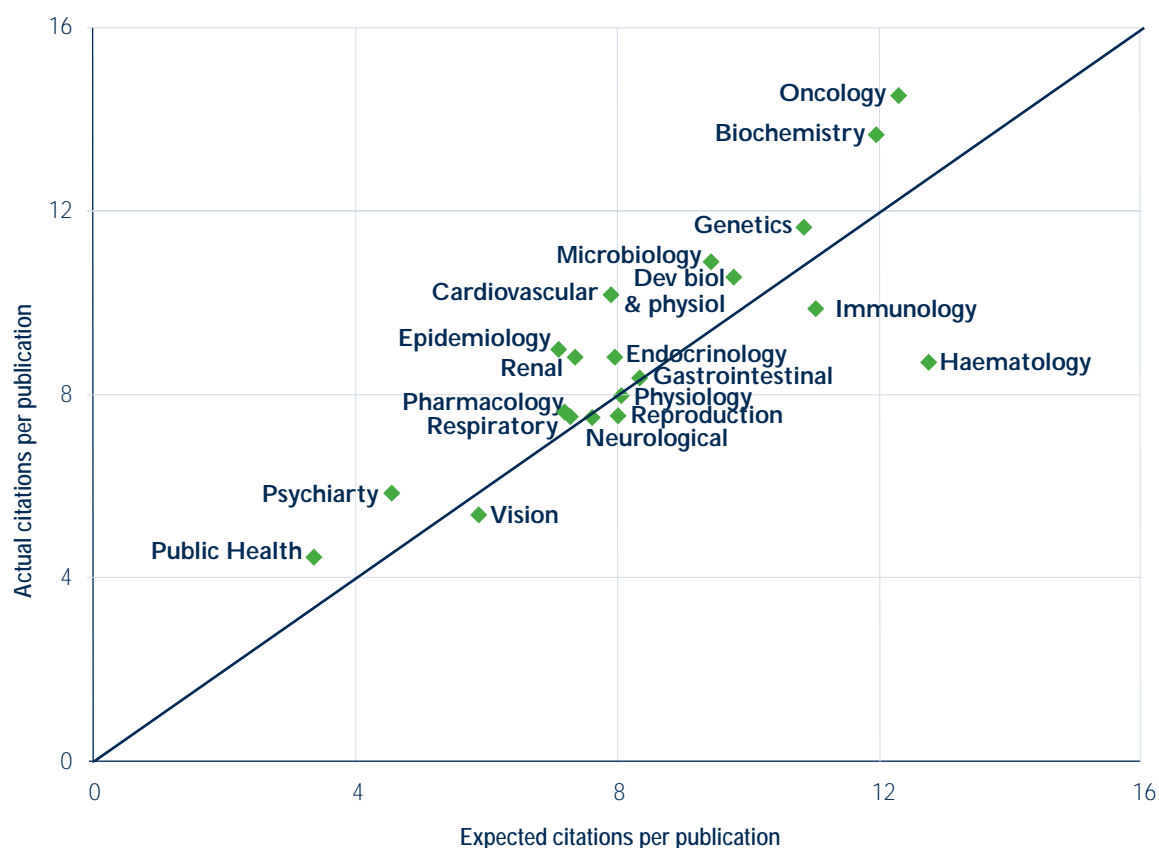
Table 7: Discipline classification of grants linked to publications

| Discipline | Linked Grants | | Number of Publications |
|---|---------------|------|------------------------|
| | Number | % | |
| Developmental biology and physiology | 59 | 3.2 | 231 |
| Nursing | 3 | 0.2 | 5 |
| Anaesthetics and intensive care | 11 | 0.6 | 28 |
| Biochemistry and clinical chemistry | 137 | 7.3 | 496 |
| Biomedical engineering and biophysics | 3 | 0.2 | 18 |
| Biostatistics | 3 | 0.2 | 3 |
| Cardiovascular diseases and sciences | 95 | 5.1 | 356 |
| Community Health | 9 | 0.5 | 13 |
| Dentistry and oral surgery | 17 | 0.9 | 59 |
| Dermatology | 4 | 0.2 | 9 |
| Endocrinology | 88 | 4.7 | 326 |
| Epidemiology | 52 | 2.8 | 173 |
| Gastrointestinal diseases and sciences | 46 | 2.5 | 204 |
| Gerontology and geriatrics | 12 | 0.6 | 47 |
| Gynaecology and obstetrics | 24 | 1.3 | 98 |
| Haematology | 43 | 2.3 | 127 |
| Hepatology | 11 | 0.6 | 34 |
| Immunology | 151 | 8.1 | 533 |
| Microbiology, Parasitology, Virology | 132 | 7.1 | 437 |
| Morphology | 1 | 0.1 | 2 |
| Neurological diseases and neurosciences | 221 | 11.8 | 851 |
| Nutrition | 12 | 0.6 | 35 |
| Oncology and carcinogenesis | 93 | 5.0 | 262 |
| Orthopaedics | 20 | 1.1 | 58 |
| Otorhinolaryngology | 5 | 0.3 | 23 |
| Paediatrics | 24 | 1.3 | 66 |
| Pathology | 8 | 0.4 | 41 |
| Pharmacology | 85 | 4.6 | 313 |
| Physiology | 81 | 4.3 | 332 |
| Psychiatry and psychology | 81 | 4.3 | 224 |
| Radiology and organ imaging | 4 | 0.2 | 10 |
| Renal diseases and sciences | 33 | 1.8 | 105 |

| Discipline | Linked Grants | | Number of Publications |
|-----------------------------------|---------------|-----|------------------------|
| | Number | % | |
| Reproduction | 22 | 1.2 | 103 |
| Respiratory diseases and sciences | 52 | 2.8 | 156 |
| Rheumatology | 20 | 1.1 | 79 |
| Surgery | 13 | 0.7 | 50 |
| Toxicology | 1 | 0.1 | 8 |
| Vision and ophthalmology | 29 | 1.6 | 145 |
| Nuclear Medicine | 2 | 0.1 | 2 |
| Genetics | 91 | 4.9 | 330 |
| Public health | 39 | 2.1 | 109 |
| Health economics | 4 | 0.2 | 4 |
| Miscellaneous | 25 | 1.3 | 71 |

Figure 4 presents an analysis of actual and expected citations for the NHMRC disciplines. It is important to note that, as with the broad fields of research in the previous section, this analysis is not based on journal sets, but rather uses the researchers' own classification of their work for each grant. Consequently, publications are classified to the code relating to the grant with which they are associated, irrespective of the journal in which they appear. This is most important in relation to papers appearing in high impact journals such as Nature.

Figure 4: Actual and expected citation rates—Project Grants disciplines



The grants exhibiting the strongest citation performance through 1999 to 2003, attracting at least 20 percent more citations than expected for their journal set, were those classified to: cardiovascular diseases and sciences; epidemiology; psychiatry and psychology; renal diseases and sciences; and public health. Immunology fell over 10 percent short of its expected level of citations, and haematology was significantly lower still (over 30 percent below the diagonal).

This is only a partial view of the citation performance of the different publication sets as it is difficult to gauge whether they are appearing in relatively high or low impact journals for their discipline due to the inclusion of multidisciplinary journals in the analysis. For this reason, the position of disciplines along the x-axis is not necessarily significant, though it does generally reflect the level of focus of research. More applied research appears in journals with a lower average impact than disciplines with a basic research focus.

3.3 Fellowships – Gender

A citation analysis was undertaken for fellowship grants, disaggregated to type of fellowship (Project or Institute) and gender. The result is shown in Figure 5.

Figure 5: Actual and expected citation rates—Fellowships by gender



There was a noticeable difference in citation performance between male and female Institute Fellows, though both cohorts demonstrated exceptionally strong citation impact. In the last analysis there was little to distinguish between the sexes for Institute Fellows, though Project Fellows in that instance recorded differential performance. In order to examine this further, I investigated the distribution of output across RFCD subfields, as detailed in Table 8.

Table 8: RFCD fields and subfields of publications linked to fellowships, by gender

| RFCD Fields/Subfields | cpp | Institute Fellows | | Project Fellows | |
|--------------------------------------|------|-------------------|-----|-----------------|-----|
| | | F | M | F | M |
| Biological Sciences | | | | | |
| Biochemistry & Cell Biology | 8.79 | 20 | 27 | 19 | 27 |
| Genetics | 9.37 | 5 | 9 | 2 | 4 |
| Microbiology | 5.63 | 2 | 1 | 0 | 1 |
| Biotechnology | 5.12 | 2 | 4 | 2 | 2 |
| Medical & Health Sciences | | | | | |
| Immunology | 7.61 | 15 | 15 | 8 | 10 |
| Clinical Chemistry | 4.11 | 0 | 0 | 0 | 1 |
| Pharmacology & Pharmaceutical Sci | 4.60 | 5 | 5 | 8 | 8 |
| Medical Physiology | 5.64 | 8 | 7 | 9 | 8 |
| Neurosciences | 6.98 | 3 | 11 | 19 | 14 |
| Dentistry | 2.33 | 0 | 0 | 0 | 0 |
| Clinical Sciences | 5.38 | 52 | 35 | 51 | 38 |
| Public Health & Health Services | 1.46 | 4 | 3 | 2 | 2 |
| Human Movement & Sports Sci | 3.72 | 0 | 0 | 0 | 1 |
| Other Medical & Health Sciences | 3.57 | 0 | 0 | 0 | 0 |
| General Medicine Sciences | 6.52 | 6 | 7 | 3 | 5 |
| Multi-disciplinary Sciences | | | | | |
| All Publications | 6.47 | 100 | 100 | 100 | 100 |

What is noticeable from Table 8 is that in both cohorts (Institute and Project Fellows), the output of female researchers is more heavily concentrated in medical and health sciences, and particularly in clinical sciences. Correspondingly, there is much lower output in the high impact subfields of the biological sciences – biochemistry and cell biology, and genetics. This may explain part of the differences seen in Figure 5, but is unlikely to provide all the answers. It may well be worth investigating these differences in more detail, as a number of other factors may be at play.

4 RFCD FIELDS AND SUB-FIELDS OF RESEARCH

Analyses detailing citation per publication rates, actual and expected citation rates, and highly cited Australian publications are presented in this section for all fields and sub-fields of the RFCD for which there are at least 100 publications linked to NHMRC support.

The fields covered in this section are constructed using journal sets, that is, publications are classified to a field or sub-field on the basis of the journal in which they are published. Details of the relevant translation of ISI journal sets into the fields and sub-fields of the RFCD is given at the start of each section.

4.1 Sub-Field: Biochemistry and cell biology

Field: Biological Sciences

ISI journal set analysed: Biochemistry and molecular biology; Cell biology.

Table 9: Citations per publication—Biochemistry and cell biology

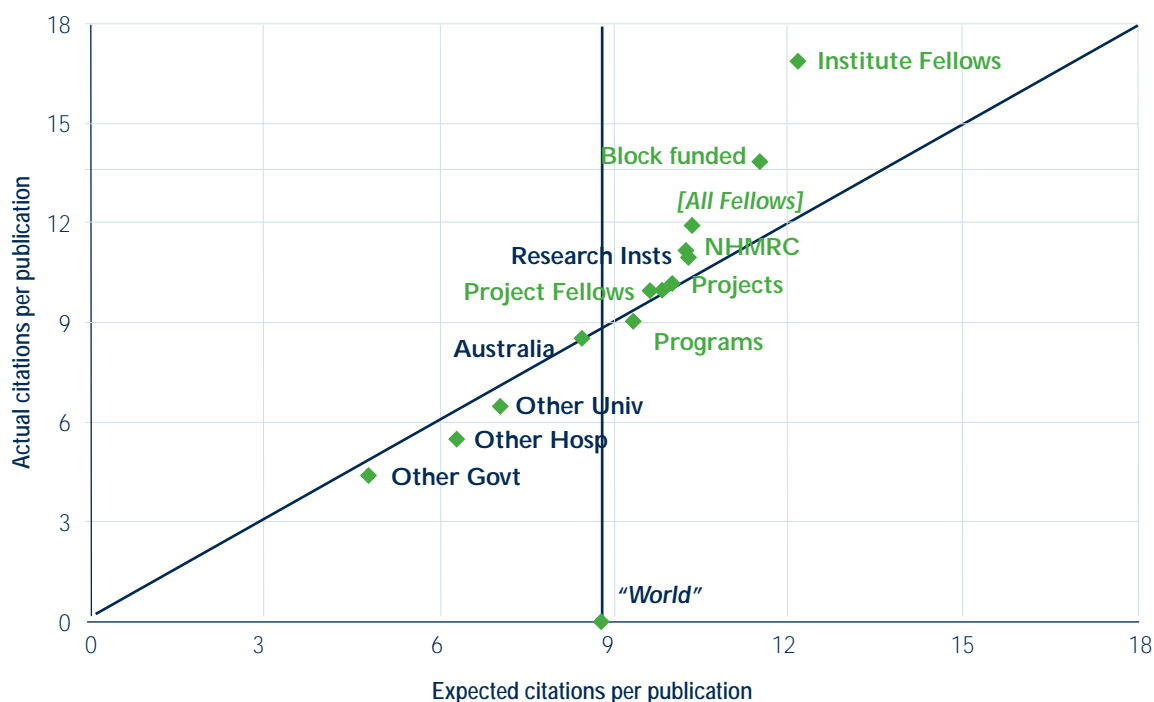
| Sector | Cites | Pubs | cpp |
|---------------------------|--------------|-------------|--------------|
| NHMRC - Institute Fellows | 6024 | 357 | 16.87 |
| NHMRC - Block-funded | 10842 | 782 | 13.86 |
| NHMRC - All Fellows | 14438 | 1209 | 11.94 |
| NHMRC | 29287 | 2634 | 11.12 |
| Research Institutes | 15128 | 1378 | 10.98 |
| NHMRC - Projects | 15057 | 1477 | 10.19 |
| NHMRC - Project Fellows | 8741 | 875 | 9.99 |
| CRCs | 1664 | 167 | 9.96 |
| NHMRC - Programs | 2995 | 330 | 9.08 |
| Other University | 21001 | 3230 | 6.50 |
| Other Hospital | 2358 | 428 | 5.51 |
| Other Government | 1028 | 232 | 4.43 |
| Australia | 60708 | 7130 | 8.51 |

Table 10: Most highly cited Australian publications—Biochemistry and cell biology

- Top 1% = 72 cites (70 pubs)
- Top 5% = 32 cites (354 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|---------------------------|----------------|-----------------|-----------------|
| NHMRC - Institute Fellows | 357 | 5 | 10 |
| NHMRC - Block-funded | 782 | 3 | 10 |
| NHMRC - All Fellows | 1209 | 2 | 8 |
| Research Institutes | 1378 | 2 | 8 |
| NHMRC | 2634 | 2 | 7 |
| NHMRC - Projects | 1477 | 1 | 7 |
| NHMRC - Project Fellows | 875 | 1 | 7 |
| NHMRC - Programs | 330 | 1 | 6 |
| CRCs | 167 | 2 | 4 |
| Other University | 3230 | 0 | 3 |
| Other Hospital | 428 | 0 | 2 |
| Other Government | 232 | 0 | 1 |

Figure 6: Actual and expected citation rates—Biochemistry and cell biology



Comments:

Over one third of all Australian publications classified to biochemistry and cell biology resulted from research funded, at least in part, by the NHMRC.

Australia’s relatively weak citation performance in this sub-field has been well-documented, though there has been some improvement since our last analysis. While achieving the expected level of citations for the journals in which they appear, Australian research is appearing in a relatively low impact set of journals. In contrast, NHMRC research is appearing in journals with a higher impact than the full journal set for the sub-field, and achieves higher than the expected level of citations for these journals. This is a noticeable improvement on the performance achieved for publications analysed in REPP’s previous study (for articles published between 1996 and 2000).

The performance of the Institute fellows is particularly noteworthy; with a citations per publication rate almost double the world average. This sector is publishing in very high impact journals and achieving well above its expected citation rate. Their position in Table 10, where they are responsible for five times the number of discipline’s most highly cited publications than expected given their size, reflects this strong citation performance. The Block-funded sector is also well represented in the highly cited publications and is performing above the expected citation rate, primarily due to publications from the Institute fellows, most of which are also classified to the Block-funded sector.

The Project Grants, Project Fellows, Research Institutes and CRC sectors also perform strongly in this discipline.

4.2 Sub-Field: Genetics

Field: Biological Sciences

ISI journal set analysed: Genetics and heredity.

