**School of Media, Creative Arts and Social Inquiry**

# A Study of Open Access Publishing by NHMRC Grant Recipients

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# Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

The research presented and reported in this thesis was conducted in accordance with Chapters 5.1.7 and 5.1.18-5.1.21 of the National Health and Medical Research Council, the Australian Research Council and the Australian Vice-Chancellors Committee *National Statement on Ethical Conduct in Human Research* (NHMRC, ARC & ACCC, 2015).

The research study received human research ethics approval from the Curtin University Human Research Ethics Committee (EC00262), Approval Number MCCA-04-14.

Signature:

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# Abstract

In 2012, Australia's premier medical research funder, the National Health and Medical Research Council implemented its policy mandating open access for all Council funded journal articles along with the deposit of metadata in Australian institutional repositories. An extensive literature revealed the diverse range of journal open access models and the low levels of author participation in depositing accepted manuscripts in repositories. Within this context, this study investigated the extent of compliance with the Council's Open Access Policy during its first two full years.

A key finding of this study was that over two-thirds (67.3%) of the articles were open access, most published in journals (56.24%) with a small number of accepted manuscripts located in Australian institutional repositories (7.24%) and PubMed Central (3.82%). The extent of open access articles published in journals was higher than that reported by other studies. Hybrid open access comprised 25.58%, with 20.85% in fully open access journals. Delayed open access journals contributed 8.75%.

The level of metadata in institutional repositories was high (74.92%), mostly due to the work of repository staff. Despite grant recipients having access to author accepted manuscripts at the time of acceptance, the deposit of these versions in institutional repositories was low. Issues affecting deposits in repositories included the authors' lack of understanding of the requisite open access version, complicated repository procedures, and publishers' embargoes beyond the twelve months mandated by the Council's Policy.

This study is the first comprehensive investigation to measure compliance with Australia's earliest national-level open access policy. Filling a gap in information about the publishing patterns of the Council's grant recipients, the research also highlighted the need for supportive guidelines, procedures, and programs for authors. A coherent national approach addressing the main issues of open access would increase awareness and greater compliance with the National Health and Medical Research Council Open Access Policy.

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# List of Abbreviations

| | |
|---|---|
| APC | Article processing charge or articles publication charge |
| AOASG | Australasian Open Access Strategy Group |
| AAM | Author Accepted Manuscript, also referred to as a postprint |
| ARROW | Australian Research Repositories Online to the World |
| BOAI | Budapest Open Access Initiative |
| CC | Creative Commons |
| CC BY | Creative Commons Attribution |
| CC BY-NC | Creative Commons Attribution Non-Commercial |
| CC BY-NC-ND | Creative Commons Attribution Non-Commercial No-Derivative |
| CC BY-ND | Attribution-No Derivatives |
| CC BY-SA | Attribution-ShareAlike |
| DOAJ | Directory of Open Access Journals |
| DOI | Digital Object Identifier |
| IR | Institutional repository |
| NIH | National Institutes of Health |
| NLA | National Library of Australia |
| OA | Open Access |
| PLOS | Public Library of Science |
| PMC | PubMed Central |
| RoMEO | Rights Metadata for Open Archiving |
| SCN | Scholarly collaboration (or communication) network |
| SHERPA | Securing a Hybrid Environment for Research Preservation and Access |
| VoR | Version of Record |
| WoS | Web of Science |

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# Chapter 1: Introduction

Open Access (OA) mandates are policies that require researchers to provide free and unobstructed access to their published research. In May 2018, there were over 900 OA mandates internationally, of which funders, including those collaborating with research organisations, made up 15% (ROARMAP, 2018). Government funders are keen to demonstrate the use of publicly funded research to serve the public good (Pinfield, 2015). Funders also wish "to secure maximum impact for the research they fund, plus value for money" (Finch, 2012, p. 6). For researchers and members of the public, the benefits of OA publishing include research sharing and addressing equity issues, especially to health information (Spedding, 2016).

OA is a complicated concept with a range of definitions. Some definitions of open access encompass publicly accessible publications that do not permit reuse. The Budapest Open Access Initiative (BOAI) set the standard as the first formal statement on OA peer-reviewed literature and defined OA as "free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles …" (BOAI, 2002, para. 3). The OA movement promoted the growth in journal OA models and repositories. Notwithstanding, OA publishing in hybrid subscription journals and the deposits of author accepted manuscripts in institutional repositories have been low (Laakso, 2014; Laakso & Björk, 2012; Solomon, 2014).

OA advocates are optimistic that OA policies will increase the extent of scholarly OA research, especially in repositories. Harnad (2015) recommended that the "only way to get peer-reviewed journal articles to be made OA is to mandate (require) that they must be made OA" (para. 12). Indeed, Frosio (2014) assessed funder OA policies as "another critical contribution to the OAP [OA publishing] movement" (p. 175). A large body of literature exists on the extent of OA, but there have been few investigations of compliance with national OA mandates, the work of Borrego (2016) being the primary exception.

On 1 July 2012, the National Health and Medical Research Council (hereafter referred to as the NHMRC or the Council) put in force the *Revised Policy on Dissemination of Research Findings* (NHMRC, 2012a). The 2012 and 2014 versions of the policy were the initial frameworks for this study, the various titles uniformly referred to as the NHMRC OA Policy (NHMRC, 2012a; NHMRC, 2014b; NHMRC, 2014c). While a reflection of OA developments in Australia, the policy is also in alignment with the global implementation of OA policies by funding bodies, governments, and institutions.