Table 11: Citations per publication—Genetics

| Sector | Cites | Pubs | cpp |
|---------------------------|--------------|-------------|--------------|
| NHMRC - Institute Fellows | 1436 | 109 | 13.17 |
| NHMRC - Projects | 3430 | 264 | 12.99 |
| NHMRC - All Fellows | 2839 | 238 | 11.93 |
| NHMRC - Block-funded | 3410 | 289 | 11.80 |
| NHMRC | 7207 | 650 | 11.09 |
| NHMRC - Project Fellows | 1426 | 134 | 10.64 |
| Research Institutes | 2603 | 246 | 10.58 |
| NHMRC - Programs | 1294 | 147 | 8.80 |
| Other University | 6399 | 992 | 6.45 |
| Other Hospital | 1667 | 260 | 6.41 |
| Other Government | 445 | 110 | 4.05 |
| Australia | 17072 | 2063 | 8.28 |

Figure 7: Actual and expected citation rates—Genetics

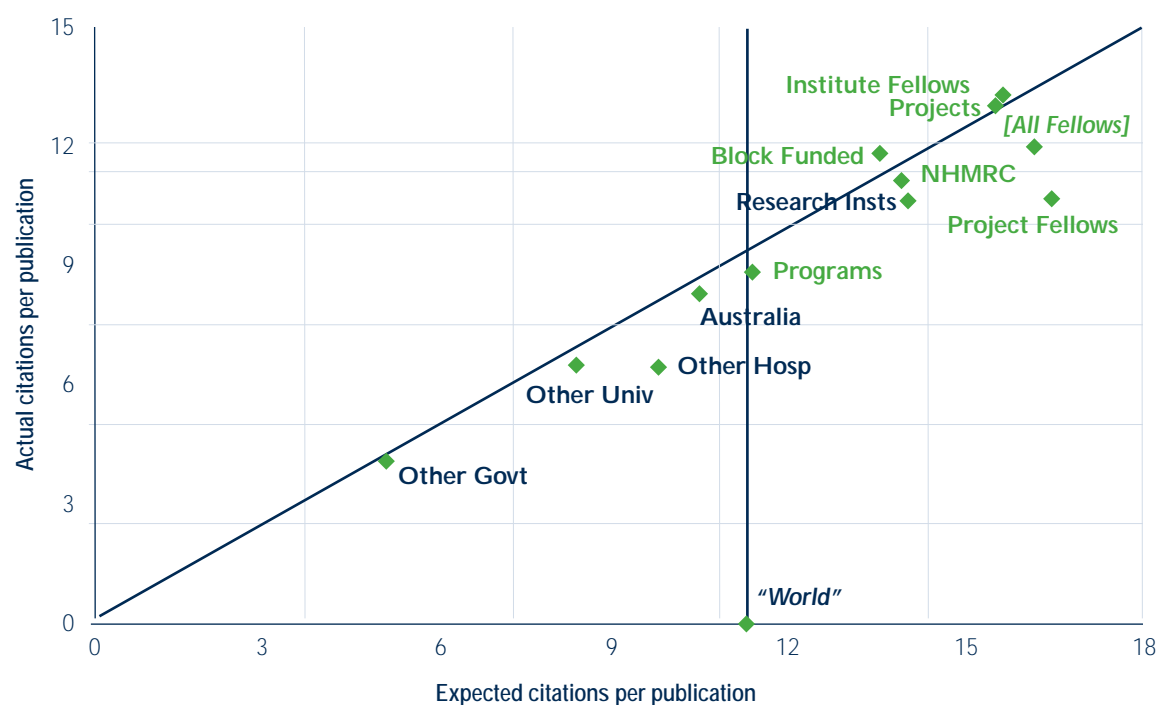


Table 12: Most highly cited Australian publications—Genetics

- Top 1% = 76 cites (20 pubs)
- Top 5% = 32 cites (101 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|---------------------------|----------------|-----------------|-----------------|
| NHMRC - Institute Fellows | 109 | 2 | 12 |
| NHMRC - Projects | 264 | 3 | 9 |
| NHMRC - All Fellows | 238 | 2 | 8 |
| NHMRC - Block-funded | 289 | 2 | 8 |
| NHMRC | 650 | 2 | 7 |
| Research Institutes | 246 | 2 | 7 |
| NHMRC - Programs | 147 | 1 | 6 |
| NHMRC - Project Fellows | 134 | 1 | 4 |
| Other Hospital | 260 | 0 | 3 |
| Other University | 992 | 1 | 3 |

Comments:

Genetics is one sub-field of biological sciences in which Australia's citation rate still falls noticeably below the world average. The citation performance of NHMRC-funded publications is in stark contrast to the Australian position.

The centrality of NHMRC to research in this sub-field is demonstrated by the fact that half of the most highly cited Australian publications (10 of the 20 top 1%) are linked to its support. The Institute fellows and Projects sectors have particularly strong impact in genetics, with their publications appearing in high impact journals and achieving close to the expected level of citations for these journals. Both sectors, together with the Block-funded sector, had a strong presence in the most highly cited list of publications.

Genetics publications linked to Project Fellows appeared in very high impact journals, but their actual citation rate fell well below the expected level, though still above the world benchmark.

It should be noted that the performance of three sectors was based on less than 200 publications – Programs (147), Project Fellows (134) and Institute fellows (109) and this should be taken into account when interpreting the performance of these sectors.

4.3 Sub-Field: Microbiology

Field: *Biological Sciences*

ISI journal set analysed: Microbiology.

Table 13: Citations per publication—Microbiology

| Sector | Cites | Pubs | cpp |
|------------------|--------------|-------------|-------------|
| NHMRC - Projects | 998 | 123 | 8.11 |
| NHMRC | 1546 | 194 | 7.97 |
| Other Hospital | 1695 | 278 | 6.10 |
| Other University | 6626 | 1193 | 5.55 |
| Other Government | 1135 | 212 | 5.35 |
| Australia | 10470 | 1801 | 5.81 |

Figure 8: Actual and expected citation rates—Microbiology

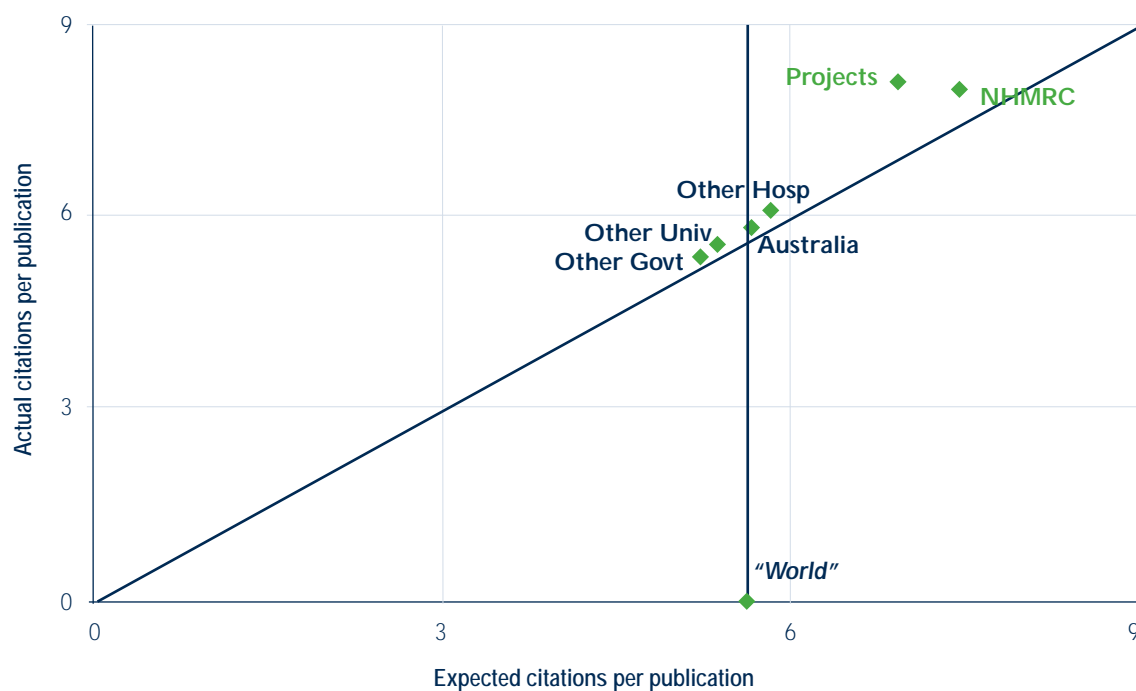


Table 14: Most highly cited Australian publications—Microbiology

- Top 1% = 45 cites (19 pubs)
- Top 5% = 22 cites (90 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|------------------|----------------|-----------------|-----------------|
| NHMRC | 194 | 2 | 9 |
| NHMRC - Projects | 123 | 2 | 9 |
| Other Hospital | 278 | 1 | 6 |
| Other Government | 212 | 0 | 4 |
| Other University | 1193 | 1 | 4 |

Comments:

Few sectors are above the 100 publications threshold for this subfield, but it can be clearly seen that in this set of journals the NHMRC performance is well in excess of both the Australian and world averages, which are at an almost identical level.

Since only 11% of Australian publications in this sub-field come from NHMRC sectors they have only a small influence on the overall Australian performance, which is driven largely by the Other University sector which accounts for nearly two-thirds of Australia’s microbiology publications.

The Project Grants scheme accounts for 63% of the NHMRC publications in microbiology. Although only accounting for a modest proportion of the total Australian output, a quarter of the top 5% of highly cited publications are linked to NHMRC funding.

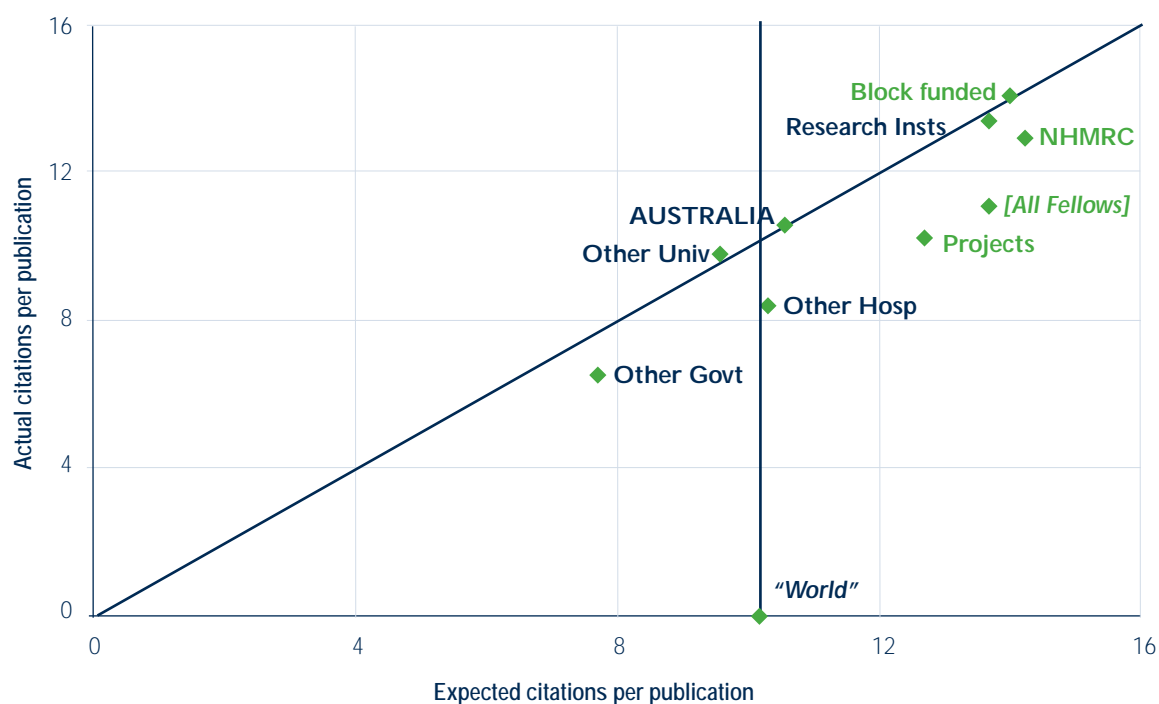
4.4 Sub-Field: Biotechnology

Field: Biological Sciences

ISI journal sets analysed: Biotechnology and applied microbiology; Biochemical research methods.

Table 15: Citations per publication—Biotechnology

| Sector | Cites | Pubs | c/p |
|----------------------|--------------|-------------|-------------|
| NHMRC - Block-funded | 879 | 125 | 7.03 |
| Research Institutes | 1268 | 190 | 6.67 |
| NHMRC | 2489 | 386 | 6.45 |
| NHMRC - All Fellows | 664 | 120 | 5.53 |
| NHMRC - Projects | 1043 | 204 | 5.11 |
| Other University | 6564 | 1342 | 4.89 |
| Other Hospital | 519 | 124 | 4.19 |
| Other Government | 634 | 194 | 3.27 |
| Australia | 11911 | 2263 | 5.26 |

Figure 9: Actual and expected citation rates—Biotechnology

Table 16: Most highly cited Australian publications—Biotechnology

- Top 1% = 51 cites (23 pubs)
- Top 5% = 20 cites (115 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|----------------------|----------------|-----------------|-----------------|
| NHMRC - Block-funded | 125 | 2 | 8 |
| Research Institutes | 190 | 2 | 8 |
| NHMRC | 386 | 1 | 7 |
| NHMRC - Projects | 204 | 0 | 5 |
| Other University | 1342 | 1 | 4 |
| NHMRC - All Fellows | 120 | 2 | 3 |
| Other Hospital | 124 | 2 | 3 |
| Other Government | 194 | 1 | 2 |

Comments:

The citation performance of NHMRC publications in biotechnology encompasses a number of interesting aspects. In aggregate, its citation rate is well above the world average, but falls below the level expected for its journals. When drilled down to the individual funding schemes, there are quite varying performances. The Block-funded, Project and Fellows sectors all publish in similarly high impact journal sets, but whereas the Block-funded publications achieve their citation targets, those from the other two sectors fall well below expected levels.

The highly cited publications, particularly the 5% band, are more evenly distributed between the sectors than in many other disciplines.

4.5 Field: Medical and Health Sciences

ISI journal sets analysed: Journals from all subject categories listed in the sections 4.6 to 4.12 plus those in the following additional categories not analysed separately – Chemistry, medicinal; Dentistry, oral surgery and medicine; Nursing; Sports sciences; Medical laboratory technology.

Table 17: Citations per publication—Medical and Health Sciences

| Sector | Cites | Pubs | cpp |
|---------------------------|---------------|--------------|-------------|
| NHMRC - Institute Fellows | 9158 | 912 | 10.04 |
| NHMRC - Block-funded | 21083 | 2227 | 9.47 |
| NHMRC - All Fellows | 31027 | 3391 | 9.15 |
| NHMRC - Programs | 10971 | 1213 | 9.04 |
| NHMRC - Project Fellows | 22616 | 2538 | 8.91 |
| NHMRC | 71251 | 8414 | 8.47 |
| Research Institutes | 30372 | 3677 | 8.26 |
| NHMRC - Projects | 35362 | 4458 | 7.93 |
| NHMRC - Units | 2711 | 364 | 7.45 |
| CRCs | 2324 | 414 | 5.61 |
| Other Hospital | 45929 | 9291 | 4.94 |
| Other University | 75817 | 16022 | 4.73 |
| Other Government | 7439 | 1992 | 3.73 |
| Australia | 193262 | 33303 | 5.80 |

Figure 10: Actual and expected citation rates—Medical and Health Sciences

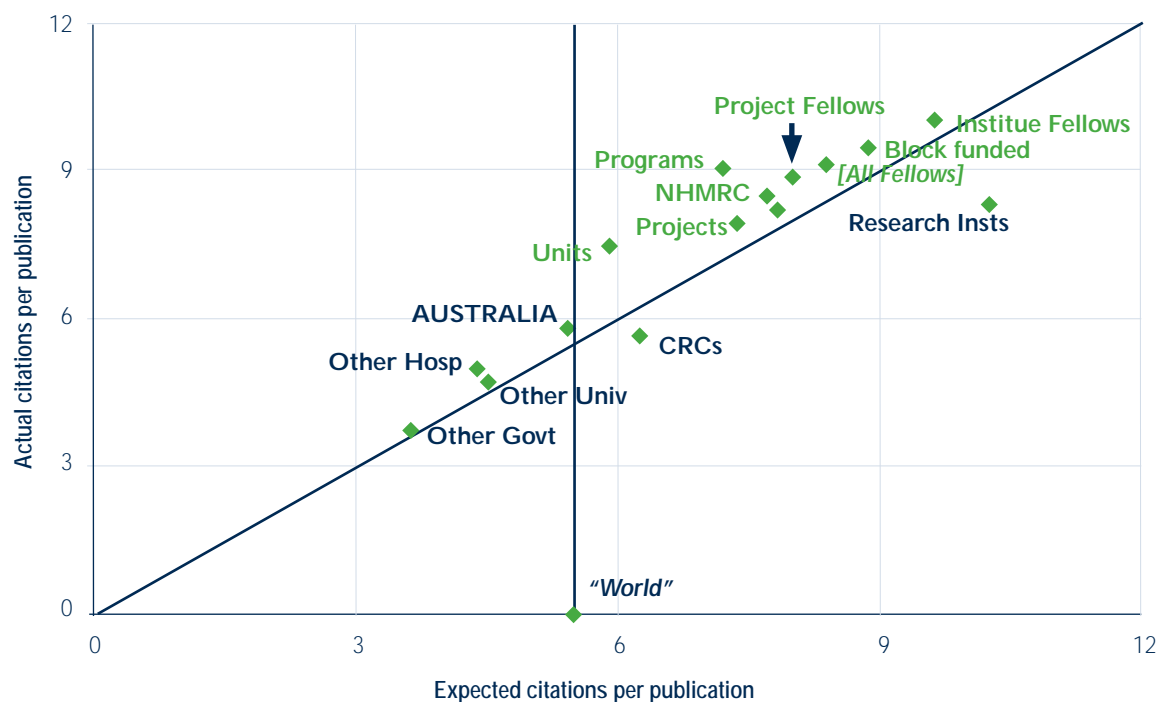


Table 18: Most highly cited Australian publications—Medical and Health Sciences

- Top 1% = 53 cites (338 pubs)
- Top 5% = 23 cites (1647 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|---------------------------|----------------|-----------------|-----------------|
| NHMRC - Institute Fellows | 912 | 3 | 12 |
| NHMRC - Block-funded | 2227 | 2 | 11 |
| NHMRC - All Fellows | 3391 | 2 | 10 |
| NHMRC - Project Fellows | 2538 | 2 | 10 |
| NHMRC | 8414 | 2 | 9 |
| Research Institutes | 3677 | 2 | 9 |
| NHMRC - Projects | 4458 | 1 | 8 |
| NHMRC - Programs | 1213 | 2 | 8 |
| NHMRC - Units | 364 | 2 | 7 |
| CRCs | 414 | 1 | 5 |
| Other Hospital | 9291 | 1 | 4 |
| Other University | 16022 | 1 | 3 |
| Other Government | 1992 | 0 | 2 |

Comments:

As medical and health sciences account for between 64% and 91% of the total output of each sector, it is perhaps surprising that, for a few sectors, there are discernable differences between the citation performance in this field and in aggregate. Specifically, while the Block-funded and Institute fellows sectors are publishing in high impact journals, their actual citations mirror expected rates. In contrast, their aggregate citation rates are well above the diagonal line. This is primarily due to the strength of their performance in the high impact multidisciplinary journals (see section 4.13).

Again we see the publications of all NHMRC sectors except units appearing in high impact journals. All NHMRC sectors achieve above the expected citation level for their journal set –Programs and Units by a sizeable margin. The position of the Units sector along the x-axis (expected citations per publication) is to a large extent explained by its strong focus on clinical medicine, and having only one publication in the high impact field of immunology, in contrast to a figure of 14% for total NHMRC output.

While accounting for 25% of Australia’s output in the field, NHMRC funding schemes are linked to 41% of the most highly cited publications. The Research Institutes also have a strong citation performance and presence in the most highly cited set of publications.

4.6 Sub-Field: Immunology

Field: Medical and Health Sciences

ISI journal sets analysed: Immunology; Allergy.

Table 19: Citations per publication—Immunology

| Sector | Cites | Pubs | c/p |
|---------------------------|--------------|-------------|--------------|
| NHMRC - Institute Fellows | 2764 | 189 | 14.62 |
| NHMRC - Block-funded | 5560 | 417 | 13.33 |
| NHMRC - All Fellows | 6662 | 512 | 13.01 |
| NHMRC - Project Fellows | 4083 | 337 | 12.12 |
| NHMRC | 13591 | 1200 | 11.33 |
| NHMRC - Programs | 1807 | 169 | 10.69 |
| Research Institutes | 7221 | 681 | 10.60 |
| NHMRC - Projects | 5548 | 604 | 9.19 |
| CRCs | 1319 | 173 | 7.62 |
| Other Hospital | 3833 | 530 | 7.23 |
| Other University | 5375 | 907 | 5.93 |
| Australia | 24536 | 2836 | 8.65 |

Figure 11: Actual and expected citation rates—Immunology



Table 20: Most highly cited Australian publications—Immunology

- Top 1% = 76 cites (28 pubs)
- Top 5% = 32 cites (144 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|---------------------------|----------------|-----------------|-----------------|
| NHMRC - Block-funded | 417 | 3 | 9 |
| NHMRC - Institute Fellows | 189 | 4 | 9 |
| NHMRC - All Fellows | 512 | 3 | 9 |
| NHMRC - Project Fellows | 337 | 2 | 9 |
| NHMRC - Programs | 169 | 3 | 8 |
| NHMRC | 1200 | 2 | 7 |
| Research Institutes | 681 | 1 | 7 |
| Other Hospital | 530 | 1 | 4 |
| NHMRC - Projects | 604 | 1 | 4 |
| Other University | 907 | 0 | 2 |
| CRCs | 173 | 1 | 2 |

Comments:

Over 40% of Australian immunology publications are linked to NHMRC funding schemes, as are three-quarters of all Australia's highly cited publications.

Sectoral performance in immunology is broadly similar to their performance in medical and health sciences as a whole. The outstanding feature in this sub-field is the performance of the Institute Fellows who are responsible for only 189 publications (or 7% of all Australian publications) yet account for more than one-quarter of all the most highly cited publications.

The data highlights the centrality of NHMRC support to immunology research in general, and particularly to high impact research in the discipline.

4.7 Sub-Field: Pharmacology and pharmaceutical science

Field: Medical and Health Sciences

ISI journal sets analysed: Pharmacology and pharmacy; Toxicology.

Table 21: Citations per publication—Pharmacology & pharmaceutical science

| Sector | Cites | Pubs | c/p |
|-------------------------|--------------|-------------|-------------|
| NHMRC - Projects | 2830 | 436 | 6.49 |
| NHMRC | 4681 | 769 | 6.09 |
| NHMRC - Block-funded | 774 | 130 | 5.95 |
| NHMRC - Project Fellows | 1491 | 261 | 5.71 |
| Research Institutes | 1516 | 269 | 5.64 |
| NHMRC - All Fellows | 1821 | 324 | 5.62 |
| Other University | 6188 | 1485 | 4.17 |
| Other Hospital | 1510 | 404 | 3.74 |
| Other Government | 535 | 176 | 3.04 |
| Australia | 13403 | 2758 | 4.86 |

Figure 12: Actual and expected citation rates—Pharmacology & pharmaceutical science

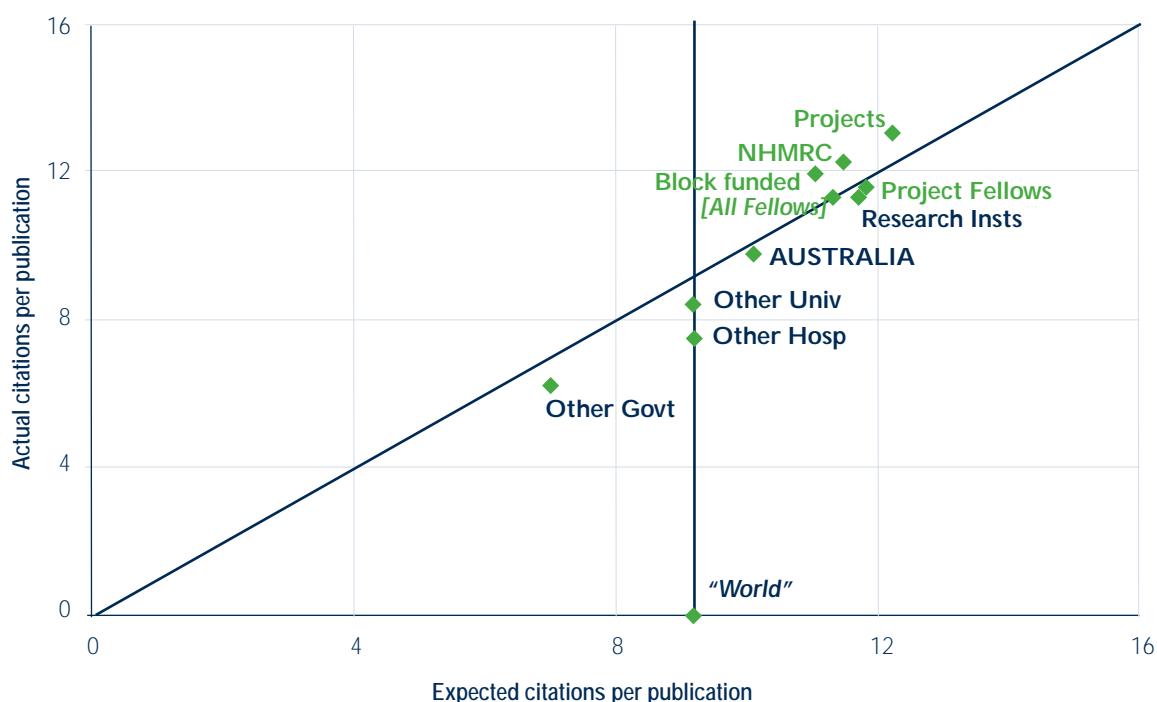


Table 22: Most highly cited Australian publications—Pharmacology & pharmaceutical science

- Top 1% = 39 cites (27 pubs)
- Top 5% = 19 cites (138 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|-------------------------|----------------|-----------------|-----------------|
| NHMRC - Block-funded | 130 | 0 | 9 |
| NHMRC - Projects | 436 | 1 | 8 |
| NHMRC | 769 | 1 | 7 |
| NHMRC - All Fellows | 324 | 1 | 7 |
| Research Institutes | 269 | 2 | 7 |
| NHMRC - Project Fellows | 261 | 2 | 7 |
| Other University | 1485 | 1 | 4 |
| Other Hospital | 404 | 0 | 2 |
| Other Government | 176 | 0 | 2 |

Comments:

Just over one-quarter of Australian publications in pharmacology and pharmaceutical science result from research funded by NHMRC. These publications are appearing in a high impact set of journals, and overall achieve close to the expected citation levels. Projects and Block-funded publications are performing slightly above the expected levels.

While the NHMRC accounts for nearly 40 percent of articles in the top 5% band, its presence in the top 1% set of highest impact publications is, in contrast to the overall field, relatively modest.

There is little to distinguish between the performance of most NHMRC sectors, with all having similar citation levels and appearing in journal sets with a similar average impact.

4.8 Sub-Field: Medical physiology

Field: *Medical and Health Sciences*

ISI journal sets analysed: Anatomy and morphology; Physiology.

Table 23: Citations per publication—Medical physiology

| Sector | Cites | Pubs | cpp |
|-------------------------|--------------|-------------|-------------|
| NHMRC - Project Fellows | 2127 | 280 | 7.60 |
| Research Institutes | 1791 | 247 | 7.25 |
| NHMRC - All Fellows | 2597 | 368 | 7.06 |
| NHMRC - Projects | 3436 | 493 | 6.97 |
| NHMRC | 5248 | 768 | 6.83 |
| NHMRC - Block-funded | 939 | 157 | 5.98 |
| Other Hospital | 825 | 181 | 4.56 |
| Other University | 5606 | 1263 | 4.44 |
| Australia | 12110 | 2234 | 5.42 |

Figure 13: Actual and expected citation rates—Medical physiology

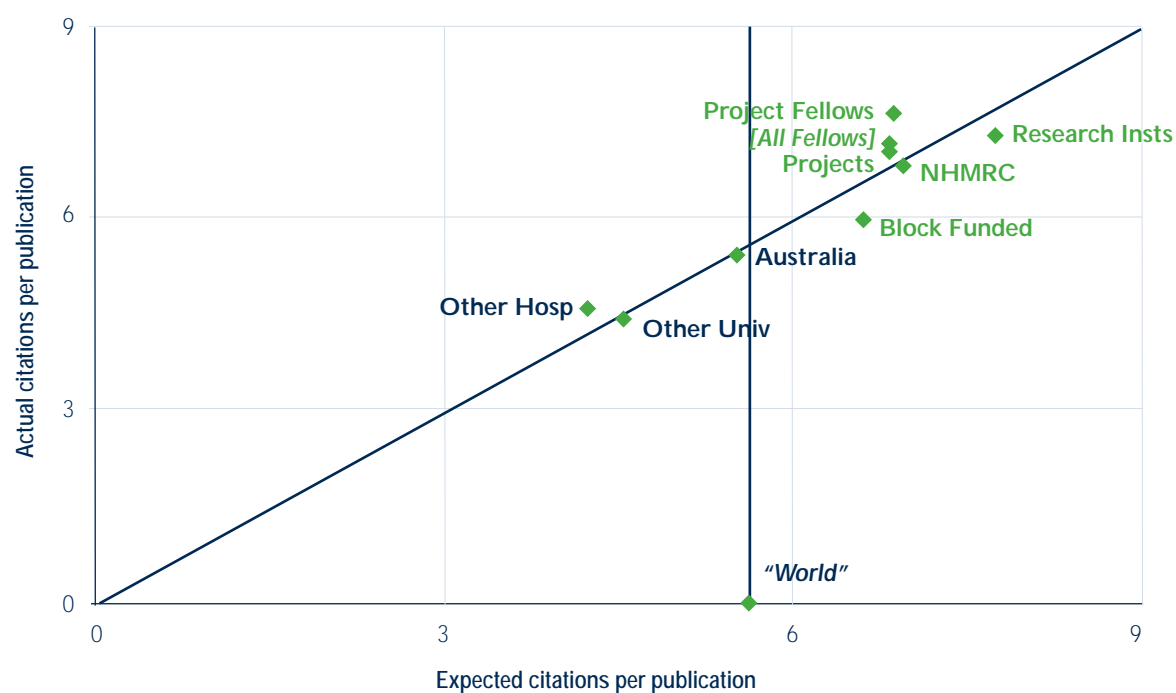


Table 24: Most highly cited Australian publications—Medical physiology

- Top 1% = 40 cites (21 pubs)
- Top 5% = 21 cites (108 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|-------------------------|----------------|-----------------|-----------------|
| NHMRC - Project Fellows | 280 | 2 | 9 |
| NHMRC - Projects | 493 | 1 | 8 |
| NHMRC - All Fellows | 368 | 2 | 7 |
| Research Institutes | 247 | 2 | 7 |
| NHMRC | 768 | 1 | 7 |
| NHMRC - Programs | 95 | 3 | 5 |
| NHMRC - Block-funded | 157 | 1 | 4 |
| Other Hospital | 181 | 1 | 4 |
| Other University | 1263 | 1 | 3 |

Comments:

The Medical Physiology sub-field as a whole has changed considerably since the last REPP report was carried out. There has been a significant improvement in the relative citation rate in the last five year period (from 3.69 in 1996-2000 to 6.83 for 1999-2003). As it accounts for one-third of Australian output, this increase is also reflected in the national rate.

Project Fellows are performing above the expected citation level, and accounted for almost 50% of the NHMRC most highly cited publications. In addition, NHMRC publications represent over 50% of all of Australia’s most highly cited publications.

4.9 Sub-Field: Neurosciences

Field: Medical and Health Sciences

ISI journal set analysed: Neurosciences.

Table 25: Citations per publication—Neurosciences

| Sector | Cites | Pubs | c/p |
|---------------------------|--------------|-------------|-------------|
| NHMRC - Institute Fellows | 1182 | 140 | 8.44 |
| Research Institutes | 3937 | 474 | 8.31 |
| NHMRC - Block-funded | 1738 | 225 | 7.72 |
| NHMRC - All Fellows | 4725 | 665 | 7.11 |
| NHMRC - Project Fellows | 3737 | 540 | 6.92 |
| Other Hospital | 3347 | 487 | 6.87 |
| NHMRC | 9444 | 1387 | 6.81 |
| NHMRC - Projects | 5621 | 844 | 6.66 |
| NHMRC - Programs | 1033 | 182 | 5.68 |
| Other University | 8387 | 1600 | 5.24 |
| Australia | 21374 | 3395 | 6.30 |

Figure 14: Actual and expected citation rates—Neurosciences

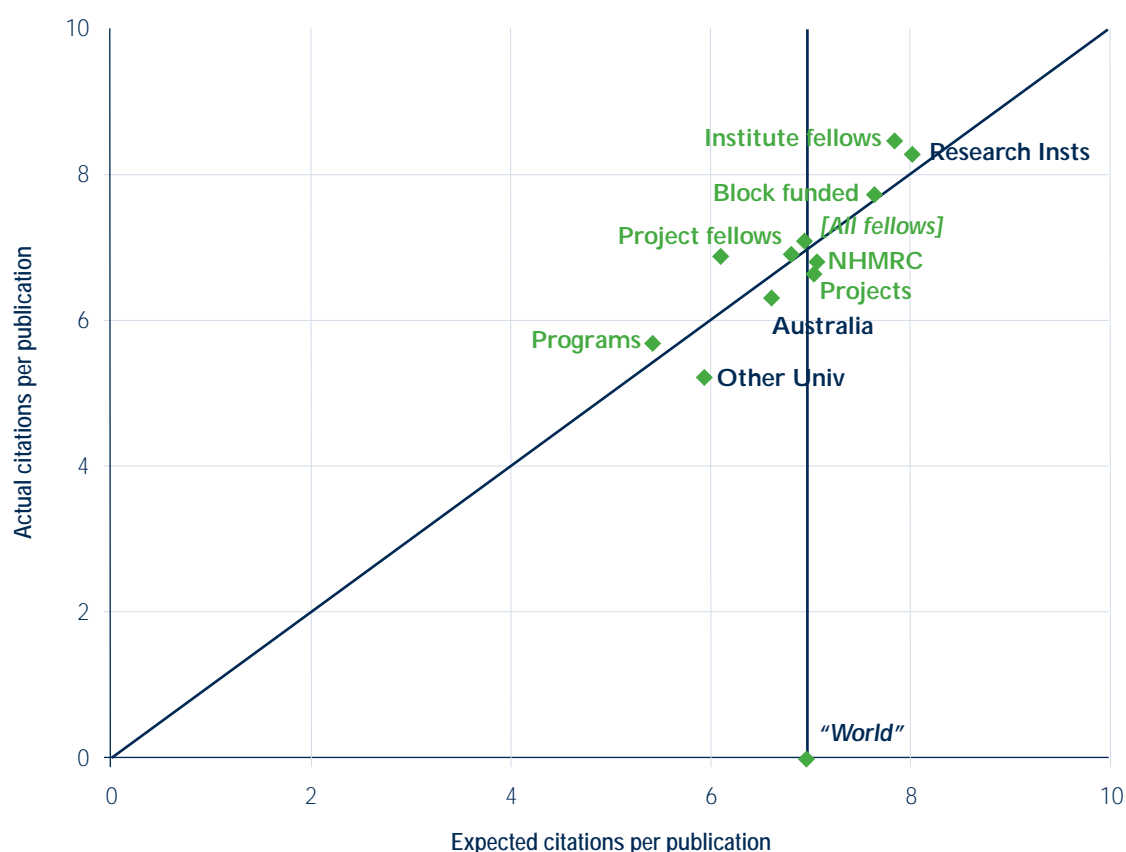


Table 26: Most highly cited Australian publications—Neurosciences

- Top 1% = 48 cites (34 pubs)
- Top 5% = 25 cites (163 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|---------------------------|----------------|-----------------|-----------------|
| Research Institutes | 474 | 1 | 7 |
| Other Hospital | 487 | 1 | 7 |
| NHMRC - Block-funded | 225 | 3 | 6 |
| NHMRC - Project Fellows | 540 | 1 | 5 |
| NHMRC - All Fellows | 665 | 1 | 5 |
| NHMRC - Institute Fellows | 140 | 3 | 5 |
| NHMRC | 1387 | 1 | 5 |
| NHMRC - Projects | 844 | 1 | 5 |
| Other University | 1600 | 1 | 3 |
| NHMRC - Programs | 182 | 1 | 3 |

Comments:

Publications resulting from NHMRC-funded research account for 40% of the Australian journal output in neurosciences. Only its share of immunology publications is higher.

The performance of sector publication sets is more homogenous in neurosciences than in most other disciplines. There is a comparatively small variation in the average journal impact for each sector, except for the Other University and Program sectors. Most NHMRC sectors are performing close to the expected citation rate.

Institute fellows have a greater than expected level, however this is based on a low number of publications (140). Nevertheless, they are responsible for over 25% of the most highly cited Australian publications.

The aggregate citation performance of NHMRC-funded publications in the Neurosciences sub-field is on par with the world average.

4.10 Sub-Field: Clinical sciences

Field: Medical and Health Sciences

ISI journal sets analysed: Andrology; Anaesthesiology; Cardiac and cardiovascular systems; Clinical neurology; Dermatology and venereal diseases; Emergency medicine and critical care; Endocrinology and metabolism; Gastroenterology and hepatology ; Geriatrics and gerontology; Haematology; Infectious diseases; Medicine, general and internal; Obstetrics and gynaecology; Oncology; Ophthalmology; Orthopaedics; Otorhinolaryngology; Pathology; Paediatrics; Peripheral vascular disease; Psychiatry; Psychology; Radiology, nuclear medicine and medical imaging; Rehabilitation; Rheumatology; Respiratory system; Transplantation; Surgery; Urology and nephrology; Tropical medicine.