The NHMRC's primary rationale for the OA Policy was "to maximise the benefits from research, publications resulting from research activities must be disseminated as broadly as possible to allow access by other researchers and the wider community" (NHMRC, 2014b, para. 1). The Council also emphasised the importance of the "open access sharing of publications" (NHMRC, 2018, para. 1). To promote the dissemination of funded research, the NHMRC recognised the need for the deposit of the metadata of all funded journal articles in the institutional repositories of grant recipients. Compliance with the NHMRC OA Policy includes:

- OA published articles in journals;
- Author accepted manuscripts in institutional and subject repositories;
- Publication metadata of journal articles in Australian institutional repositories.

This study investigates the extent of compliance during the first two full years of the Council's mandate.

# Problem Statement

The NHMRC OA Policy mandates OA for all Council funded journal articles, but the extent of OA compliance is unknown. While literature demonstrates the increase in the range of journal OA models, it also records low levels of author participation in depositing author accepted manuscripts in repositories.

## Research Questions

Four detailed research questions relating to NHMRC funded peer-reviewed journal articles published 2013 and 2014 drive this study:

1. What proportion of NHMRC funded articles is open access in journals?
2. What proportion of NHMRC funded articles not open access in journals has author accepted manuscripts in at least one Australian institutional repository?
3. What proportion of NHMRC funded journal article metadata is in Australian institutional repositories?

The policies of journal titles are the subject of the final research question:

4. What are the open access models and author accepted manuscript policies of the journal titles in which NHMRC grant recipients publish?

## The Significance of the Study

This study is significant for many reasons:

- It is the first study into compliance with the NHMRC OA Policy during its early years;
- It measures the extent to which researchers and the broader community have access to NHMRC publications;
- It reveals a greater understanding of the publishing pattern of Australian medical and health researchers; and
- It contributes to international bibliometric studies into the extent of OA publishing, especially under funder OA mandates.

The benefits of the study include:

- A better understanding of the dissemination of publicly funded NHMRC research to the broader community and other researchers;
- The documentation of the journal publishing patterns of NHMRC researchers especially OA articles;
- The compilation of data of interest to repository and library managers to assist in the promotion of institutional repositories;
- A demonstration of a practical example in which the bibliometric method can support an understanding of funder mandates and scholarly OA.

## Definitions

There are two main routes to OA: by publishing OA (the gold route) or by depositing OA versions in repositories and websites (the green route). Definitions of the two main routes to OA are:

- **Gold Open Access** (gold OA**)**: the approach or route to scholarly OA by publishing OA in scholarly publications such as journals, books, and conference proceedings.
- **Green Open Access** (green OA**)**: the approach or route to scholarly OA by depositing OA versions in repositories and websites.

The BOAI specified the "new generation of open-access journals" (BOAI, 2002, para. 6) as the means to achieve OA in peer-reviewed journals. By "open-access journals", the BOAI identified fully and immediately OA journals listed in the Directory of Open Access Journals (DOAJ) that are accessible without subscriptions.

Non-subscription as well as subscription journals support a range of journal OA models. Journal OA models include:

- **Fully open access journals** (**OAJD**): a journal OA model in which all content is fully and immediately OA, the journal titles listed in the DOAJ.
- **Hybrid Open Access** (**hybrid OA**): a journal OA model that provides immediate OA at the article level in a subscription journal upon payment of an Article Processing Charge.
- **Delayed Open Access** (**delayed OA**): a journal OA model providing access after an embargo period.
- **Partial Open Access** (**partial OA**): a journal OA model in which some articles, usually research articles, are freely available.
- **Gratis Open Access** (**gratis OA**): a journal OA model in which articles are free to the public but usually without open licensing and the right to reuse.

Publishing an OA article in a journal sometimes incurs an **Article Processing Charge** (**APC**), which is a fee charged by publishers to publish OA. In the case of hybrid subscription journals, APCs are additional to subscriptions.

Creative Commons licensing and reuse are also key concepts in the understanding of OA. Relevant definitions appear below:

- **Creative Commons (CC)**: A non-profit organisation that provides a range of legal CC licences to determine the extent of sharing or reuse.
- **CC BY (Creative Commons Attribution):** The CC licence permitting authors to retain copyright and allowing reuse with the attribution of the authors and the source.
- **Reuse right:** Granting permission to reuse publications in repositories and on websites usually through a CC licence.
- **Public access**: Free access without the freedom to reuse.

For information on other types of CC licences, see Appendix E: Glossary.

Green OA is the route to OA that includes the deposit of OA versions in repositories. The three main OA versions deposited in repositories are the:

- **Preprint**: The author's version of a manuscript submitted to a journal or other publication that has not been through the publisher's peer-review process.
- **Author Accepted Manuscript (AAM)**: The final version of a manuscript before publication after peer-review and revisions.
- **Publisher's version**: The version of record (VoR) published in its final form.

To the NHMRC, the author accepted manuscript under its OA policy is the "version of a manuscript that has been through the peer-review process of the publisher and has addressed the peer-reviewers' comments" (NHMRC, 2018, p. 9). While not mandated by the Council's OA Policy, the NHMRC encourages the deposit of the publisher's versions in repositories on condition that they comply with copyright and licensing requirements. Preprints, OA versions preceding peer-review, are non-compliant with most funder policies, including the NHMRC OA Policy.

The NHMRC identified the deposit of author manuscripts in institutional and subject repositories as compliant with its policy. Definitions of institutional and subject repositories appear below:

- **Institutional Repository:** An online and publicly accessible repository (usually hosted by an institution) that stores and preserves the metadata and OA versions of scholarly publications and research data. Another term for an

institutional repository (hereafter IR) is a research publication repository (RPR).

- **Subject repository:** An online repository that collects and preserves the intellectual digital output within a discipline(s) or subject(s). Examples of subject repositories include PubMed Central (PMC) specific to medicine and arXiv specialising in physics.

## Research Design and Methods

Quantitative research design is best suited to answer the research questions posed by this study. The main benefit of quantitative research includes its usefulness in reducing large quantities of data to a manageable form (Connaway & Radford, 2016; Gall, Borg, & Gall, 1996; Wildemuth, 2016). Research questions in quantitative research design are generally characterised by the "what" questions asking "what is the amount or extent of a given variable?" (Connaway & Radford, 2016, p. 79).

Quantitative research relating to a body of scholarly literature or communication is known as bibliometrics (Narin, 1976; Nicholas & Ritchie, 1978; Van Leeuwen, 2004). Bibliometric research uses quantitative methods to describe a body of literature or communication in order "to explore the communication patterns, trends and networks occurring in that literature" (Haddow, 2018, p. 241). The bibliometric methodology is appropriate when describing the features and characteristics of a large set of publication data.

The body of literature in this study is NHMRC funded journal articles published during 2013 and 2014. Bibliographic databases are valuable sources of publication data, including NHMRC funded articles. As the bibliometric method is quantitative, numeric coding is integral to the design of the journal instruments and coding sheets for data collection and analysis. Statistical programs, including Microsoft Excel, are useful tools for storing and analysing bibliometric data.

## Data Analysis

Data analysis in bibliometrics is the process of making sense of quantitative data, including the identification of patterns and trends in a body of literature. Data analysis involves an integrated and systematic approach, which achieves a detailed

and objective understanding of the data and valid results or solutions to identified problems. The steps in data analysis include the categorisation of the data and the calculation of appropriate statistics. The use of descriptive statistics enables the interpretation of the data to communicate the characteristics of publications, with tables, charts and other graphical formats providing alternative presentations of numerical results.

## Assumptions

The concept of OA is complicated, and sometimes used interchangeably with the principle of public access. The tenet of OA represents the freedom to share, copy and redistribute. The idea of public access incorporates free access but not permission to reuse (Suber, 2012). As the Council makes no restriction on the journals in which researchers choose to publish their articles, the assumption is that all journal OA models are compliant. Some studies make a distinction between those journals that meet the BOAI definition of scholarly OA, and those that do not, such as delayed or gratis OA journals (Piwowar et al., 2017).

The other assumption is that, while there are a wide variety of OA versions, the AAM or postprint is the version required under the NHMRC OA Policy. The NHMRC does not mandate published articles in repositories, although the Council has no issue with their deposit on condition that they meet copyright and licensing requirements. Preprints, as versions preceding formal peer-review, are non-compliant under the NHMRC OA Policy.

It is also an assumption that the inclusion of the NHMRC grant identification (ID) number in the metadata of IRs was a requirement from the very beginning. The Council in 2012 advised that "any material published in respect of an NHMRC-funded research activity must include acknowledgement of NHMRC's funding, including the grant identification number (clause 20.2)" (NHMRC, 2012a, "What information needs to be submitted to the institutional repository and when?"). In February 2014, the NHMRC explicitly stated that the "Chief Investigator A (CIA) on the NHMRC grant is responsible for providing the publication metadata and relevant NHMRC Grant ID …." (NHMRC, 2014b, "Who is responsible for implementing the

policy?"). The acknowledgement of the Council and grant IDs is also a condition of NHMRC funding agreements.

## Thesis Structure

The thesis comprised five chapters including the current chapter, *Chapter 1: Introduction*, which outlines the research problem and questions, definitions of the terminology, and a brief description of the bibliometric method including quantitative data collection and analysis. *Chapter 2: Background and Literature Review* begins with information on the intricacies of the NHMRC OA Policy, followed by a discussion of the various journal OA publishing models. The next section of the chapter includes a review of the bibliometric studies into OA. Also reviewed is the literature on international funder OA policies and the research into compliance with these policies. This chapter concludes with a discussion of the challenges of conducting journal studies, especially as journal titles vary in volume and rates of publication.

*Chapter 3: Research Design, Methods and Data Analysi*s explains the bibliometric method in more detail, followed by a description of the data collection process, including the units of measurement, the features of the two main instruments, the reasons for and the methods used in sampling, and the time frames used for data collection. Also described are the units of data analysis and the use of descriptive statistics. *Chapter 4: Results* presents the study findings that answer the research questions. *Chapter 5: Discussion* interprets and discusses the results emerging from the study, explains the implications and possible reasons for the specific outcomes, including comparisons with other studies. *Chapter 6: Conclusion* summarises the significant findings regarding OA compliance under the NHMRC OA Policy, acknowledges the study's limitations, and makes recommendations for further research.

## Research Ethics

This study received approval under Curtin University's process for low-risk research (Approval Number MCCA-04-14) and is compliant with Chapters 5.1.7, 5.1.18-5.1.21 of the *National Statement on Ethical Conduct in Human Research* (NHMRC,

ARC & ACCC, 2015). The numerically coded data protects the identity of authors, institutions, IRs, and areas of research. The results of this research comprise aggregated data, with individual researchers and institutions not reported. The approach averted the risk of divulging information that could be detrimental to those authors and institutions securing future funding.

# Chapter 2: Background and Literature Review

A vast body of literature surrounds scholarly OA, although only a small proportion focusses on compliance with funder policies. The two complementary strategies recommended by BOAI (2002) to achieve OA of scholarly journal articles also apply to compliance under funder mandates. The BOAI strategies include publishing in the "new generation of journals committed to open access" and depositing "refereed journal articles in open electronic archives, a practice commonly called, self-archiving" (BOAI, 2002, para. 5). The BOAI identified OA journals listed in the DOAJ as the new generation of journals, and PMC and arXiv as examples of open electronic archives. The growth in journal OA models and the IRs also contributed to the extensive range of options available to researchers when making decisions about publishing and meeting the requirements of OA policies (Ware & Mabe, 2015).