Table 27: Citations per publication—Clinical sciences

| Sector | Cites | Pubs | cpp |
|---------------------------|---------------|--------------|-------------|
| NHMRC - Institute Fellows | 4900 | 517 | 9.48 |
| NHMRC - Programs | 7600 | 802 | 9.48 |
| NHMRC - Project Fellows | 13099 | 1411 | 9.28 |
| NHMRC - All Fellows | 17565 | 1902 | 9.24 |
| NHMRC - Block-funded | 12936 | 1459 | 8.87 |
| NHMRC | 43568 | 5102 | 8.54 |
| NHMRC - Projects | 21363 | 2588 | 8.25 |
| NHMRC - Units | 1818 | 226 | 8.04 |
| Research Institutes | 17609 | 2270 | 7.76 |
| Other University | 52288 | 9784 | 5.34 |
| Other Hospital | 40285 | 7935 | 5.08 |
| CRCs | 1165 | 250 | 4.66 |
| Other Government | 4804 | 1222 | 3.93 |
| Australia | 131231 | 21921 | 5.99 |

Table 28: Most highly cited Australian publications—Clinical sciences

- Top 1% = 55 cites (220 pubs)
- Top 5% = 24 cites (1075 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|---------------------------|----------------|-----------------|-----------------|
| NHMRC - Institute Fellows | 517 | 2 | 10 |
| NHMRC - All Fellows | 1902 | 2 | 10 |
| NHMRC - Project Fellows | 1411 | 2 | 10 |
| NHMRC - Block-funded | 1459 | 2 | 9 |
| NHMRC - Units | 226 | 2 | 9 |
| NHMRC | 5102 | 1 | 8 |
| NHMRC - Projects | 2588 | 1 | 8 |
| Research Institutes | 2270 | 1 | 7 |
| NHMRC - Programs | 802 | 2 | 7 |
| Other University | 9784 | 1 | 4 |
| Other Hospital | 7935 | 1 | 4 |
| CRCs | 250 | 0 | 4 |
| Other Government | 1222 | 0 | 2 |

Figure 15: Actual and expected citation rates—Clinical sciences



Comments:

Clinical sciences is by far the largest sub-field in the RFCD classification of Medical and Health Sciences – in Australia it accounts for nearly two-thirds of all publications from the field. It is therefore predictable that the citation performance of sectors in clinical sciences is very similar to their performance in medical and health sciences as a whole.

While NHMRC sectors account for only 23% of total Australian output in clinical sciences, research funded under these schemes accounts for one-third of highly cited publications in both the top 1% and 5% bands. The individual NHMRC sectors are all well represented in both bands, with Project Fellows accounting for most of NHMRC output in both.

NHMRC publications are, in aggregate, appearing in high impact journals, and achieve above the expected citation rate for these journals – and over 50% higher than the world citation per publication rate.

4.11 Sub-Field: Public health and health services

Field: Medical and Health Sciences

ISI journal sets analysed: Ergonomics; Health care sciences and services; Health policy and services (SSCI); Medical informatics; Nutrition and dietetics; Public, environmental and occupational health; Substance abuse

Table 29: Citations per publication—Public health and health services

| Sector | Cites | Pubs | cpp |
|----------------------|--------------|-------------|-------------|
| NHMRC - All Fellows | 1016 | 111 | 9.15 |
| NHMRC - Block-funded | 1178 | 163 | 7.23 |
| NHMRC | 2868 | 487 | 5.89 |
| NHMRC - Projects | 1158 | 221 | 5.24 |
| Research Institutes | 877 | 210 | 4.18 |
| Other Hospital | 2012 | 605 | 3.33 |
| Other Government | 1833 | 574 | 3.19 |
| Other University | 8116 | 2561 | 3.17 |
| Australia | 13111 | 3764 | 3.48 |

Figure 16: Actual and expected citation rates—Public health and health services

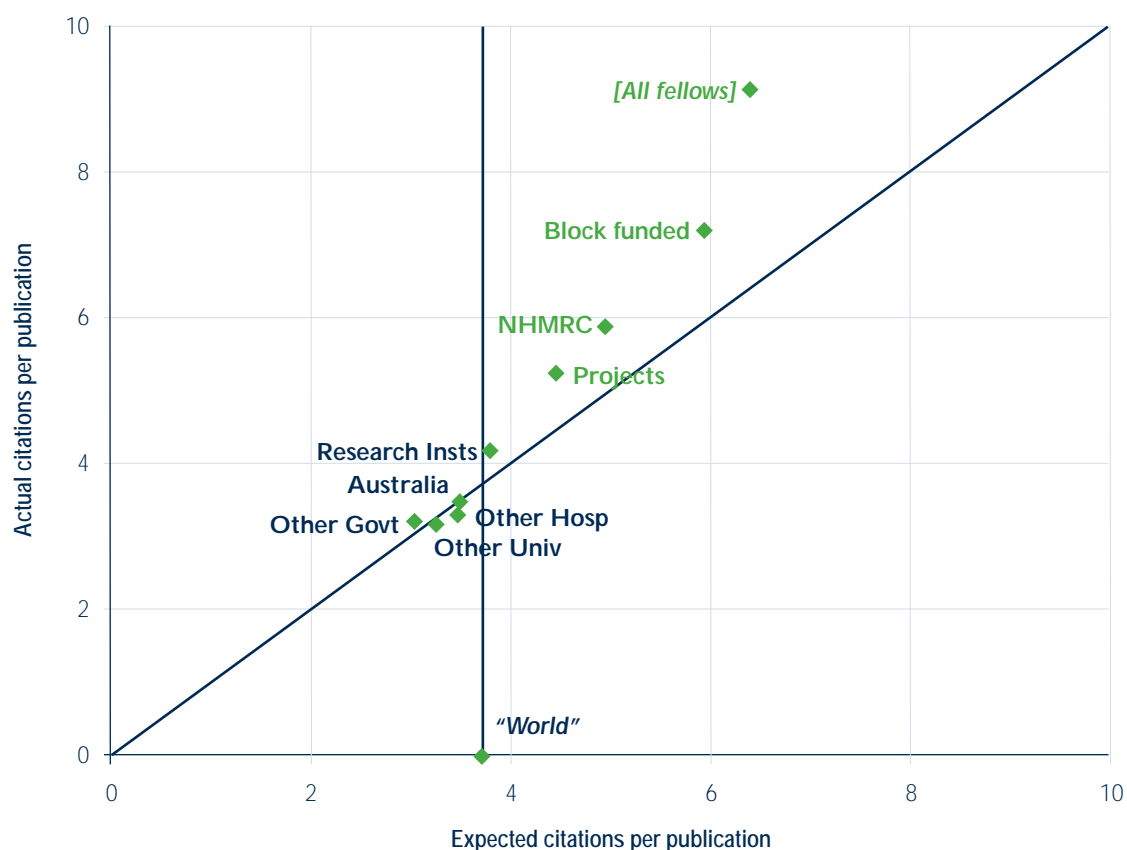


Table 30: Most highly cited Australian publications—Public health and health services

- Top 1% = 31 cites (37 pubs)
- Top 5% = 14 cites (190 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|----------------------|----------------|-----------------|-----------------|
| NHMRC - All Fellows | 111 | 6 | 19 |
| NHMRC - Block-funded | 163 | 4 | 12 |
| NHMRC | 487 | 3 | 11 |
| NHMRC - Projects | 221 | 3 | 9 |
| Research Institutes | 210 | 2 | 6 |
| Other Government | 574 | 1 | 5 |
| Other University | 2561 | 1 | 4 |
| Other Hospital | 605 | 1 | 4 |

Comments:

Much of the output from public health and health services research appears in media other than the ISI-indexed journals, such as professional or locally-based journals, government reports, newspapers, and the like. Nevertheless, there are 3,764 publications indexed by ISI that can be classified to the sub-field, and an analysis of their citation impact is useful additional data to use in conjunction with other measures of the impact and esteem of research funded by NHMRC in this area.

The number of publications attributable to NHMRC support in this discipline has increased by one-fifth since our last study, and this has enabled us to identify more sectors in the current analysis.

The combined fellows sector stands out as the highest achiever in both citations per publication (over two and half times greater than the Australian rate) and their representation in highly cited publications (6% of their publications are in the top 1% band, and 19% in the top 5%).

In aggregate, the NHMRC's share of publications classified to public health and health services research is modest (13%), yet they account for over one-third of the most highly cited publications in the top 1% band, and just under 30 percent in the top 5% band. NHMRC publications are appearing in high impact journals and achieving above expected citation levels for them.

4.12 Sub-Field: Medicine general

Field: Medical and Health Sciences

A number of journals, classified by ISI as 'Medicine, General and Internal', cannot be allocated to a specific sub-field as they have a wide discipline coverage. Examples are the *Medical Journal of Australia*, *Lancet*, *New England Journal of Medicine*, and the like. This section separately analyses this set of journals.

Table 31: Citations per publication—Medicine general

| Sector | Cites | Pubs | cpp |
|-------------------------|--------------|-------------|-------------|
| NHMRC - Project Fellows | 1981 | 163 | 12.15 |
| Research Institutes | 3688 | 307 | 12.01 |
| NHMRC - All Fellows | 2893 | 242 | 11.95 |
| NHMRC - Block-funded | 2276 | 210 | 10.84 |
| NHMRC | 5842 | 590 | 9.90 |
| NHMRC - Projects | 2359 | 279 | 8.46 |
| Other University | 2992 | 526 | 5.69 |
| Other Hospital | 1301 | 258 | 5.04 |
| Australia | 11503 | 1460 | 7.88 |

Figure 17: Actual and expected citation rates—Medicine general

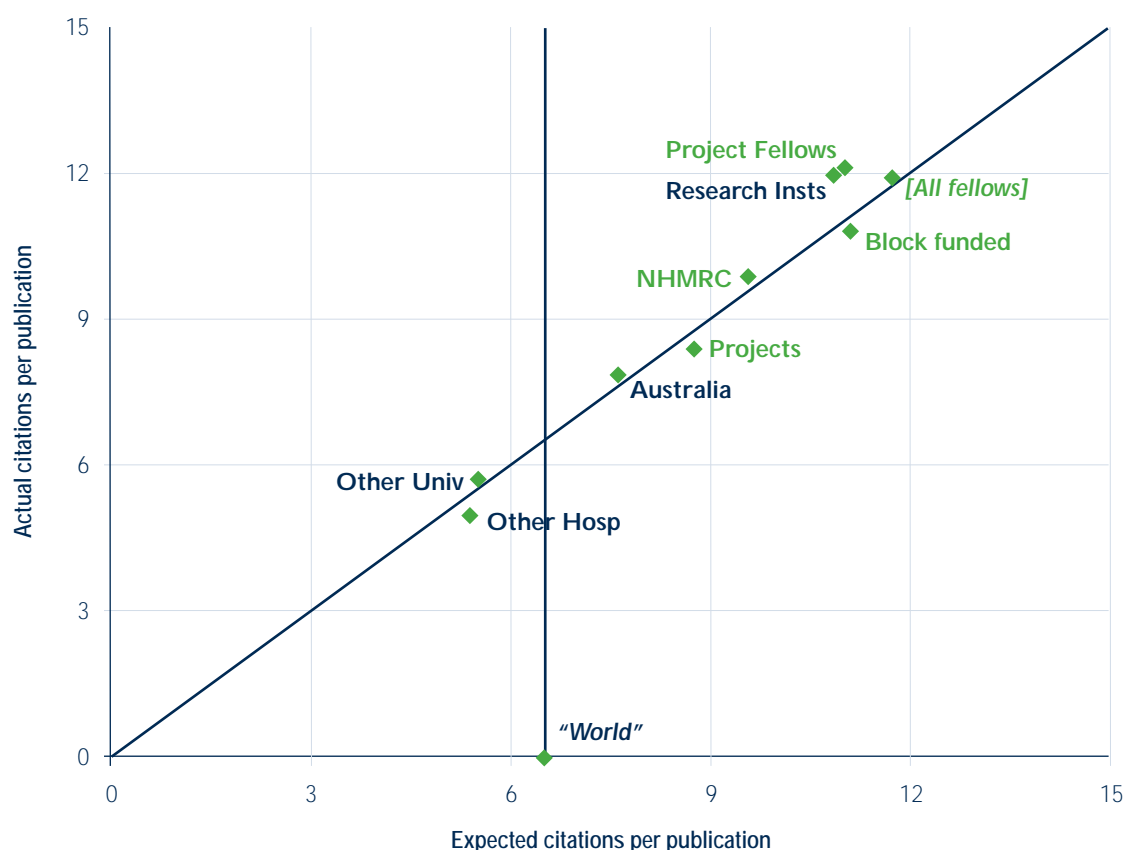


Table 32: Most highly cited Australian publications—Medicine general

- Top 1% = 76 cites (15 pubs)
- Top 5% = 31 cites (73 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|-------------------------|----------------|-----------------|-----------------|
| NHMRC - Project Fellows | 163 | 2 | 10 |
| NHMRC - All Fellows | 242 | 2 | 10 |
| Research Institutes | 307 | 3 | 9 |
| NHMRC - Block-funded | 210 | 2 | 9 |
| NHMRC | 590 | 1 | 7 |
| NHMRC - Projects | 279 | 0 | 6 |
| Other University | 526 | 0 | 3 |
| Other Hospital | 258 | 0 | 2 |

Comments:

As in all fields, general journals usually have a higher citation rate than specialty journals. The journals in the general medical set reflect this with an average citation per publication rate of 6.5 compared to 5.5 for the field as a whole (world averages). The average citation per publication rates for NHMRC-funded articles exceeds both the Australian and world averages.

NHMRC publications appear in a subset of these journals with a high average impact and achieve slightly greater than expected levels of citation. Three sectors have strong performances in this sub-field, with their publications appearing in very high impact journals and attracting more citations than expected even for this set of journals – Project Fellows, Research Institutes and Block-funded.

4.13 Sub-Field: Multidisciplinary science

Field: Science - general

Some journals indexed by ISI cover a wide variety of disciplines and cannot be classified to a particular field, or even sub-field. ISI groups them together in a 'Multidisciplinary Sciences' subject category, and it covers journals such as *Nature*, *Science*, *Proceedings of the National Academy of Science*, etc.

Table 33: Citations per publication—Multidisciplinary science

| Sector | Cites | Pubs | cpp |
|----------------------|--------------|-------------|--------------|
| NHMRC | 6415 | 224 | 28.64 |
| Other Government | 1320 | 137 | 9.64 |
| Other University | 8718 | 926 | 9.41 |
| NHMRC - Block-funded | 3691 | 102 | 36.19 |
| NHMRC - All Fellows | 4099 | 129 | 31.78 |
| Australia | 23021 | 1425 | 16.16 |

Figure 18: Actual and expected citation rates—Multidisciplinary science

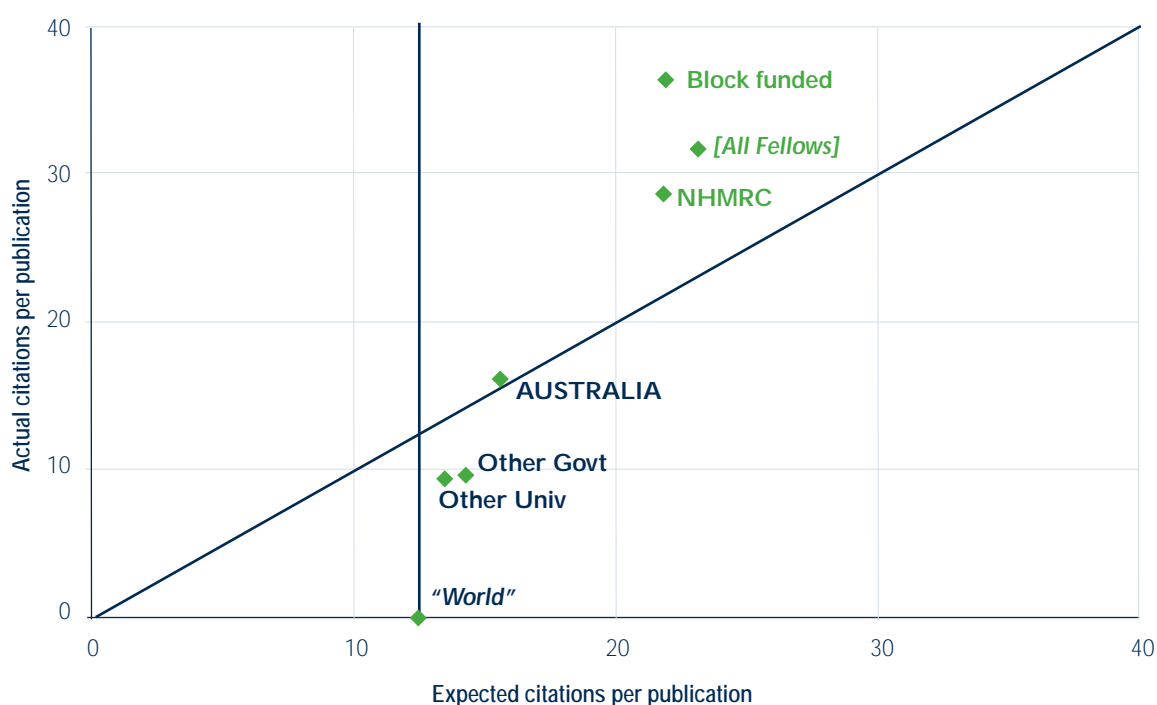


Table 34: Most highly cited Australian publications—Multidisciplinary science

- Top 1% = 177 cites (14 pubs)
- Top 5% = 69 cites (72 pubs)

| Sector | Total No. Pubs | %Pubs in Top 1% | %Pubs in Top 5% |
|----------------------|----------------|-----------------|-----------------|
| NHMRC - All Fellows | 129 | 2 | 16 |
| NHMRC - Block-funded | 102 | 4 | 16 |
| NHMRC | 224 | 2 | 13 |
| Other Government | 137 | 0 | 4 |
| Other University | 926 | 1 | 3 |

Comments:

Multidisciplinary journals are more highly cited than any other set of journals. However, not all fields achieve the same elevated citation levels that occur for the journals in aggregate. Studies have shown that biomedical articles in these journals are, on average, more heavily cited than, for example, articles on botany. These latter articles may well attract many more citations than is the norm for even the most highly cited journal in their specialty, but it is still likely to fall well short of the average levels for these journals. This, to a large extent, explains the position of the Other Government and University sectors. For example, in the Other University sector 219 of their publications come from engineering departments, 115 from earth sciences departments, 68 from mathematics departments, etc.

The average citation rate for NHMRC publications in this journal set is more than double the world average, and is particularly strong for the combined fellows sectors who together account for over half the NHMRC's output in this sub-field. Five of the fourteen most highly cited publications in the journal set result from NHMRC-funded research, as do 40% of publications found in the top 5% band.

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TECHNICAL ANNEX: METHODOLOGY

T1 The Research Evaluation and Policy Project Database

The REPP database was created from data files purchased from the Institute for Scientific Information (ISI) and, at the time this study was commissioned, covered the period 1981–2003. It captures all publications with an Australian address in the three major ISI Indices: Science Citation Index (SCI), Social Sciences Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI). The database also contains the yearly counts of citations to each of the Australian publications.

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. Addresses in most other sectors are ‘cleaned’ only to the institution level. The REPP database as it now stands contains just under 400,000 Australian publications.