This chapter begins with a description of international funder mandates, followed by background information on the intricacies of the NHMRC OA Policy. To provide context to funder mandates, a review of the literature on the various OA publishing models is necessary, including OA provided by journal publishers and accepted OA versions in repositories. An essential part of the chapter focuses on bibliometric studies into OA, incorporating investigations into the extent of scholarly OA. The next section introduces funder OA policies internationally, including their similarities and differences. Finally, there is a description of the growing body of bibliometric literature into funding acknowledgement data and the extent to which authors provide this data.

## Background to Funder Open Access Mandates

While the theoretical foundation for funder mandates emanates from the BOAI (2002) declaration, an examination of the *Registry of Open Access Repository Mandates and Policies* (ROARMAP) demonstrates considerable diversity in funder policies (ROARMAP, 2018). The mandates differ in their requirements, with some preferring immediate published OA, while others specify the deposit of the AAMs in repositories.

The United States National Institutes of Health (NIH), the Wellcome Trust, and the research councils making up Research Councils UK (RCUK) were among the first funders to mandate OA of funded research. The NIH Public Access Policy came into effect in 2008 (United States. Department of Health & Human Services, 2008). The NIH mandate requires all funded peer-reviewed articles to be accessible to the public by publishing in participating publishers' journals or depositing author manuscripts in PMC (PubMed Central, n.d.-b). Many publishers lodge publications in PMC on behalf of the authors. Over a third of the three million articles in PMC have CC BY licences permitting redistribution and reuse (Ware & Mabe, 2015).

In Canada, the Tri-Agency Open Access Policy on Publications applies to several agencies and requires peer-reviewed journal publications arising from agency-supported research to be freely accessible within 12 months of publication. Grant recipients do this by publishing their articles in journals offering immediate or delayed OA of 12 months or less, or by depositing accepted manuscripts into IRs or disciplinary repositories such as PMC. For the decade from 2008, the Canadian Institutes of Health Research (CIHR) mandated CIHR funded AAMs in PMC Canada, but the deposit was low. With the decommissioning of PMC Canada in early 2018, CIHR transferred their collection of AAMs to the National Research Council digital repository with authors required to deposit in IRs (Canadian Institutes of Health Research, 2017, December 18).

Lasthiotakis, Kretz and Sá (2015) found similarities in the time frames and monitoring in the OA policies of research councils in the United Kingdom (UK), United States (USA) and Canada. Under the *RCUK Policy on Open Access and Supporting Guidance* (Research Councils UK, 2013), most research councils support the granting of funds to offset OA costs, including APCs. The Open Access Research Policy of the Higher Education Funding Councils for England (HEFCE) identified OA in journals as well as the deposit of AAMs in repositories for recognition under the Research Excellence Framework (HEFCE, 2016).

The Wellcome Trust, an independent global charitable foundation, introduced its mandatory OA policy in 2005 (Wellcome Trust, n.d.). The initial mandate of the Trust encouraged immediate OA by providing grant holders with additional funding to

cover APCs in all journal OA models (Pinfield, 2015; Pinfield, Salter, & Bath, 2017). Under the Wellcome Trust policy, authors who publish non-OA articles are compliant by depositing AAMs in Europe PMC within six months of publication (Wellcome Trust, n.d.). In 2018, the Wellcome Trust reviewed its OA policy, especially the use of grants to pay for APCs in hybrid subscription journals. A predicted outcome is greater support for publishing in OAJDs over hybrid OA (Kingsley, 2018, June 4).

The UK Working Group on Expanding Access to Published Research Findings, known as the Finch Committee after its chair Janet Finch, examined the accessibility of UK funded research findings (Finch Committee, 2012). The Finch Committee criticised the effectiveness of funder and institutional OA policies and UK IRs for low deposits under funder and institutional mandates. According to the Finch Committee report published in 2012:

> Most universities in the UK now have an institutional repository, though there are considerable differences in size and scope of holdings, and levels of usage. The policies of neither research funders nor universities themselves have yet had a major effect in ensuring that researchers make their publications accessible in institutional repositories as a matter of routine: levels of deposit as yet remain low, and for journal articles in particular, most of the records in institutional repositories tend to consist of metadata rather than full text (Finch Committee, 2012, p. 82).

The Committee concluded that funder and institutional mandates have little effect on increasing OA content in IRs, with most of the records consisting of metadata.

There has been criticism of UK funders for allowing grant money to pay for APCs over support for IRs (Pinfield et al., 2017). Pinfield (2015) described the situation as a "mandated Gold-oriented environment" (p. 619). In 2017, the HEFCE, the RCUK, the Joint Information Systems Committee UK (JISC) and the Wellcome Trust commissioned a review of institutions' progress in delivering funders' OA policies. The survey reported that 60% of research outputs met the OA deposit and access requirements for Research Excellence Framework 2021 (Research England, Fraser, Hill, Snaith, & Taffs, 2018). The report of the survey also described the considerable manual work undertaken by IR staff to achieve the level of OA compliance:

> Manually depositing authors' accepted manuscripts (AAMs) is resource-intensive. Many institutions put this down to publishers either not informing institutions (as opposed to authors) when a manuscript has been accepted, or not providing the relevant metadata via APIs for software to automatically ingest (Research England et al., 2018, p. 22).

The survey reported that the complexities of publisher policies, variations in embargo periods, and the lack of publisher and funder policy alignment contributed to the demanding work of depositing AAMs in IRs (Research England et al., 2018). In the wake of the survey, the HEFCE ceased to exist in April 2018 with its duties divided between the newly created Office for Students and Research England (Research England, n.d.).

The implementation of OA policies by Australia's leading funders, the Australian Research Council (ARC) and the NHMRC, brought the councils into line with other international research funding agencies in the USA and the UK. The chief principle behind both Australian OA policies is the provision of public access to publicly funded research (ARC, 2017; NHMRC, 2012b; NHMRC, 2014b; NHMRC, 2014c; NHMRC, 2018). The main difference between the NHMRC and ARC policies is that the latter includes scholarly books, book chapters, as well as non-traditional research outputs. The other significant difference relates to timing. The NHMRC OA Policy applies to journal articles (and later peer-reviewed conference papers) published from 1 July 2012, regardless of the date of grant that supported the research. The ARC OA policy relates to all funded research outputs since 1 January 2013.

The Australian Department of Industry, Innovation and Science (DIIS) also urged universities and publicly funded research agencies to implement OA policies:

> The Australian, and State and Territory governments should implement an open access policy for publicly funded research. The policy should provide free and open access arrangements for all publications funded by governments, directly or through university funding, within 12 months of publication. The policy should minimise exemptions (DIIS, 2017, p. 18).

The Australian Productivity Commission recommended all Australian, State and Territory Governments "implement an open access policy for publicly-funded research" (Productivity Commission, 2016, p. 38).

The Council for Australian University Librarians (CAUL), the peak leadership organisation for university libraries in Australia, recognises the benefits of the wide dissemination of research especially under funder and institutional OA policies (CAUL, 2015). CAUL and its member institutions facilitate open scholarship by developing infrastructure, including IRs, and by collaborating with researchers, educators, universities, and publishers to raise awareness of the principles, practice, and benefits of OA publishing. The Australasian Open Access Strategy Group (AOASG), supported by several Australian and New Zealand institutions with a commitment to OA, promotes OA awareness. The AOASG synthesises information on funder OA mandates in Australasia and globally and provides summaries of the policies and evaluations about the strengths and weaknesses (AOASG, 2015).

The libraries of the Group of Eight Australia (Go8) universities also acknowledge the need to comply with the funding rules and OA policies of the ARC, NHMRC and other major international and private research funding organisations. In a statement, Go8 university libraries committed to:

- develop governance frameworks, services and infrastructure (e.g. institutional repositories, research information management systems) to facilitate the broadest possible dissemination of, long term access to and preservation of research outputs;
- assist grant funding bodies to continue to develop their open access policies;
- provide open publishing platforms to facilitate the rapid and open communication of research (Go8, 2014, para 2).

An essential part of the Go8 statement is the pledge to develop services and infrastructure, including IRs and IR systems.

# Background to the NHMRC Open Access Policy

## Documentation

This study began under the NHMRC policy that came into force on 1 July 2012 and continued until January 2014 (NHMRC, 2012a). Previous documentation existed alerting grant recipients of the nature of the mandate and commencement date (NHMRC, 2012b). There were two major updates to the policy during 2014

(NHMRC, 2014a; NHMRC, 2014b; NHMRC, 2014c). The implementation of the 2014 policies occurred while data collection was still in progress.

During the writing of this thesis, the NHMRC launched its 2018 policy, a valuable source for definitions that did not alter the focus of the original research on articles published 2013 and 2014. The new documentation precipitated the removal of the 2012 and 2014 NHMRC OA Policies from the Council's website. Archived copies available through the Internet Archive (https://archive.org) proved invaluable as access to the earlier policies was essential to provide the context for this research. Chronologically listed in Table 1 and the Appendices are the different iterations of the NHMRC policy from July 2012. The evolving policies over time collectively contributed to the NHMRC OA Policy, the uniform title used by this study.

*Table 1: Timeline of NHMRC Policies*

| Date | Title of Policy |
|---|---|
| 2012, July | *NHMRC revised policy on the dissemination of research findings* (NHMRC, 2012a) (Appendix A) |
| 2014, February | *NHMRC's policy on the dissemination of research findings* (NHMRC, 2014b) (Appendix B) |
| 2014, November | *NHMRC's policy on the dissemination of research findings* (NHMRC, 2014c) (Appendix C) |
| 2014, November | *NHMRC open access policy: Key updates 20 November 2014* (NHMRC, 2014a) (Appendix D) |
| 2018, January | *National Health and Medical Research Council: Open access policy: 15 January 2018* (NHMRC, 2018) |

## Framework

The NHMRC OA Policy is the framework for this research. Based on the definition developed by the BOAI (2002), the Council defined scholarly OA as:

> … the availability of research outputs via the internet, such that any user can find, freely access, read, download, copy, distribute, print, search, link, crawl, mine and otherwise use and reuse the research outputs both manually and using automated tools. Any use or reuse is subject to full and proper attribution, and usually will have an appropriate licence, such as any of the options available through the Creative Commons suite of licences and should not infringe any copyrights to third-party material included in the Research Output (NHMRC, 2018, p. 5).

The NHMRC policy requires peer-reviewed journal articles resulting from its grant funding to be OA within twelve months of publication. Authors retain the right to

select journal titles of their choice, with the AOASG (2015) maintaining that any attempt to control this choice would meet author resistance. Hybrid OA and OAJD articles are immediately OA and automatically compliant with the NHMRC OA Policy. Articles in delayed OA journals are compliant after the expiry of embargoes of twelve months or less. The Council also encourages authors to publish in journals with policies aligned with the FAIR (Findable, Accessible, Interoperable, Reusable) principles (Universities Australia & CAUL, 2017).

The NHMRC policy does not refer to the direct payment of APCs, but some grants are eligible to pay for publication costs. The NHMRC Direct Research Costs Guidelines allow grants to pay for APCs on condition that the articles stem from approved research activities (NHMRC, 2014a). According to the AOASG, the Council's support for the deposit of AAMs in IRs is to reduce pressure for NHMRC funded APCs:

> This choice takes advantage of the mature network of open access repositories already in place in Australian institutions. It also avoids any expectation of the funding body or the institutions to pay article processing charges (APC) for publication in open access journals. [Policies which mandate publication in open access journals, particularly when the funder offers to pay APCs, potentially could push up the cost of APCs. This would create an unsustainable financial situation] (AOASG, 2015, "5. The policies require deposit in institutional repositories").