Since there is no consensus in the research policy community about the ‘best’ way to count publications and citations, we list a series of options available in the REPP database and used for the tables compiled for this analysis:

- the types of publications counted were limited to research articles and review articles⁶;
- data was compiled on a publication-year basis, not a tape-year basis (i.e. the year the item was published, not the year its details were entered in ISI’s database);
- the analysis focuses on the period 1999–2003;
- the analysis was based on whole publication counts (i.e. where more than one sector collaborated in a publication, each was given a count of 1 for that publication⁷).

T2 Assignment of multi-institutional addresses

Most publications in the REPP database list only one institution in an address line. A small proportion, however, refer to two institutions, a phenomenon almost exclusively found in the medical and health sciences. Two examples of this type of address are:

WOOLLONGABBA/UNIV QUEENSLAND, PRINCESS ALEXANDRA HOSP, DEPT MED
SYDNEY/GARVAN INST MED RES, UNIV NEW S WALES

Three interpretations can be applied to this form of address:

- i) it represents a collaboration between authors from the two institutions; or
- ii) it represents a joint appointment for a single author; or
- iii) the second segment of the address merely represents the physical location of the first listed institution.

⁶ Previous studies have covered two additional publication types – notes and proceedings papers. ISI stopped classifying publications as ‘notes’ in 1996. Proceedings papers were no longer identified separately from 2003, and these papers were retrospectively re-classified as research articles.

⁷ The exception to this rule was in the delineation of comparator sectors — see the discussion in section T7.

REPP undertook extensive consultation with universities and funding agencies before deciding how to treat these two types of addresses. These discussions led to the consistent view that in the case of a multi-address referring to a university and a hospital, the publication should be attributed to the university. It was considered that the hospital part of the address was, in the majority of cases, merely a reflection of the university department's physical location. This was supported by the distribution of such addresses which were principally in clinically-oriented faculty of medicine departments.

In the case of multi-addresses referring to a university and a medical research institute, there were more divergent views. However the clear preference of the funding agencies, in particular the ARC and the NHMRC, was to allocate these publications to the medical research institutes, and REPP has adopted this strategy. Relatively few publications are affected by this decision – for example, in relation to the University of Sydney, there were less than 10 such publications a year. It must be noted, also, that these publications may still have been allocated to the university as in some instances additional addresses (from a multi-authored paper) will refer to the university specifically.

T3 Field of research classification

The ideal scenario for field of research analysis is to classify each publication separately. This is usually impossible for large-scale studies, and standard practice is to classify the journal which carries the publication (Narin 1976). The major advantage of the methodology used in this study is that, for publications linked to Project Grants, it has been possible to use the investigators' own classification of their research for analytical purposes. This means that publications appearing in multidisciplinary journals (eg *Nature*) can be ascribed to the field of research most appropriate to the content of the article. The NHMRC category 'b' discipline codes were used. However, for other sectors it is necessary to revert to the standard practice of journal set analysis. The results of both types of field analyses are presented in this study.

The makeup of journal sets for field of research analysis rests on ISI's classification schemes. ISI has its own descriptive classification system involving around 200 subject categories and REPP has, for a number of previous exercises, translated these as closely as possible into the fields and sub-fields 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. Most ISI subject categories slot neatly into one of the RFCD sub-fields, but some problems were encountered. For example, in contrast to the RFCD, ISI does not distinguish between research that focuses on animals and that which focuses on humans. Subject categories such as Physiology, Virology and Parasitology can have elements of two or more RFCD fields in their composition. To avoid allocating too many categories to interdisciplinary codes, REPP classified a journal set to a particular field where more than half the journals appeared clearly related to that field. The subject categories ascribed to each biomedical ASRC sub-field are shown at the start of each analysis in Section 4.

It should be noted that ISI allocates some journals to more than one subject category with the effect of some double counting between fields and/or sub-fields.

T4 Small numbers

A special note of caution is required concerning the small numbers of publications tabulated in some research fields. In the ISI system as a whole, many publications receive no citations at all, and the majority receive less than 5 citations (Garfield 1989). The number achieving a high citation count is extremely small. 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.

For the bibliometric measures used in this analysis, citation information based on any units with less than 100 publications has been omitted.

Our experience also suggests that extra caution should be used for citation figures based on units with between 100 and 200 publications.

T5 ISI coverage

Before any discussion of publications and citations occurs, it is important to be clear about the proportion of research output from the units under study that is covered by bibliometric measures.

Fields of research vary in the extent to which journal publication can be regarded as the normal mode of research dissemination. Most biomedical publications appear in journals indexed by ISI. However, this pattern is not true of every sub-discipline. To illustrate this, Table T1 draws on publication details for 1995, 1997 and 1999 that universities reported to the Department of Education, Science and Training. This data, analysed in the Experimental Database constructed by REPP in the course of a recent ARC Linkage Grant research project, identifies where medical departments are publishing.

Table T1: Distribution of research by type of publication and field

| Academic departments | Number of publications | Books Chapters | Journal Articles | | Conference Papers |
|------------------------------------|------------------------|----------------|------------------|-----------|-------------------|
| | | | ISI | Non-ISI | |
| | | | <i>Percent</i> | | |
| Immunology | 167 | 7 | 88 | 3 | 1 |
| Neurosciences | 112 | 9 | 87 | 4 | 1 |
| Pharmacology & pharmaceutical sci | 766 | 4 | 83 | 11 | 2 |
| Medical microbiology | 287 | 5 | 82 | 7 | 6 |
| Medical biochemistry | 480 | 8 | 81 | 6 | 5 |
| Medical physiology | 933 | 8 | 78 | 8 | 6 |
| Human movement and sports sci | 781 | 4 | 75 | 17 | 3 |
| Other medical and health sciences | 78 | 13 | 69 | 14 | 4 |
| Clinical Sciences | 7437 | 9 | 69 | 18 | 4 |
| Dentistry | 320 | 3 | 59 | 31 | 7 |
| Public health and health services | 1705 | 10 | 55 | 27 | 7 |
| Nursing | 97 | 40 | 43 | 9 | 5 |
| Optometry | 147 | 3 | 37 | 41 | 19 |
| Complementary/alternative medicine | 30 | 0 | 10 | 83 | 0 |
| Total | 13288 | 8 | 68 | 18 | 5 |

Table T1 shows that in the field of medical and health science, output in journals represent approximately two-thirds of total output from university departments. However, this level is not universal for all disciplines, with the proportion for the last five listed sub-fields being lower. While calculated from a small sample, the data suggest that publications from departments of complementary and alternative medicine rarely appear in ISI indexed journals. Only a third of optometry publications are in ISI journals, and nursing places a greater reliance on book chapters as a means of communicating research.

While bibliometric analysis is appropriate for most biomedical research, clearly there are some disciplines where it is problematic — much of their research is not published in journal articles, and even when it is, the capture rate in ISI indices is very small. This must be borne in mind when interpreting the data presented for these disciplines.

T6 Distribution of publication years

When comparing sectoral citation rates using five year windows, an underlying assumption is that each sector has a similar, and even, distribution across the five years. A concentration of publications in the earlier years will inflate citation rates (as most publications will have had several years to attract citations), while a concentration in the later years will deflate citation rates (as most publications will have had little time to attract citations). This issue meant that, even though a number of NHMRC grant schemes (Block-funded, Unit, Program) have undergone significant changes during the five years covered by this study, it was necessary to combine the new and old versions for analytical purposes. This will no longer be necessary for the next update, which is scheduled to cover the period 2002-2006.

T7 Identification of publications from NHMRC sectors

A number of methods were needed to identify NHMRC publications resulting from research funded through different grant programs.

T7.1 Project Grants (sector 1)

T7.1.1 Background to methodology

Project Grants are awarded to individual researchers, or groups of researchers, and the publications linked to this scheme cannot be identified directly from the REPP database. There are three possible methods for identifying the relevant publications: surveying the researchers directly; obtaining publication details from the final reports of the grant; or, obtaining publication details from the application forms researchers submit when applying for new grants.

It is unlikely that a survey of researchers would result in a response rate high enough to identify an accurate set of publications.

The final report from a successful Project Grant is not useful in providing details of the research publications that result from that grant, as many are still in press, in draft form, or still in 'gestation' at the time the report is submitted. It is not until a number of years have elapsed after the completion of the grant that a more accurate account of the research output can be made.

The best methodology lies in the third scenario. Applications for new Project Grants within the NHMRC rubrik require chief investigators to list all their previous NHMRC support and the publications that resulted from this support. By focussing on new applications from 2004 and 2005, REPP expected to obtain a comprehensive coverage of 1999 to 2003 publications for these applicants, and be able to extract a full list of publications linked to previous NHMRC Project Grants. This data was supplemented by 1999 and 2000 publications identified in the 2003 study.

The efficacy of the methodology relies on the following assumptions:

- virtually all active medical researchers will apply for a new grant at least once in the selected period; and
- application forms will be meticulously and accurately completed.

A previous study conducted by REPP for the NHMRC (Butler and Biglia 2001) showed that this methodology “resulted in an accurate, though not perfect, set of publications for analysing output from the NHMRC’s Project Grants scheme” (p.72). Some relevant publications will not have been identified – investigators may not have applied in the relevant period because they had moved overseas, returned to full-time medical practice, etc. However we believe that the shortfall is unlikely to effect the assessment of citation performance for the scheme as a whole, though acknowledge it has the potential to impact on analysis at the sub-field level.

T7.1.2 Outline of methodology

An outline of the methodology used to identify publications resulting from research funded by the NHMRC Project Grants scheme is set out in the box below, followed by a detailed discussion of some aspects of the methodology.

- Step 1:** Bibliographic details for all publications in the REPP database for 1999 to 2003, limited to research and review articles, were extracted.
- Step 2:** NHMRC provided an electronic list of all successful large Project Grants for the period 1990-2003.
- Step 3:** An electronic list of all applications received by NHMRC for Project Grants in the period 2003-2005 was obtained.
- Step 4:** Details of the publications linked to past NHMRC Project Grants were extracted from applications in Excel spreadsheet format.
- Step 5:** Publication lists from all 2005 applications that reported links to past grants were printed out from the electronic application files.
- Step 6:** Publications from our target years, 1999 to 2003, were identified in the publication lists and matched against the publications in the REPP database.
- Step 7:** Where a match was made, the relevant grant number was appended to the publication record.
- Step 8:** 2004 applications were checked to identify any that linked publications to grants not already reported in 2005 applications, and steps 4 to 6 were repeated.
- Step 9:** Steps 4 to 7 identified the anticipated number of publications from journals that appeared between 2001 and 2003, however 1999 and 2000 numbers were lower than anticipated. Additional publications for these years were identified from the data assembled for the previous study.
- Step 10:** Analysis was undertaken of the resulting publication set.

T7.1.3 Discussion of the methodology

Step 1:

The bibliographic details extracted for 1999 to 2003 publications were: publication ID, title, journal, volume, start page, and authors. This provided sufficient information to make a confident match with details provided in the publication lists of the grant applications.

Step 2:

Experience gained in a previous analysis of the output from NHMRC Project Grants (Butler and Biglia 2001), led us to expect that nearly all 1999 to 2003 publications linked to this scheme would have come from grants which commenced between 1996 and 2003.

Steps 3-4, 8:

Details contained in applications for large grants made between 2003 and 2005, identifying links between publication lists and past NHMRC grants, were available electronically. Applications from 2005 were targeted in the first instance, as these had the most complete bibliographic information for 1999 to 2003 publications. If no 2005 applications relating to a particular prior NHMRC Project Grant could be found, a 2004 application was selected.

Details were not extracted from all applications from the 2005 round, as in many instances researchers or groups had made multiple applications and the information they contained was duplicated. From the 2004 round, far fewer applications were examined as we only accessed those linking publications to grants that we had not previously covered.

1,594 applications made in 2005 were examined (73% of total), but only 148 made in 2004 contained links to prior grants not covered in the 2005 applications (7% of total).

Steps 5 to 7:

The publication lists obtained from application files were examined, and journal publications in the target period, 1999 to 2003, were identified. In most cases, full bibliographic details were available and matching publications to the REPP database was a straightforward, though very time consuming, task. In 13.8% of cases, researchers linked a publication to more than one Project Grant.

Step 9:

As relatively few 2004 applications contained additional data, a decision was made to use data from the previous triennial analysis to identify publications for 1999 and 2000 publications which were to that point under-represented. Table T3 sets out the distribution of publications obtained in the first 8 steps of the methodology, and also the additional publications obtained in this final step.

Table T3: Distribution of publications by year and source

| Publication year | Publications identified in 2004-05 applications | Initial Distribution | Publications identified in previous study (2003) | Final Distribution |
|------------------|---|----------------------|--|--------------------|
| 1999 | 916 | 16.0 | 298 | 19.6 |
| 2000 | 1069 | 18.6 | 160 | 19.8 |
| 2001 | 1266 | 22.0 | | 20.4 |
| 2002 | 1230 | 21.4 | | 19.8 |
| 2003 | 1261 | 22.0 | | 20.3 |
| Total | 5742 | 100.0 | 458 | 100.0 |

T7.1.4 Final database

The comprehensive and detailed methodology outlined above resulted in the identification of 6,200 publications that could be linked directly to NHMRC Project Grants; could also be found in the REPP database, and were classified as articles or reviews. Of these, 6,046 publications were in journals covered by the REPP database (this is a slightly reduced list compared to the full *Web of Knowledge* on-line version).

T7.1.5 Coverage achieved

The methodology used to identify publications that result from research funded under the Project Grants scheme is not perfect. The coverage of prior grants we were able to achieve by our methodology is summarised in Table T4.

Table T4: Coverage of successful Project Grants awarded between 1994 and 2003

| Grant year | Total grants awarded | Grants with linked pubs | Grants with no in-scope pubs | No. grants covered | |
|------------|----------------------|-------------------------|------------------------------|--------------------|----|
| | | | | No. | % |
| 1994 | 371 | 3 | 4 | 7 | 2 |
| 1995 | 387 | 12 | 5 | 17 | 4 |
| 1996 | 307 | 158 | 55 | 213 | 59 |
| 1997 | 404 | 282 | 60 | 342 | 77 |
| 1998 | 356 | 238 | 66 | 304 | 77 |
| 1999 | 336 | 228 | 64 | 292 | 82 |
| 2000 | 396 | 228 | 78 | 306 | 70 |
| 2001 | 422 | 218 | 105 | 323 | 72 |
| 2002 | 378 | 171 | 100 | 271 | 66 |
| 2003 | 408 | 125 | 165 | 290 | 67 |

Not all researchers or groups who were awarded Project Grants in earlier years will have applied for a new grant during the two years we initially targeted in this study. However, by also using data gathered in the 2003 study undertaken for the NHMRC, we believe our coverage is very comprehensive. Researchers may have retired, moved out of research, or gone overseas, and information about this group will be missing. It is difficult to know what proportion this group would be of the total, but with the combination of the two methodologies, I estimate it to be around 10%. The most important cohort of grants are those that commenced between 1997 and 2002, as these provide most of the targeted publications (1999 to 2003). Between two-thirds and three-quarters of the grants from these years have been covered. The lower coverage of grants commenced before 1997 and after 2002 will not have a huge impact on total coverage and is not of major concern.

This coverage is five percentage points better than that achieved in the previous study. This had been expected given that some of the under-reporting in the 2003 study was due to the omission of clear instructions to link researchers publications to past NHMRC grants in the electronic version of the application form, an omission that had since been rectified.

This issue must be borne in mind when interpreting the results of the study, but given the large number of publications that were identified, it is unlikely to have a significant effect on the average citation rates on which most of the analysis is based. It is of most concern when publication numbers drop to fairly low levels. In addition, as nearly half the publications linked to Project Grants are also linked to other NHMRC schemes (see Table T5 below), the shortfall is even less significant for aggregate NHMRC analyses.

T7.2 Program Grants (sector 2)

A list of Program Grants active during 1999 to 2003 was provided by NHMRC, together with the years for which they were in receipt of funding, and the details of the researchers associated with the grants. All the researchers' publications for 1999 to 2003 were extracted from the REPP database. The author's institutional location was also used as an additional field for identification, particularly where common surnames were involved.

Where a Program was not in receipt of funding for the whole period, the publications extracted were limited to the funding period, with a one year time lag built in. For example, publications were limited to 1999 and 2000 for those Programs whose grant finished in 1999; and publications were limited to 2002 and 2003 for those Programs whose grant commenced in 1999.

There was a major change to the Program Grants scheme in the period covered by our study. It was not practical to separate out publications attributed to the 'new' and 'old' schemes, as doing so would have resulted in severely skewed citation counts (see Section T.6 above for a more detailed explanation of this issue). For this reason, the two forms of the scheme were treated as a single unit.

The Program Grants were linked to 1,670 in-scope publications in the REPP database.

T7.3 Block-funded research institute grants (sector 3)

The Block-funded institutes receiving NHMRC support during 1999 to 2003 were:

- Garvan Institute of Medical Research
- Baker Medical Research Institute
- Howard Florey Institute
- Walter and Eliza Hall Institute
- Murdoch Institute for Research into Birth Defects
- Queensland Institute of Medical Research

The REPP database is structured to enable publications to be attributed to the institutions on the basis of addresses.

This funding scheme ceased during the period covered by our study. For the same reason as that outlined for the Program Grants sector above, it was not possible to undertake a comparative analysis of publications from this scheme that was limited to the period for which it was operational. A decision was taken to attribute publications to this scheme as if it had been running for the full five years.

From the REPP database, 3,330 in-scope publications for the Block-funded institutes were identified in the relevant time period.

T7.4 Research Unit grants (sector 4)

The research Units receiving grants at the relevant period were:

- Centre for Mental Health Research at the Australian National University
- Clinical Trials Unit at the University of Sydney
- NHMRC Network for Brain Research into Mental Disorders
- National Research Centre for Environmental Toxicology at the University of Queensland
- NHMRC Road Accident Research Unit at the University of Adelaide
- National Centre for Health Economics Research at Monash University

The REPP database is structured to enable publications to be attributed to the institutions of their authors. This attribution is also possible down to the level of faculty and department (or their equivalent) in universities, CSIRO and some government departments. In Australian universities it is possible to assign over 90% of all publications to departments (Bourke and Butler 1998). In the case of five of the six Units, it was a straightforward task to identify their publications. However, the Network for Brain Research, involving cross-institutional collaboration, could not readily be created on an address basis from the REPP database and this may have resulted in some under-reporting of publications.

As with sector 3, this funding scheme ceased during the period covered by our study. For the same reason as that outlined for the previous two sectors, it was not possible to undertake a comparative analysis of publications from this scheme that was limited to the period for which it was operational. A decision was taken to attribute publications to this scheme as if the Units had been running for the full five years.

From the database, 443 in-scope publications were identified with the research Units.

T7.5 Research Fellowships Awards (sectors 5 and 6)

A list of recipients of research fellowships funded during the period 1998 to 2003 was provided by NHMRC. Both researchers funded under the scheme linking Research Fellowships to Project Grants, and those taking up their fellowship in the Block-funded institutes, were included, though separately identified.

Details of all the researchers' publications for the period they were on scholarship were extracted from the REPP database, with a one year time lag factored in. For example, publications were limited to 1999 and 2000 for those researchers whose award finished in 1999; and publications were limited to 2002 and 2003 for those researchers whose award commenced in 2001.

The research fellows were linked to 4,740 in-scope publications in the REPP database: 1,347 related to Institute Fellows, and 3,485 to Project Fellows (with some overlap). The definition of this sector leads to considerable overlap with other NHMRC sectors. Many of the fellowship holders are linked to Project Grants, and most of the remainder are associated with NHMRC's six Block-funded institutes, with the result that most publications for this sector are also associated with sectors 1 and 3. However, the sector is retained as a separate entity as it draws together the work of researchers from a number of different types of institutions who have been identified as the leading researchers in their fields.

T8 Delineation of comparator sectors

The methodology used in this analysis aimed at creating sectors with quite distinct characteristics and as little overlap as possible. ***It will become clear from the methodology employed that some of the sectors created do not bear a strong resemblance to their commonly perceived definition.***

T8.1 Other Research Institutes (sector 7)

The sector covers all in-scope publications (i.e. research and review articles that were published between 1999 and 2003 inclusive) from Block-funded institutions (or part-thereof) active in medical research. This sector covers:

Institute of Advanced Studies, The Australian National University

John Curtin School of Medical Research

CSIRO

Division of Health Sciences and Nutrition

Australian Association of Medical Research Institutes

Austin Research Institute

Bernard O'Brien Institute of Microsurgery

Bionic Ear Institute

Brain Research Institute

Centenary Institute of Cancer Medicine and Cell Biology

Centre for Eye Research Australia

Child Health Research Institute

Children's Cancer Institute Australia for Medical Research

Children's Medical Research Institute

Genomics Disorders Research Centre

George Institute for International Health
Hanson Institute
Heart Research Institute
Lions Eye Institute
Ludwig Institute for Cancer Research
Macfarlane Burnet Institute for Medical Research and Public Health
Mater Medical Research Institute
Mental Health Research Institute of Victoria
Menzies School of Health Research
Murdoch Children's Research Institute
National Ageing Research Institute
Peter MacCallum Cancer Centre
Prince Henry's Institute of Medical Research
Prince of Wales Medical Research Institute
St Vincent's Research Institute
Telethon Institute for Child Health Research
Victor Chang Cardiac Research Institute
Wesley Research Institute
Western Australian Institute for Medical Research
Westmead Millennium Institute
Woolcock Institute of Medical Research

5,154 in-scope publications were identified for this sector.

T8.2 Cooperative Research Centres (sector 8)

All in-scope publications from the CRC's classified as Medical Science and Technology were identified. The relevant CRC's were:

CRC for Aboriginal Health
CRC for Asthma
CRC for Biopharmaceutical Research
CRC for Cellular Growth Factors
CRC for Cochlear Implant and Hearing Aid Innovation
CRC for Diagnostics
CRC for Discovery of Genes for Common Human Diseases
CRC for Eye Research and Technology
CRC for Oral Health Science
CRC for Tissue Growth and Repair
CRC for Vaccine Technology

All components of a CRC, whichever participating institution appeared on the publication address, were identified and resulted in 639 publications being classified to the sector.

T8.3 Other University publications (sector 9)

The sector covers all in-scope publications (i.e. 1999 to 2003 research and review articles) from universities appearing in journals classified to the biomedical sciences.

Publications that were found in a number of other sectors were specifically excluded from this sector, viz. those publications identified with sectors 1 to 8. In this respect, ***the sector is not a true reflection of total university output, but is more accurately a reflection of output funded principally through general operating grants and funding agencies other than NHMRC. Some publications resulting from ARC funding, however, will be included in this sector.***

T8.4 Other Hospital publications (sector 10)

The sector covers all in-scope publications (i.e. 1999 to 2003 research and review articles) from hospitals, both public and private institutions.

Publications that were found in a number of other sectors were specifically excluded from this sector, viz. those publications identified with sectors 1 to 8. In this respect, ***the sector is not a true reflection of total hospital output, but is more accurately a reflection of output funded principally through general operating grants and funding agencies other than NHMRC. Some publications resulting from ARC funding, however, will be included in this sector.***

T8.5 Other Government publications (sector 11)

The sector covers all in-scope publications (i.e. 1999 to 2003 research and review articles) from state and commonwealth departments and agencies appearing in biomedical journals.

Publications that were found in a number of other sectors were specifically excluded from this sector, viz. those publications identified with sectors 1 to 8. ***In this respect, the sector is not a true reflection of the total government sector output, but is more accurately a reflection of output funded principally through departmental and agency recurrent funds. Some publications resulting from ARC funding, however, will be included in this sector.***

T9 Sector overlap

Given the nature of research in the medical and health sciences, it would be impossible to create completely discrete sectors without severely distorting the analysis. Less than 10% of publications are attributed to a single author and over 50% result from collaboration between two or more institutions (see Section 2.2 above). The success of the methodology used in this study lies in creating sectors with quite distinct sets of publications and where the degree of overlap has been restricted.

Three grids showing the overlap between pairs of sectors were developed. Table T5 shows the overlap between sectors 1 to 8. As publications from the fellows sectors are, by definition, also expected to appear in either the Block or Project sectors, the data is recalculated excluding these sectors (Table T6). Table T7 shows the overlap between sectors 9 to 11. The methodology ensured there was no overlap between the two groups of sectors. The tables also show the total number of in-scope publications in each sector and the total number and percentage of a sector's publications that appear in one or more of the other sectors.

Table T5: Overlap of sector publication sets (sectors 1-8)

| | Block-funded Grants | | | | | | | |
|---------------------------|---------------------|-------------------|-----------------|----------------|----------------|-------------|------------|---------------------|
| Institute Fellows | 1296 | Institute Fellows | | | | | | |
| Project Fellows | 308 | 92 | Project Fellows | | | | | |
| Program Grants | 212 | 100 | 571 | Program Grants | | | | |
| Project Grants | 636 | 251 | 1568 | 209 | Project Grants | | | |
| Unit Grants | 45 | 39 | 116 | 32 | 66 | Unit Grants | | |
| CRCs | 226 | 110 | 64 | 26 | 113 | 0 | CRCs | |
| Research Institutes | 330 | 139 | 1350 | 645 | 1435 | 77 | 0 | Research Institutes |
| Total publications | 3330 | 1347 | 3485 | 1670 | 6046 | 443 | 639 | 5154 |
| Total duplications | 2034 | 1323 | 2685 | 1063 | 2910 | 154 | 401 | 2705 |
| Percentage overlap | 61% | 98% | 77% | 64% | 48% | 51% | 63% | 52% |

Table T6: Overlap of sector publication sets (sectors 1-5 and 8)

| | Block-funded Grants | Program Grants | Project Grants | Unit Grants | CRCs | Research Institutes |
|---------------------------|---------------------|----------------|----------------|-------------|------------|---------------------|
| Total publications | 3330 | 1670 | 6046 | 443 | 639 | 5304 |
| Total duplications | 1124 | 915 | 2083 | 154 | 385 | 2278 |
| Percentage overlap | 34% | 55% | 34% | 35% | 60% | 43% |

Table T7: Overlap of sector publication sets (sectors 9-11)

| | Other University | | |
|---------------------------|------------------|----------------|------------------|
| Other Hospital | 4383 | Other Hospital | |
| Other Government | 1466 | 591 | Other Government |
| Total publications | 21249 | 10140 | 2620 |
| Total duplications | 5507 | 4632 | 1715 |
| Percentage overlap | 26% | 46% | 65% |

None of the sectors are composed of discrete sets of publications. This was to be expected, given the collaborative nature of medical research. Once the publications of fellows have been excluded from the calculation, the highest overlaps occurred with the CRC and Programs sector, and also with the Other Government sector.

Table A2: Collaboration patterns by sector (Figure 1)

| Sector | Single | | Group | | National | | International | | Total |
|---------------------------|--------|---|-------|----|----------|----|---------------|----|-------|
| | No. | % | No. | % | No. | % | No. | % | |
| NHMRC - Project | 173 | 3 | 4229 | 70 | 2945 | 49 | 1836 | 30 | 6046 |
| NHMRC - Block | 123 | 4 | 1807 | 54 | 2006 | 60 | 1370 | 41 | 3330 |
| NHMRC - Unit | 32 | 7 | 282 | 64 | 249 | 56 | 139 | 31 | 443 |
| NHMRC - Project Fellows | 106 | 3 | 2238 | 64 | 1555 | 45 | 1215 | 35 | 3485 |
| NHMRC - Institute Fellows | 28 | 2 | 866 | 64 | 678 | 50 | 495 | 37 | 1347 |
| NHMRC - All Fellows | 134 | 3 | 3043 | 64 | 2143 | 45 | 1674 | 35 | 4740 |
| NHMRC - Programs | 56 | 3 | 1044 | 63 | 996 | 60 | 588 | 35 | 1670 |
| NHMRC | 429 | 4 | 7387 | 63 | 5724 | 49 | 4029 | 35 | 11636 |
| Research Institutes | 219 | 4 | 2891 | 56 | 3086 | 60 | 1933 | 38 | 5154 |
| CRCs | 14 | 2 | 456 | 71 | 447 | 70 | 176 | 28 | 639 |
| Other University | 1767 | 8 | 11371 | 54 | 8159 | 38 | 7525 | 35 | 21249 |
| Other Hospital | 811 | 8 | 5721 | 56 | 5871 | 58 | 2684 | 26 | 10140 |
| Other Government | 179 | 7 | 1506 | 57 | 1808 | 69 | 649 | 25 | 2620 |

Table A3: International collaboration by sector and country (Table 3)

| COUNTRY | NHMRC Sectors | | | | | | | | | | | | Comparator Sectors | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------|---------------|----|-----|-------|----|----|------|----|-----|-----------------|-----|----|--------------------|----|------|-------------|-----|----|----------|----|------|-------------|-----|----|---------------------|----|--|------------|---|--|------------|---|--|------------|---|--|------|---|--|------|---|
| | Project | | | Block | | | Unit | | | Project Fellows | | | Institute Fellows | | | All Fellows | | | Programs | | | NHMRC TOTAL | | | Research Institutes | | | Other Univ | | | Other Hosp | | | Other Govt | | | | | | | |
| | Pubs | % | | Pubs | % | | Pubs | % | | Pubs | % | | Pubs | % | | Pubs | % | | Pubs | % | | Pubs | % | | Pubs | % | | Pubs | % | | Pubs | % | | Pubs | % | | Pubs | % | | Pubs | % |
| US | 876 | 48 | 693 | 51 | 35 | 25 | 529 | 44 | 249 | 50 | 765 | 46 | 262 | 45 | 1869 | 46 | 925 | 48 | 69 | 39 | 2671 | 35 | 976 | 36 | 254 | 39 | | | | | | | | | | | | | | | |
| England | 282 | 15 | 227 | 17 | 23 | 17 | 178 | 15 | 53 | 11 | 227 | 14 | 120 | 20 | 659 | 16 | 338 | 17 | 22 | 13 | 1416 | 19 | 781 | 29 | 113 | 17 | | | | | | | | | | | | | | | |
| Germany | 175 | 10 | 129 | 9 | 25 | 18 | 130 | 11 | 52 | 11 | 172 | 10 | 51 | 9 | 403 | 10 | 230 | 12 | 13 | 7 | 648 | 9 | 249 | 9 | 39 | 6 | | | | | | | | | | | | | | | |
| Japan | 161 | 9 | 122 | 9 | 11 | 8 | 102 | 8 | 56 | 11 | 155 | 9 | 37 | 6 | 337 | 8 | 134 | 7 | 6 | 3 | 488 | 6 | 118 | 4 | 32 | 5 | | | | | | | | | | | | | | | |
| Canada | 99 | 5 | 73 | 5 | 9 | 6 | 85 | 7 | 20 | 4 | 104 | 6 | 46 | 8 | 256 | 6 | 98 | 5 | 8 | 5 | 644 | 9 | 320 | 12 | 73 | 11 | | | | | | | | | | | | | | | |
| France | 86 | 5 | 90 | 7 | 6 | 4 | 73 | 6 | 30 | 6 | 101 | 6 | 40 | 7 | 236 | 6 | 115 | 6 | 11 | 6 | 404 | 5 | 194 | 7 | 35 | 5 | | | | | | | | | | | | | | | |
| New Zealand | 92 | 5 | 59 | 4 | 17 | 12 | 90 | 7 | 31 | 6 | 112 | 7 | 30 | 5 | 198 | 5 | 94 | 5 | 8 | 5 | 426 | 6 | 181 | 7 | 69 | 11 | | | | | | | | | | | | | | | |
| Sweden | 73 | 4 | 55 | 4 | 5 | 4 | 69 | 6 | 15 | 3 | 83 | 5 | 36 | 6 | 184 | 5 | 76 | 4 | 3 | 2 | 351 | 5 | 135 | 5 | 29 | 4 | | | | | | | | | | | | | | | |
| Switzerland | 57 | 3 | 77 | 6 | 7 | 5 | 51 | 4 | 21 | 4 | 72 | 4 | 19 | 3 | 177 | 4 | 72 | 4 | 8 | 5 | 235 | 3 | 133 | 5 | 33 | 5 | | | | | | | | | | | | | | | |
| Netherlands | 70 | 4 | 50 | 4 | 2 | 1 | 22 | 2 | 14 | 3 | 36 | 2 | 30 | 5 | 150 | 4 | 54 | 3 | 6 | 3 | 308 | 4 | 169 | 6 | 36 | 6 | | | | | | | | | | | | | | | |
| Italy | 59 | 3 | 41 | 3 | 1 | 1 | 42 | 3 | 17 | 3 | 57 | 3 | 24 | 4 | 139 | 3 | 68 | 4 | 1 | 1 | 264 | 4 | 184 | 7 | 31 | 5 | | | | | | | | | | | | | | | |
| Peoples R China | 46 | 3 | 45 | 3 | 8 | 6 | 31 | 3 | 7 | 1 | 37 | 2 | 15 | 3 | 117 | 3 | 41 | 2 | 4 | 2 | 327 | 4 | 105 | 4 | 24 | 4 | | | | | | | | | | | | | | | |
| Scotland | 38 | 2 | 33 | 2 | 6 | 4 | 32 | 3 | 8 | 2 | 40 | 2 | 13 | 2 | 95 | 2 | 44 | 2 | 4 | 2 | 234 | 3 | 109 | 4 | 41 | 6 | | | | | | | | | | | | | | | |
| Belgium | 24 | 1 | 19 | 1 | 8 | 6 | 30 | 2 | 3 | 1 | 33 | 2 | 14 | 2 | 74 | 2 | 34 | 2 | 2 | 1 | 132 | 2 | 118 | 4 | 8 | 1 | | | | | | | | | | | | | | | |
| Denmark | 25 | 1 | 28 | 2 | 3 | 2 | 24 | 2 | 13 | 3 | 37 | 2 | 8 | 1 | 74 | 2 | 21 | 1 | 2 | 1 | 198 | 3 | 76 | 3 | 17 | 3 | | | | | | | | | | | | | | | |
| Finland | 37 | 2 | 20 | 1 | 1 | 1 | 33 | 3 | 4 | 1 | 37 | 2 | 9 | 2 | 74 | 2 | 42 | 2 | 3 | 2 | 113 | 2 | 66 | 2 | 6 | 1 | | | | | | | | | | | | | | | |
| Spain | 26 | 1 | 15 | 1 | 1 | 1 | 24 | 2 | 2 | 0 | 26 | 2 | 5 | 1 | 60 | 1 | 30 | 2 | 4 | 2 | 113 | 2 | 81 | 3 | 24 | 4 | | | | | | | | | | | | | | | |
| Israel | 30 | 2 | 16 | 1 | 2 | 1 | 11 | 1 | 4 | 1 | 15 | 1 | 10 | 2 | 58 | 1 | 25 | 1 | | | 75 | 1 | 54 | 2 | 9 | 1 | | | | | | | | | | | | | | | |
| Singapore | 20 | 1 | 9 | 1 | 7 | 5 | 15 | 1 | 6 | 1 | 20 | 1 | 17 | 3 | 52 | 1 | 17 | 1 | | | 117 | 2 | 48 | 2 | 9 | 1 | | | | | | | | | | | | | | | |
| Thailand | 11 | 1 | 21 | 2 | 3 | 2 | 4 | 0 | 3 | 1 | 7 | 0 | 1 | 0 | 36 | 1 | 12 | 1 | 6 | 3 | 115 | 2 | 18 | 1 | 16 | 2 | | | | | | | | | | | | | | | |
| Austria | 16 | 1 | 10 | 1 | 1 | 1 | 11 | 1 | 4 | 1 | 15 | 1 | 1 | 0 | 35 | 1 | 20 | 1 | | | 136 | 2 | 90 | 3 | 7 | 1 | | | | | | | | | | | | | | | |
| Wales | 15 | 1 | 13 | 1 | 1 | 1 | 6 | 0 | 4 | 1 | 10 | 1 | 4 | 1 | 32 | 1 | 12 | 1 | | | 60 | 1 | 30 | 1 | 1 | 0 | | | | | | | | | | | | | | | |
| Ireland | 9 | 0 | 14 | 1 | 9 | 6 | 5 | 0 | 4 | 1 | 9 | 1 | 5 | 1 | 31 | 1 | 3 | 0 | | | 48 | 1 | 38 | 1 | 2 | 0 | | | | | | | | | | | | | | | |
| Norway | 8 | 0 | 3 | 0 | 4 | 3 | 9 | 1 | 1 | 0 | 10 | 1 | 11 | 2 | 30 | 1 | 12 | 1 | 1 | 1 | 73 | 1 | 46 | 2 | 8 | 1 | | | | | | | | | | | | | | | |
| South Africa | 8 | 0 | 8 | 1 | | | 11 | 1 | | | | | | | 26 | 1 | 10 | 1 | | 0 | 155 | 2 | 47 | 2 | 12 | 2 | | | | | | | | | | | | | | | |