The network of Australian IRs is pivotal to the Council's OA strategy.

The NHMRC requires the deposit of non-OA articles as AAMs in Australian IRs. The Council defined the accepted OA version as the "author's version of the article (as accepted by the journal after peer review, with revisions having been made)" (NHMRC, 2014c, "What manuscript versions are acceptable under the policy?" para. 1). With the Council's policy implemented in mid-2012, the deposit of accepted manuscripts in IRs was not a requirement until 1 July 2013 (NHMRC, 2014b). According to the NHMRC, preprints are not acceptable publisher's versions (NHMRC, 2018), a preprint defined as the "version of a manuscript as submitted to a journal or other publication…. [that] has not been through the publisher's peer-review process" (NHMRC, 2018, p. 5). There is no NHMRC requirement for the

deposit the final published OA article in IRs, although encouraged if copyright and licensing requirements allow.

The NHMRC also cites PMC as an acceptable subject repository (NHMRC, 2014a). For a Council funded journal article to appear in PMC, either one of the authors received funding from the NIH or an affiliated organisation, or a deposit agreement existed between the journal publisher and PMC. Earlier versions of the NHMRC OA Policy were imprecise regarding the use of other websites for self-archiving, the 2014 policy referring to "elsewhere" (NHMRC, 2014a, "CIA's responsibility", col. 3, para. 2; NHMRC, 2014c, "Who is responsible for implementing the policy?", para. 3). Popular among researchers are websites known as Scholarly Collaboration (or Communication) Networks (SCNs), the primary examples being ResearchGate and Academia.edu. Lacking support for long-term preservation and copyright, the Council classified SCNs as "not acceptable repositories for the purposes of this policy" (NHMRC, 2018, p. 9).

An essential feature of the NHMRC OA Policy is the deposit of the metadata of all Council funded articles in IRs. The grant's Chief Investigator A is responsible for ensuring that the metadata includes the acknowledgement of NHMRC funding and the grant ID number(s) (NHMRC, 2012a; NHMRC, 2014a; NHMRC, 2014c). According to the AOASG, funding acknowledgement details in the metadata of IR metadata is essential for tracking and measuring compliance:

> Without tracking there is considerably less incentive to comply with the mandate. Even if there are no ramifications for non-compliance in the first year or two, this type of tracking allows an assessment to be made on the effectiveness and blocks in the implementation of the policy. Tracking research allows for an audit of funded research and the delivery of research outputs to the community (AOASG, 2015, "4. Compliance will be tracked through a standardised field in institutional repositories which can be harvested").

The NHMRC OA Policy requires time frames for the deposit of metadata and AAMs in IRs. Earlier NHMRC policies required the deposit of metadata either immediately or soon after publication (NHMRC, 2012a; NHMRC, 2012b; NHMRC, 2014a;

NHMRC, 2014b; NHMRC, 2014c), although the requirement of the 2018 policy is no later than three months from publication (NHMRC, 2018). To the AOASG (2015), the timing of the deposit of the metadata is the key to the acquisition of the accepted OA version:

> By requiring deposit of metadata around the time of acceptance, it catches the researchers at the point they are most likely to have a copy of the accepted author manuscript version of the work to deposit to the repository (AOASG, 2015, "Strengths of these policies: 2 ..." ).

To comply with the time frames of the NHMRC policy, authors of non-OA journal articles need to deposit the AAMs in repositories within 12 months of publication.

# Open Access in Journals and Repositories

The two main routes to OA are by publishing OA or by depositing OA versions in repositories and websites. The BOAI (2002) identified OA journals listed in the DOAJ as the new generation of journals, and PMC and arXiv as examples of open electronic archives. The OA movement promoted the growth of a wide range of journal OA models including OA in fully OA journals (OAJDs) and hybrid OA in hybrid subscription journals. Society publishers, supported by membership subscriptions, impart value to members through delayed or partial OA to their journals. Gratis OA provide public access usually without open licensing permitting reuse.

The OA movement also stimulated the rapid growth of IRs with over 3,000 globally at the time of writing, including over 50 in Australia (AOASG, 2016; OpenDOAR, n.d.). The principal purpose of IRs is to preserve the intellectual output of institutions. OA content in IRs includes teaching resources and presentations, manuscripts and preprints, peer-reviewed author accepted manuscripts and final publisher's versions. The various journal OA models and OA versions in repositories are the subjects of large bodies of literature.

## Open Access in Journals

Close to 30,000 scholarly peer-reviewed English-language journals collectively publish around 2.5 million articles a year (Plume & van Weijen, 2014; Ware & Mabe, 2015), most financed by the subscriptions of individuals and institutions.

Gratis and delayed OA journals were among the earliest to offer OA; some subsidised by universities and research institutes; others supported by members of associations and learned societies (Björk & Solomon, 2012).

The beginning of the 21st century witnessed the rise in "new generation of journals committed to open access" (BOAI, 2002, para. 5) offering immediate OA in OAJDs. The new breed of publishers included BioMed Central, the Hindawi Publishing Corporation and the Public Library of Science (PLOS) (Binfield, 2011; Björk & Solomon, 2012; Ganley, 2013; Pinfield, 2015; Solomon & Björk, 2012b; Wellen, 2013). The more successful OA megajournals charge APCs (Björk, 2015). Commercial publishers also introduced the payment of APCs for hybrid OA in conjunction with the existing business model of subscriptions.

### *Fully Open Access Journals*

Fully open access journals listed in the DOAJ embody the BOAI's definition of OA and acknowledge readers' rights to "read, download, copy, distribute, print, search, or link to the full texts of these articles" (DOAJ, n.d.). A list of OAJDs appears in the DOAJ, an independent online directory launched in 2003 at Lund University, Sweden. The number of journal titles in DOAJ is a gauge to the rate of OA publishing in OAJDs (Morrison, Salhab, Calvé-Genest, & Horava, 2015; Zhao, 2014). At the time of writing, the DOAJ (https://doaj.org) listed around 10,000 journal titles.

Emergent literature documented the rapid rise and increasing share of OAJDs in publishing in medicine (Curry, 2013; Kurata, Morioka, Yokoi, & Matsubayashi, 2013; Rohrich & Sullivan, 2013). The payment of APCs is part of the business model of large and successful OAJDs such as *PLOS ONE*, although some OAJDs do not charge APCs (Björk, 2015; De Castro, 2016, May 11; Lawson, 2015; Morrison et al., 2015; Solomon & Björk, 2012a). Solomon and Björk (2012a) argued that the charges reflect "what they expect the market can bear" (p. 1492), with the highest fees for OAJDs in biomedicine.

Commercial publishing houses recognised the charging of APCs as a viable business model. Commercial publishers created new OAJD titles and converted subscription

journals to the APC model (Björk & Solomon, 2012; Solomon & Björk, 2012b). Elsevier is one of the world's largest publishers of fully open access journals, with over 500 titles in 2016 (Morrison, 2017; Solomon & Björk, 2016). Dallmier-Tiessen et al. (2010) estimated that the five largest commercial publishers accounted for 19% of the journals in DOAJ in 2010, with this figure steadily increasing with the conversion of subscription journals to OAJDs (Solomon & Björk, 2016).

The quality of most OAJDs is high (Greenberg, 2015; Pinfield, 2015; Rowley, Johnson, Sbaffi, Frass, & Devine, 2017). Notwithstanding, the lack of journal quality and unethical behaviour of some OAJD publishers were factors in the labelling of selected journals as "predatory" (Beall, 2012, p. 179; 2013, p. 79; Haug, 2013, p. 792). Pinfield (2015) commented that the wide variability in quality conveys a "negative aspect of a positive feature of OA" (p. 619). Nevertheless, Laakso and Björk (2013) maintained that a great deal of misinformation exists concerning OAJDs, with Solomon (2013) making a case for objective standards to protect authors and funders.

### *Hybrid Open Access*

Publishing an OA article in a subscription journal is known as hybrid OA, which Björk et al. (2010) described as "paid article level access" (p. 8). Commercial publishers were quick to seize the capability of APCs to pay the cost of OA publishing, demonstrated by the rapid growth of hybrid OA journals in comparison to subscription-only (Sotudeh, Ghasempour, & Yaghtin, 2015).

Springer was an early adopter of hybrid OA with the introduction of Springer Open Choice in 2004 (Pinfield, Salter, & Bath, 2016). In 2008, the Association of Learned and Professional Society Publishers commissioned the Scholarly Publishing Practice Survey and found that 30% of the 189 publishers published at least one hybrid OA title (Bird & Richardson, 2009). In their 2010 study, Dallmeier-Tiessen et al. (2010) examined over 8,000 journals by science, technology and medical publishers, of which a quarter offered hybrid OA. The publishers of most hybrid subscription journals are the commercial publishers, Elsevier, Springer, Wiley-Blackwell, Taylor and Francis and Sage, (Jubb et al., 2015; Laakso, 2014; Laakso & Björk, 2016).

According to Ware and Mabe (2015), the hybrid OA model provides publishers with a "relatively low risk way for established subscription journals to experiment with open access, in effect allowing the market (i.e. authors, or their funders) to decide what value they place on open access" (p. 92). In most cases, publishers promote hybrid OA as a value-added option with brandings such as Wiley's OnlineOpen, Karger's Author's Choice™ and Taylor and Francis' iOpenAccess. Some publishers provide special OA services for societies, such as CSIRO Publishing offering Society-Sponsored Open Access with full or partial OA (CSIRO Publishing, n.d.). Other publishing houses publish both OAJD and hybrid OA journals, including Elsevier and its imprint Cell Press, and merged publishers Nature Publishing and Springer (Björk & Solomon, 2012; Chawla, 2015, January 15).

### *Delayed Open Access*

Not all OA is immediate. Societies and associations publish journals with embargoes on OA known as delayed OA, the primary rationale to provide value to members (Laakso & Björk, 2013; Laakso & Lindman, 2016). Articles in delayed OA journals are highly cited and make up a significant component of OA in journals (Borrego, 2016; Laakso & Björk, 2013; Laakso & Lindman, 2016; Piwowar et al., 2017; Willinsky, 2003).

### *Partial Open Access*

In partial OA journals "only selected content in the journal is freely available either upon publication or after a specified interval of subscription-only access" (McVeigh & Pringle, 2005, p. 45). Scholarly societies or professional associations adopted partial OA to retain members at a time of declining memberships (Willinsky, 2006).

### *Gratis Open Access*

Gratis OA journals provide public access with all articles free to read (Martín-Martín, Costas, van Leeuwen, & López-Cózar, 2018; Suber, 2012). The publishers of gratis OA journals retain copyright with no open licensing. The other characteristic of gratis OA journals is the absence of APCs (Bakker, Stephenson, Stephenson, & Chaves, 2017).

### *Subscription Only*

Subscription journals financed by the subscriptions of individuals and institutions represent the traditional model of scholarly publishing, especially in the science, technology, and medical disciplines. Subscription-only journals include journals such as *Nature* or *Science*. The estimated cost of publishing in *Nature* is approximately £20,000-£30,000 per paper for which APCs would be extremely high for hybrid OA (Ware & Mabe, 2015). Instead of charging high APCs, *Nature*-branded journals operate solely on the subscription journal business model complemented by a supportive self-archiving policies (Springer Nature, n.d.).