Continued ⇨

Table A4: Actual and expected citation rate – all publications (Figure 2)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./Exp. | Av. Exp | Av. Act. |
|---------------------------|----------------|----------------|----------------|------------|------------|------------|
| NHMRC - Institute Fellows | 18146 | 14656 | 1347 | 1.2 | 10.9 | 13.5 |
| NHMRC - Block-funded | 37265 | 32088 | 3330 | 1.2 | 9.6 | 11.2 |
| NHMRC - All Fellows | 49890 | 43838 | 4740 | 1.1 | 9.2 | 10.5 |
| NHMRC - Project Fellows | 33073 | 30245 | 3485 | 1.1 | 8.7 | 9.5 |
| NHMRC | 109843 | 98671 | 11636 | 1.1 | 8.5 | 9.4 |
| NHMRC - Programs | 15602 | 13384 | 1670 | 1.2 | 8.0 | 9.3 |
| Research Institutes | 47496 | 45210 | 5154 | 1.1 | 8.8 | 9.2 |
| NHMRC - Projects | 53724 | 49978 | 6046 | 1.1 | 8.3 | 8.9 |
| NHMRC - Units | 3262 | 2517 | 443 | 1.3 | 5.7 | 7.4 |
| CRCs | 4520 | 4628 | 639 | 1.0 | 7.2 | 7.1 |
| Other University | 111515 | 113201 | 21249 | 1.0 | 5.3 | 5.2 |
| Other Hospital | 50463 | 46014 | 10140 | 1.1 | 4.5 | 5.0 |
| Other Government | 10825 | 11463 | 2620 | 0.9 | 4.4 | 4.1 |
| Australia | 281459 | 267112 | 42621 | 1.1 | 6.3 | 6.6 |
| World | 9986496 | 9986496 | 1543086 | 1.0 | 6.5 | 6.5 |

Table A5: Actual and expected citation rates – Project Grants broad areas of research (Figure 3)

| Broad Area of Research | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp. | Av. Act. |
|-------------------------------|--------------|----------------|----------|------------|----------|----------|
| Basic science | 39150 | 37847 | 4129 | 1.0 | 9.2 | 9.5 |
| Clinical medicine and science | 12754 | 11717 | 1629 | 1.1 | 7.2 | 7.8 |
| Preventative medicine | 2155 | 1043 | 156 | 2.1 | 6.7 | 13.8 |
| Public health | 1745 | 1278 | 296 | 1.4 | 4.3 | 5.9 |
| Health services research | 559 | 439 | 81 | 1.3 | 5.4 | 6.9 |

Table A6: Actual and expected citation rates – Project Grants disciplines (Figure 4)

| Disciplines | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp. | Av. Act. |
|--------------------------------------|--------------|----------------|----------|------------|----------|----------|
| Developmental biology and physiol | 2451 | 2249 | 231 | 1.1 | 9.7 | 10.6 |
| Biochemistry and clinical chemistry | 6799 | 5905 | 496 | 1.2 | 11.9 | 13.7 |
| Cardiovascular diseases and sci | 3644 | 2802 | 356 | 1.3 | 7.9 | 10.2 |
| Endocrinology | 2882 | 2587 | 326 | 1.1 | 7.9 | 8.8 |
| Epidemiology | 1542 | 1231 | 173 | 1.3 | 7.1 | 8.9 |
| Gastrointestinal diseases and sci | 1710 | 1697 | 204 | 1.0 | 8.3 | 8.4 |
| Haematology | 1106 | 1617 | 127 | 0.7 | 12.7 | 8.7 |
| Immunology | 5260 | 5862 | 533 | 0.9 | 11.0 | 9.9 |
| Microbiology, Parasitology, Virology | 4747 | 4126 | 437 | 1.2 | 9.4 | 10.9 |
| Neurological diseases & neurosci | 6413 | 6440 | 851 | 1.0 | 7.6 | 7.5 |
| Oncology and carcinogenesis | 3821 | 3224 | 262 | 1.2 | 12.3 | 14.6 |
| Pharmacology | 2355 | 2256 | 313 | 1.0 | 7.2 | 7.5 |
| Physiology | 2645 | 2664 | 332 | 1.0 | 8.0 | 8.0 |
| Psychiatry and psychology | 1311 | 1018 | 224 | 1.3 | 4.5 | 5.9 |
| Renal diseases and sciences | 929 | 765 | 105 | 1.2 | 7.3 | 8.8 |
| Reproduction | 776 | 822 | 103 | 0.9 | 8.0 | 7.5 |
| Respiratory diseases and sciences | 1163 | 1134 | 156 | 1.0 | 7.3 | 7.5 |
| Vision and ophthalmology | 780 | 851 | 145 | 0.9 | 5.9 | 5.4 |
| Genetics | 3842 | 3573 | 330 | 1.1 | 10.8 | 11.6 |
| Public health | 484 | 363 | 109 | 1.3 | 3.3 | 4.4 |

Table A7: Actual and expected citation rates by type of fellowship and gender (Figure 5)

| Gender | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp. | Av. Act. |
|---------------|---------------|----------------|--------------|------------|------------|------------|
| Institute (M) | 16251 | 12865 | 1127 | 1.3 | 11.4 | 14.4 |
| Institute (F) | 2767 | 2344 | 228 | 1.2 | 10.3 | 12.1 |
| Project (M) | 27110 | 24263 | 2705 | 1.1 | 9.0 | 10.0 |
| NHMRC | 109843 | 98671 | 11636 | 1.1 | 8.5 | 9.4 |
| Project (F) | 5579 | 5661 | 759 | 1.0 | 7.5 | 7.4 |

Table A8: Most highly cited Australian publications—Biochemistry and cell biology (Table 10)

| Sector | Total Pubs | %Pubs in top 1% | | Pubs in top 5% | |
|---------------------------|-------------|-----------------|----------|----------------|----------|
| | No. | No. | % | No. | % |
| NHMRC - Institute Fellows | 357 | 17 | 5 | 37 | 10 |
| NHMRC - Block-funded | 782 | 22 | 3 | 75 | 10 |
| NHMRC - All Fellows | 1209 | 28 | 2 | 93 | 8 |
| Research Institutes | 1378 | 24 | 2 | 106 | 8 |
| NHMRC | 2634 | 47 | 2 | 193 | 7 |
| NHMRC - Projects | 1477 | 19 | 1 | 101 | 7 |
| NHMRC - Project Fellows | 875 | 12 | 1 | 57 | 7 |
| NHMRC - Programs | 330 | 3 | 1 | 20 | 6 |
| CRCs | 167 | 4 | 2 | 7 | 4 |
| Other University | 3230 | 12 | 0 | 97 | 3 |
| Other Hospital | 428 | | | 10 | 2 |
| Other Government | 232 | | | 3 | 1 |

Table A9: Actual and expected citation rates—Biochemistry and cell biology (Figure 6)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act. / Exp. | Av. Exp | Av. Act. |
|---------------------------|----------------|----------------|---------------|-------------|-------------|-------------|
| NHMRC - Institute Fellows | 6024 | 4347 | 357 | 1.4 | 12.2 | 16.9 |
| NHMRC - Block-funded | 10842 | 89667 | 782 | 1.2 | 11.5 | 13.9 |
| NHMRC - All Fellows | 14438 | 12487 | 1209 | 1.2 | 10.3 | 11.9 |
| NHMRC | 29287 | 26969 | 2634 | 1.1 | 10.2 | 11.1 |
| Research Institutes | 15128 | 14141 | 1378 | 1.1 | 10.3 | 11.0 |
| NHMRC - Projects | 15057 | 14767 | 1477 | 1.0 | 10.0 | 10.2 |
| NHMRC - Project Fellows | 8741 | 8439 | 875 | 1.0 | 9.6 | 10.0 |
| CRCs | 1664 | 1641 | 167 | 1.0 | 9.8 | 10.0 |
| NHMRC - Programs | 2995 | 3079 | 330 | 1.0 | 9.3 | 9.1 |
| Other University | 21001 | 22730 | 3230 | 0.9 | 7.0 | 6.5 |
| Other Hospital | 2358 | 2691 | 428 | 0.9 | 6.3 | 5.5 |
| Other Government | 1028 | 1107 | 232 | 0.9 | 4.8 | 4.4 |
| Australia | 60708 | 60105 | 7130 | 1.0 | 8.4 | 8.5 |
| World | 2580057 | 2580057 | 293644 | 1.0 | 8.8 | 8.8 |

Table A10: Actual and expected citation rates—Genetics (Figure 7)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|---------------------------|---------------|----------------|--------------|------------|-------------|-------------|
| NHMRC - Institute Fellows | 1436 | 14220 | 109 | 1.0 | 13.0 | 13.2 |
| NHMRC - Projects | 3430 | 3418 | 264 | 1.0 | 12.9 | 13.0 |
| NHMRC - All Fellows | 2839 | 3214 | 238 | 0.9 | 13.5 | 11.9 |
| NHMRC - Block-funded | 3410 | 3264 | 289 | 1.0 | 11.3 | 11.8 |
| NHMRC | 7207 | 7544 | 650 | 1.0 | 11.6 | 11.1 |
| NHMRC - Project Fellows | 1426 | 1842 | 134 | 0.8 | 13.7 | 10.6 |
| Research Institutes | 2603 | 2870 | 246 | 0.9 | 11.7 | 10.6 |
| NHMRC - Programs | 1294 | 1388 | 147 | 0.9 | 9.4 | 8.8 |
| Other University | 6399 | 6841 | 992 | 0.9 | 6.9 | 6.5 |
| Other Hospital | 1667 | 2103 | 260 | 0.8 | 8.1 | 6.4 |
| Other Government | 445 | 462 | 110 | 1.0 | 4.2 | 4.0 |
| Australia | 17072 | 17917 | 2063 | 1.0 | 8.7 | 8.3 |
| World | 569990 | 569990 | 60842 | 1.0 | 9.4 | 9.4 |

Table A11: Most highly cited Australian publications—Genetics (Table 12)

| Sector | Total Pubs | %Pubs in top 1% | | Pubs in top 5% | |
|---------------------------|------------|-----------------|----------|----------------|----------|
| | No. | No. | % | No. | % |
| NHMRC - Institute Fellows | 109 | 2 | 2 | 13 | 12 |
| NHMRC - Projects | 264 | 7 | 3 | 23 | 9 |
| NHMRC - All Fellows | 238 | 4 | 2 | 19 | 8 |
| NHMRC - Block-funded | 289 | 5 | 2 | 23 | 8 |
| NHMRC | 650 | 10 | 2 | 48 | 7 |
| Research Institutes | 246 | 6 | 2 | 18 | 7 |
| NHMRC - Programs | 147 | 1 | 1 | 9 | 6 |
| NHMRC - Project Fellows | 134 | 2 | 1 | 6 | 4 |
| Other Hospital | 260 | | | 9 | 3 |
| Other University | 992 | 5 | 1 | 30 | 3 |

Table A12: Actual and expected citation rates—Microbiology (Figure 8)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|------------------|---------------|----------------|--------------|------------|------------|------------|
| NHMRC - Projects | 998 | 852 | 123 | 1.2 | 6.9 | 8.1 |
| NHMRC | 1546 | 1446 | 194 | 1.1 | 7.5 | 8.0 |
| Other Hospital | 1695 | 1619 | 278 | 1.0 | 5.8 | 6.1 |
| Other University | 6626 | 6408 | 1193 | 1.0 | 5.4 | 5.6 |
| Other Government | 1135 | 1110 | 212 | 1.0 | 5.2 | 5.4 |
| Australia | 10470 | 10195 | 1801 | 1.0 | 5.7 | 5.8 |
| World | 359305 | 359305 | 63853 | 1.0 | 5.6 | 5.6 |

Table A13: Most highly cited Australian publications—Microbiology (Table 14)

| Sector | Total Pubs | %Pubs in top 1% | | Pubs in top 5% | |
|------------------|------------|-----------------|----------|----------------|----------|
| | No. | No. | % | No. | % |
| NHMRC | 194 | 3 | 2 | 18 | 9 |
| NHMRC - Projects | 123 | 2 | 2 | 11 | 9 |
| Other Hospital | 278 | 4 | 1 | 16 | 6 |
| Other Government | 212 | 1 | 0 | 9 | 4 |
| Other University | 1193 | 13 | 1 | 50 | 4 |

Table A14: Actual and expected citation rates—Biotechnology (Figure 9)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|----------------------|---------------|----------------|--------------|------------|------------|------------|
| NHMRC - Block-funded | 879 | 875 | 125 | 1.0 | 7.0 | 7.0 |
| Research Institutes | 1268 | 1304 | 190 | 1.0 | 6.9 | 6.7 |
| NHMRC | 2489 | 2752 | 386 | 0.9 | 7.1 | 6.4 |
| NHMRC - All Fellows | 664 | 822 | 120 | 0.8 | 6.9 | 5.5 |
| NHMRC - Projects | 1043 | 1298 | 204 | 0.8 | 6.4 | 5.1 |
| Other University | 6564 | 6445 | 1342 | 1.0 | 4.8 | 4.9 |
| Other Hospital | 519 | 641 | 124 | 0.8 | 5.2 | 4.2 |
| Other Government | 634 | 750 | 194 | 0.8 | 3.9 | 3.3 |
| Australia | 11911 | 11979 | 2263 | 1.0 | 5.3 | 5.3 |
| World | 468946 | 468946 | 91618 | 1.0 | 5.1 | 5.1 |

Table A15: Most highly cited Australian publications—Biotechnology (Table 16)

| Sector | Total Pubs | %Pubs in top 1% | | Pubs in top 5% | |
|----------------------|------------|-----------------|----------|----------------|----------|
| | No. | No. | % | No. | % |
| NHMRC - Block-funded | 125 | 3 | 2 | 10 | 8 |
| Research Institutes | 190 | 4 | 2 | 15 | 8 |
| NHMRC | 386 | 4 | 1 | 26 | 7 |
| NHMRC - Projects | 204 | 1 | 0 | 10 | 5 |
| Other University | 1342 | 13 | 1 | 58 | 4 |
| NHMRC - All Fellows | 120 | 2 | 2 | 4 | 3 |
| Other Hospital | 124 | 2 | 2 | 4 | 3 |
| Other Government | 194 | 1 | 1 | 4 | 2 |

Table A16: Actual and expected citation rates—Medical and Health Sciences (Figure 10)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|---------------------------|----------------|----------------|----------------|------------|------------|------------|
| NHMRC - Institute Fellows | 9158 | 8762 | 912 | 1.0 | 9.6 | 10.0 |
| NHMRC - Block-funded | 21083 | 19764 | 2227 | 1.1 | 8.9 | 9.5 |
| NHMRC - All Fellows | 31027 | 28398 | 3391 | 1.1 | 8.4 | 9.1 |
| NHMRC - Programs | 10971 | 8739 | 1213 | 1.3 | 7.2 | 9.0 |
| NHMRC - Project Fellows | 22616 | 20250 | 2538 | 1.1 | 8.0 | 8.9 |
| NHMRC | 71251 | 64776 | 8414 | 1.1 | 7.7 | 8.5 |
| Research Institutes | 30372 | 28653 | 3677 | 1.1 | 7.8 | 8.3 |
| NHMRC - Projects | 35362 | 32868 | 4458 | 1.1 | 7.4 | 7.9 |
| NHMRC - Units | 2711 | 2141 | 364 | 1.3 | 5.9 | 7.4 |
| CRCs | 2324 | 2575 | 414 | 0.9 | 6.2 | 5.6 |
| Other Hospital | 45929 | 40850 | 9291 | 1.1 | 4.4 | 4.9 |
| Other University | 75817 | 72121 | 16022 | 1.1 | 4.5 | 4.7 |
| Other Government | 7439 | 7263 | 1992 | 1.0 | 3.6 | 3.7 |
| Australia | 193262 | 180130 | 33303 | 1.1 | 5.4 | 5.8 |
| World | 6383557 | 6383557 | 1160581 | 1.0 | 5.5 | 5.5 |

Table A17: Most highly cited Australian publications—Medical and Health Sciences (Table 18)

| Sector | Total Pubs No. | %Pubs in top 1% | | Pubs in top 5% | |
|---------------------------|-------------------|-----------------|---|----------------|----|
| | | No. | % | No. | % |
| NHMRC - Institute Fellows | 912 | 26 | 3 | 106 | 12 |
| NHMRC - Block-funded | 2227 | 51 | 2 | 244 | 11 |
| NHMRC - All Fellows | 3391 | 70 | 2 | 344 | 10 |
| NHMRC - Project Fellows | 2538 | 47 | 2 | 247 | 10 |
| NHMRC | 8414 | 139 | 2 | 739 | 9 |
| Research Institutes | 3677 | 62 | 2 | 321 | 9 |
| NHMRC - Projects | 4458 | 51 | 1 | 361 | 8 |
| NHMRC - Programs | 1213 | 26 | 2 | 94 | 8 |
| NHMRC - Units | 364 | 6 | 2 | 26 | 7 |
| CRCs | 414 | 3 | 1 | 21 | 5 |
| Other Hospital | 9291 | 85 | 1 | 370 | 4 |
| Other University | 16022 | 102 | 1 | 540 | 3 |
| Other Government | 1992 | 8 | 0 | 49 | 2 |

Table A18: Actual and expected citation rates—Immunology (Figure 11)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|---------------------------|---------------|----------------|--------------|------------|-------------|-------------|
| NHMRC - Institute Fellows | 2764 | 2366 | 189 | 1.2 | 12.5 | 14.6 |
| NHMRC - Block-funded | 5560 | 5286 | 417 | 1.1 | 12.7 | 13.3 |
| NHMRC - All Fellows | 6662 | 6012 | 512 | 1.1 | 11.7 | 13.0 |
| NHMRC - Project Fellows | 4083 | 3753 | 337 | 1.1 | 11.1 | 12.1 |
| NHMRC | 13591 | 12831 | 1200 | 1.1 | 10.7 | 11.3 |
| NHMRC - Programs | 1807 | 1571 | 169 | 1.1 | 9.3 | 10.7 |
| Research Institutes | 7221 | 7153 | 681 | 1.0 | 10.5 | 10.6 |
| NHMRC - Projects | 5548 | 5770 | 604 | 1.0 | 9.6 | 9.2 |
| CRCs | 1319 | 1295 | 173 | 1.0 | 7.5 | 7.6 |
| Other Hospital | 3833 | 3296 | 530 | 1.2 | 6.2 | 7.2 |
| Other University | 5375 | 5622 | 907 | 1.0 | 6.2 | 5.9 |
| Australia | 24536 | 24168 | 2836 | 1.0 | 8.5 | 8.7 |
| World | 705125 | 705125 | 92669 | 1.0 | 7.6 | 7.6 |

Table A19: Most highly cited Australian publications—Immunology (Table 20)

| Sector | Total Pubs | %Pubs in top 1% | | Pubs in top 5% | |
|---------------------------|-------------|-----------------|----------|----------------|----------|
| | No. | No. | % | No. | % |
| NHMRC - Block-funded | 417 | 12 | 3 | 39 | 9 |
| NHMRC - Institute Fellows | 189 | 8 | 4 | 17 | 9 |
| NHMRC - All Fellows | 512 | 13 | 3 | 45 | 9 |
| NHMRC - Project Fellows | 337 | 6 | 2 | 29 | 9 |
| NHMRC - Programs | 169 | 5 | 3 | 13 | 8 |
| NHMRC | 1200 | 21 | 2 | 86 | 7 |
| Research Institutes | 681 | 9 | 1 | 48 | 7 |
| Other Hospital | 530 | 5 | 1 | 23 | 4 |
| NHMRC - Projects | 604 | 4 | 1 | 26 | 4 |
| Other University | 907 | 3 | 0 | 22 | 2 |
| CRCs | 173 | 2 | 1 | 4 | 2 |

Table A20: Actual and expected citation rates—Pharmacology & pharmaceutical science (Figure 12)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|-------------------------|---------------|----------------|---------------|------------|------------|------------|
| NHMRC - Projects | 2830 | 2666 | 436 | 1.1 | 6.1 | 6.5 |
| NHMRC | 4681 | 4406 | 769 | 1.1 | 5.7 | 6.1 |
| NHMRC - Block-funded | 774 | 719 | 130 | 1.1 | 5.5 | 6.0 |
| NHMRC - Project Fellows | 1491 | 1538 | 261 | 1.0 | 5.9 | 5.7 |
| Research Institutes | 1516 | 1574 | 269 | 1.0 | 5.9 | 5.6 |
| NHMRC - All Fellows | 1821 | 1833 | 324 | 1.0 | 5.7 | 5.6 |
| Other University | 6188 | 6813 | 1485 | 0.9 | 4.6 | 4.2 |
| Other Hospital | 1510 | 1858 | 404 | 0.8 | 4.6 | 3.7 |
| Other Government | 535 | 615 | 176 | 0.9 | 3.5 | 3.0 |
| Australia | 13403 | 13911 | 2758 | 1.0 | 5.0 | 4.9 |
| World | 617084 | 617084 | 134252 | 1.0 | 4.6 | 4.6 |

Table A21: Most highly cited Australian publications—Pharmacology & pharmaceutical science (Table 22)

| Sector | Total Pubs | %Pubs in top 1% | | Pubs in top 5% | |
|-------------------------|------------|-----------------|----------|----------------|----------|
| | No. | No. | % | No. | % |
| NHMRC - Block-funded | 130 | | | 12 | 9 |
| NHMRC - Projects | 436 | 6 | 1 | 36 | 8 |
| NHMRC | 769 | 8 | 1 | 55 | 7 |
| NHMRC - All Fellows | 324 | 4 | 1 | 22 | 7 |
| Research Institutes | 269 | 5 | 2 | 18 | 7 |
| NHMRC - Project Fellows | 261 | 4 | 2 | 17 | 7 |
| Other University | 1485 | 11 | 1 | 56 | 4 |
| Other Hospital | 404 | 1 | 0 | 10 | 2 |
| Other Government | 176 | | | 3 | 2 |

Table A22: Actual and expected citation rates—Medical physiology (Figure 13)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|-------------------------|---------------|----------------|--------------|------------|------------|------------|
| NHMRC - Project Fellows | 2127 | 1918 | 280 | 1.1 | 6.9 | 7.6 |
| Research Institutes | 1791 | 1908 | 247 | 0.9 | 7.7 | 7.3 |
| NHMRC - All Fellows | 2597 | 2504 | 368 | 1.0 | 6.8 | 7.1 |
| NHMRC - Projects | 3436 | 3363 | 493 | 1.0 | 6.8 | 7.0 |
| NHMRC | 5248 | 5306 | 768 | 1.0 | 6.9 | 6.8 |
| NHMRC - Block-funded | 939 | 1031 | 157 | 0.9 | 6.6 | 6.0 |
| Other Hospital | 825 | 766 | 181 | 1.1 | 4.2 | 4.6 |
| Other University | 5606 | 5720 | 1263 | 1.0 | 4.5 | 4.4 |
| Australia | 12110 | 12278 | 2234 | 1.0 | 5.5 | 5.4 |
| World | 323608 | 323608 | 57409 | 1.0 | 5.6 | 5.6 |

Table A23: Most highly cited Australian publications—Medical physiology (Table 24)

| Sector | Total Pubs | %Pubs in top 1% | | Pubs in top 5% | |
|-------------------------|------------|-----------------|----------|----------------|----------|
| | No. | No. | % | No. | % |
| NHMRC - Project Fellows | 280 | 5 | 2 | 25 | 9 |
| NHMRC - Projects | 493 | 6 | 1 | 38 | 8 |
| NHMRC - All Fellows | 368 | 6 | 2 | 27 | 7 |
| Research Institutes | 247 | 4 | 2 | 18 | 7 |
| NHMRC | 768 | 11 | 1 | 55 | 7 |
| NHMRC - Programs | 95 | 3 | 3 | 5 | 5 |
| NHMRC - Block-funded | 157 | 1 | 1 | 7 | 4 |
| Other Hospital | 181 | 2 | 1 | 8 | 4 |
| Other University | 1263 | 7 | 1 | 38 | 3 |

Table A24: Actual and expected citation rates—Neurosciences (Figure 14)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|---------------------------|---------------|----------------|---------------|------------|------------|------------|
| NHMRC - Institute Fellows | 1182 | 1100 | 140 | 1.1 | 7.9 | 8.4 |
| Research Institutes | 3937 | 3806 | 474 | 1.0 | 8.0 | 8.3 |
| NHMRC - Block-funded | 1738 | 1718 | 225 | 1.0 | 7.6 | 7.7 |
| NHMRC - All Fellows | 4725 | 4621 | 665 | 1.0 | 6.9 | 7.1 |
| NHMRC - Project Fellows | 3737 | 3688 | 540 | 1.0 | 6.8 | 6.9 |
| Other Hospital | 3347 | 2967 | 487 | 1.1 | 6.1 | 6.9 |
| NHMRC | 9444 | 9781 | 1387 | 1.0 | 7.1 | 6.8 |
| NHMRC - Projects | 5621 | 5934 | 844 | 0.9 | 7.0 | 6.7 |
| NHMRC - Programs | 1033 | 990 | 182 | 1.0 | 5.4 | 5.7 |
| Other University | 8387 | 9524 | 1600 | 0.9 | 6.0 | 5.2 |
| Australia | 21374 | 22480 | 3395 | 1.0 | 6.6 | 6.3 |
| World | 952672 | 952672 | 136533 | 1.0 | 7.0 | 7.0 |

Table A25: Most highly cited Australian publications—Neurosciences (Table 26)

| Sector | Total Pubs | %Pubs in top 1% | | Pubs in top 5% | |
|---------------------------|-------------|-----------------|----------|----------------|----------|
| | No. | No. | % | No. | % |
| Research Institutes | 474 | 6 | 1 | 35 | 7 |
| Other Hospital | 487 | 5 | 1 | 34 | 7 |
| NHMRC - Block-funded | 225 | 6 | 3 | 14 | 6 |
| NHMRC - Project Fellows | 540 | 6 | 1 | 28 | 5 |
| NHMRC - All Fellows | 665 | 9 | 1 | 34 | 5 |
| NHMRC - Institute Fellows | 140 | 4 | 3 | 7 | 5 |
| NHMRC | 1387 | 16 | 1 | 65 | 5 |
| NHMRC - Projects | 844 | 5 | 1 | 39 | 5 |
| Other University | 1600 | 11 | 1 | 55 | 3 |
| NHMRC - Programs | 182 | 2 | 1 | 6 | 3 |

Table A26: Most highly cited Australian publications—Clinical sciences (Table 28)

| Sector | Total Pubs | %Pubs in top 1% | | Pubs in top 5% | |
|---------------------------|-------------|-----------------|----------|----------------|----------|
| | No. | No. | % | No. | % |
| NHMRC - Institute Fellows | 517 | 10 | 2 | 54 | 10 |
| NHMRC - All Fellows | 1902 | 34 | 2 | 184 | 10 |
| NHMRC - Project Fellows | 1411 | 26 | 2 | 136 | 10 |
| NHMRC - Block-funded | 1459 | 24 | 2 | 134 | 9 |
| NHMRC - Units | 226 | 5 | 2 | 20 | 9 |
| NHMRC | 5102 | 72 | 1 | 417 | 8 |
| NHMRC - Projects | 2588 | 27 | 1 | 204 | 8 |
| Research Institutes | 2270 | 30 | 1 | 167 | 7 |
| NHMRC - Programs | 802 | 16 | 2 | 57 | 7 |
| Other University | 9784 | 75 | 1 | 380 | 4 |
| Other Hospital | 7935 | 75 | 1 | 301 | 4 |
| CRCs | 250 | 1 | 0 | 9 | 4 |
| Other Government | 1222 | 5 | 0 | 30 | 2 |

Table A27: Actual and expected citation rates—Clinical sciences (Figure 15)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|---------------------------|----------------|----------------|---------------|------------|------------|------------|
| NHMRC - Institute Fellows | 4900 | 4725 | 517 | 1.0 | 9.1 | 9.5 |
| NHMRC - Programs | 7600 | 5542 | 802 | 1.4 | 6.9 | 9.5 |
| NHMRC - Project Fellows | 13099 | 11183 | 1411 | 1.2 | 8.0 | 9.3 |
| NHMRC - All Fellows | 17565 | 15561 | 1902 | 1.1 | 8.2 | 9.2 |
| NHMRC - Block-funded | 12936 | 11817 | 1459 | 1.1 | 8.1 | 8.9 |
| NHMRC | 43568 | 37654 | 5102 | 1.2 | 7.4 | 8.5 |
| NHMRC - Projects | 21363 | 18523 | 2588 | 1.2 | 7.2 | 8.3 |
| NHMRC - Units | 1818 | 1456 | 226 | 1.2 | 6.4 | 8.0 |
| Research Institutes | 17609 | 16103 | 2270 | 1.1 | 7.1 | 7.8 |
| Other University | 52288 | 47015 | 9784 | 1.1 | 4.8 | 5.3 |
| Other Hospital | 40285 | 35064 | 7935 | 1.1 | 4.4 | 5.1 |
| CRCs | 1165 | 1306 | 250 | 0.9 | 5.2 | 4.7 |
| Other Government | 4804 | 4759 | 1222 | 1.0 | 3.9 | 3.9 |
| Australia | 131231 | 116931 | 21921 | 1.1 | 5.3 | 6.0 |
| World | 4155300 | 4155300 | 771671 | 1.0 | 5.4 | 5.4 |

Table A28: Actual and expected citation rates—Public health and health services (Figure 16)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|----------------------|---------------|----------------|---------------|------------|------------|------------|
| NHMRC - All Fellows | 1016 | 712 | 111 | 1.4 | 6.4 | 9.2 |
| NHMRC - Block-funded | 1178 | 969 | 163 | 1.2 | 5.9 | 7.2 |
| NHMRC | 2868 | 2417 | 487 | 1.2 | 5.0 | 5.9 |
| NHMRC - Projects | 1158 | 988 | 221 | 1.2 | 4.5 | 5.2 |
| Research Institutes | 877 | 797 | 210 | 1.1 | 3.8 | 4.2 |
| Other Hospital | 2012 | 2116 | 605 | 1.0 | 3.5 | 3.3 |
| Other Government | 1833 | 1758 | 574 | 1.0 | 3.1 | 3.2 |
| Other University | 8116 | 8318 | 2561 | 1.0 | 3.2 | 3.2 |
| Australia | 13111 | 13148 | 3764 | 1.0 | 3.5 | 3.5 |
| World | 387583 | 387583 | 104289 | 1.0 | 3.7 | 3.7 |

Table A29: Most highly cited Australian publications—Public health and health services (Table 30)

| Sector | Total Pubs No. | %Pubs in top 1% | | Pubs in top 5% | |
|----------------------|-------------------|-----------------|----------|----------------|-----------|
| | | No. | % | No. | % |
| NHMRC - All Fellows | 111 | 7 | 6 | 21 | 19 |
| NHMRC - Block-funded | 163 | 7 | 4 | 20 | 12 |
| NHMRC | 487 | 14 | 3 | 55 | 11 |
| NHMRC - Projects | 221 | 6 | 3 | 20 | 9 |
| Research Institutes | 210 | 4 | 2 | 12 | 6 |
| Other Government | 574 | 5 | 1 | 27 | 5 |
| Other University | 2561 | 19 | 1 | 109 | 4 |
| Other Hospital | 605 | 5 | 1 | 25 | 4 |

Table A30: Actual and expected citation rates—Medicine general (Figure 17)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|-------------------------|---------------|----------------|--------------|------------|------------|------------|
| NHMRC - Project Fellows | 1981 | 1792 | 163 | 1.1 | 11.0 | 12.2 |
| Research Institutes | 3688 | 3319 | 307 | 1.1 | 10.8 | 12.0 |
| NHMRC - All Fellows | 2893 | 2834 | 242 | 1.0 | 11.7 | 12.0 |
| NHMRC - Block-funded | 2276 | 2321 | 210 | 1.0 | 11.1 | 10.8 |
| NHMRC | 5842 | 5622 | 590 | 1.0 | 9.5 | 9.9 |
| NHMRC - Projects | 2359 | 2443 | 279 | 1.0 | 8.8 | 8.5 |
| Other University | 2992 | 2889 | 526 | 1.0 | 5.5 | 5.7 |
| Other Hospital | 1301 | 1388 | 258 | 0.9 | 5.4 | 5.0 |
| Australia | 11503 | 11116 | 1460 | 1.0 | 7.6 | 7.9 |
| World | 362220 | 362220 | 55562 | 1.0 | 6.5 | 6.5 |

Table A31: Most highly cited Australian publications—Medicine general (Table 32)

| Sector | Total Pubs | %Pubs in top 1% | | Pubs in top 5% | |
|-------------------------|------------|-----------------|----------|----------------|----------|
| | No. | No. | % | No. | % |
| NHMRC - Project Fellows | 163 | 3 | 2 | 16 | 10 |
| NHMRC - All Fellows | 242 | 5 | 2 | 23 | 10 |
| Research Institutes | 307 | 10 | 3 | 28 | 9 |
| NHMRC - Block-funded | 210 | 4 | 2 | 19 | 9 |
| NHMRC | 590 | 8 | 1 | 41 | 7 |
| NHMRC - Projects | 279 | 1 | 0 | 16 | 6 |
| Other University | 526 | 2 | 0 | 16 | 3 |
| Other Hospital | 258 | | | 5 | 2 |

Table A32: Actual and expected citation rates—Multidisciplinary science (Figure 18)

| Sector | Actual Cites | Expected Cites | No. Pubs | Act./ Exp. | Av. Exp | Av. Act. |
|----------------------|---------------|----------------|--------------|------------|-------------|-------------|
| NHMRC - Block-funded | 3691 | 2237 | 102 | 1.6 | 21.9 | 36.2 |
| NHMRC - All Fellows | 4099 | 2993 | 129 | 1.4 | 23.2 | 31.8 |
| NHMRC | 6415 | 4887 | 224 | 1.3 | 21.8 | 28.6 |
| Other Government | 1320 | 1950 | 137 | 0.7 | 14.2 | 9.6 |
| Other University | 8718 | 12590 | 926 | 0.7 | 13.6 | 9.4 |
| Australia | 23021 | 22295 | 1425 | 1.0 | 15.6 | 16.2 |
| World | 892807 | 892807 | 71513 | 1.0 | 12.5 | 12.5 |

Table A33: Most highly cited Australian publications—Multidisciplinary science (Table 34)

| Sector | Total Pubs | %Pubs in top 1% | | Pubs in top 5% | |
|----------------------|------------|-----------------|----------|----------------|-----------|
| | No. | No. | % | No. | % |
| NHMRC - All Fellows | 129 | 3 | 2 | 21 | 16 |
| NHMRC - Block-funded | 102 | 4 | 4 | 16 | 16 |
| NHMRC | 224 | 5 | 2 | 29 | 13 |
| Other Government | 137 | | | 5 | 4 |
| Other University | 926 | 5 | 1 | 24 | 3 |

The National Health and Medical Research Council

The National Health and Medical Research Council (NHMRC) was established in 1936 and is now a statutory body within the portfolio of the Australian Government Minister for Health and Ageing, operating under the *National Health and Medical Research Council Act 1992* (NHMRC Act). The NHMRC advises the Australian community and the Australian Government, and State and Territory governments on standards of individual and public health, and supports research to improve those standards.

The NHMRC Act provides four statutory obligations:

- to raise the standard of individual and public health throughout Australia;
- to foster development of consistent health standards between the states and territories;
- to foster medical research and training and public health research and training throughout Australia; and
- to foster consideration of ethical issues relating to health.

The NHMRC also has statutory obligations under the *Prohibition of Human Cloning Act 2002* (PHC Act) and the *Research Involving Human Embryos Act 2002* (RIHE Act).

The activities of the NHMRC translate into four major outputs: health and medical research; health policy and advice; health ethics; and the regulation of research involving donated IVF embryos, including monitoring compliance with the ban on human cloning and certain other activities.

A regular publishing program ensures that Council's recommendations are widely available to governments, the community, scientific, industrial and education groups. The Council publishes in the following areas:

- Aboriginal and Torres Strait Islander Health
- Aged Care
- Blood and Blood Products
- Cancer
- Cardiovascular Health
- Child Health
- Clinical Practice Guidelines – Standards for Developers – Topics
- Communicable Diseases, Vaccinations and Infection Control
- Diabetes
- Drug and Substance Abuse
- Environmental Health
- Ethics in Research–Animal
- Ethics in Research–Human
- Genetics and Gene Technology
- Health Procedures
- Health Promotion
- Human Cloning and Embryo Research
- Indigenous Health
- Injury including Sports Injury
- Men's Health
- Mental Health
- Musculoskeletal
- NHMRC Corporate documents
- NHMRC Session Reports
- Nutrition and Diet
- Oral Health
- Organ Donation
- Poisons, Chemicals and Radiation Health
- Research
- Women's Health

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