### *Authors' Decision-Making on Open Access Publishing*

The quantity and sheer range of journal OA models demonstrate the diverse options facing authors (Nicholas et al., 2014; Poltronieri et al., 2013; Rowley et al., 2017). Zhu (2017) found a link between attitudes towards OA publishing and OA practice. Authors who consider OA as important are more likely to publish OA (Pontika, 2011, 2015; Zhu, 2017). Some authors base their decisions on the journal's reputation and Journal Citation Reports (JCR) Impact Factor (Pontika, 2011, 2015). Poltronieri et al. (2013) found that almost half of the journals published in oncological research had high JCR Impact Factors. Other criteria influencing authors' decision-making in the selection of journals include peer review and speed of publication (Rowlands & Nicholas, 2006; Solomon & Björk, 2012a; Zhu, 2017).

The standards of peer review offered by reputable OAJDs are comparable to the criteria of respected subscription titles (Curry, 2013; Greenberg, 2015; Johnson, Fosci, Chiarelli, Pinfield, & Jubb, 2017; Nicholas et al., 2015; Nicholas et al., 2014; Pinfield, 2015; Rohrich & Sullivan, 2013; Rowley et al., 2017; Shen, 2011; Tenopir et al., 2016). Various studies identified disciplinary differences in OA publishing with publishing in OAJD journals most active in medical sciences (Björk et al., 2010; Curry, 2013; Kurata et al., 2013; Laakso & Björk, 2012; Rohrich & Sullivan, 2013; Zhu, 2017). Gargouri, Larivière, Gingras, Carr, and Harnad (2012) attributed the higher OA publishing in journals in biomedicine to the greater availability of funding. The lack of quality of some OAJDs contributes to uncertainty and negativity about OA (Pinfield, 2015; Rohrich & Sullivan, 2013; Zhu, 2017).

Nicholas et al. (2014) found less concern among authors about the reputation of established subscription journals. To some authors, OA is secondary to quality criteria such as reputation, high level of peer review and subject relevance (Ware & Mabe, 2015; Zhu, 2017). Nicholas et al. (2017) found a tendency among junior researchers to deprioritise their support for OA by choosing to publish in prestigious journals with high JCR Impact Factors. At the same time, there is a willingness to pay higher publishing charges in well-established subscription journals (Pinfield, 2015).

The payment of APCs adds a critical dimension to decision-making about OA publishing (Solomon & Björk, 2012a, 2016). Between 2010 and 2012, Neylon (2012) calculated that OA articles funded by APCs more than doubled. According to Bakker et al. (2017), OAJDs have significantly lower APCs (averaging US$1,900) than for hybrid OA (around US$3,000). Solomon and Björk (2012b) claimed that the higher APCs charged for OA in subscription journals discourages the uptake of the hybrid OA option. Some researchers use funder grants, institutional and departmental funding, and publisher schemes to pay APCs (Huggard, Steel, & Sussman, 2017; Kocher & Kelly, 2016; Pinfield et al., 2016). To the AOASG (2015), the expectation that funders or institutions pay for all APCs may influence publishers to raise charges. A small number of researchers pay for APCs out of their own pockets (Swan & Brown, 2004; Zhu, 2017).

There is an extensive literature supporting the citation advantage, higher visibility and broader readership of OA publishing (Davis, 2011; Greenberg, 2015; Hitchcock, 2013; Pislyakov, 2009; Solomon, Laakso, & Björk, 2013; Sotudeh et al., 2015; Swan, 2010; Wagner, 2010; Wouters, 2014; Zhao, 2014). Björk and Solomon (2012) and Solomon (2013) found that citation rates for OAJDs were about 30% higher than for subscription journals and higher in biomedicine. Bernal (2013) assessed the metrics provided by PLOS as significantly contributing to increased citations. Publishers' metrics add to altmetric studies that also demonstrate the citation impact of OAJDs (Laakso & Björk, 2016; Piwowar, 2013; Priem, Parra, Piwowar, Groth, & Waagmeester, 2012; Solomon et al., 2013).

Institutions differ in the extent of OA awareness among researchers. Authors within the same institution vary in OA knowledge according to experience, age, and gender (Zhu, 2017). Zhu (2017) maintained that senior academics, with more familiarity with writing funding applications, have a greater understanding of OA policies and publishing. While junior academics working with experienced researchers on projects gain this knowledge, early career researchers without this experience are less likely to learn about OA publishing and related policies. Even among some experienced researchers, there is concern about CC BY licencing and opposition to the reuse of publications for adaptations, translations, text mining, and commercial purposes (Darley, Reynolds, & Wickham, 2014; Rowley et al., 2017; Schmidt, Courtney, & Manning, 2015). Rowley (2017) maintained that publishers and policymakers need to address authors' concerns concerning intellectual property rights.

In making decisions about OA publishing, authors faced numerous challenges including unawareness of OA options, the high cost of APCs, and the quality of some journals. Zhu (2017) recommended that funding bodies provide better guidelines for authors about their OA options. Further education programs would also address the issues of unawareness and uncertainty concerning licensing and journal quality. While additional funding for APCs is a partial solution, depositing OA versions in repositories is without cost to authors.

## Open Access in Repositories

Bakker et al. (2017) argued that self-archiving is the most cost-effective method of providing OA. Gargouri, Larivière, Gingras, Brody, et al. (2012) predicted 100% cost-free OA through depositing OA in repositories. Another benefit cited in the literature is the potential for OA in IRs to replace institutional subscriptions (Houghton, 2009a, 2009b; Houghton & Oppenheim, 2010). To Zhu (2017), the deposit of OA versions in IRs provides the opportunity for financially disadvantaged researchers to self-archive their work.

Suber (2012) described the relationship between OA in repositories and journals as "complementary and synergistic" (p. 58). According to Kennan (2011), the connection is "coexistence" with the main focus of repositories "to provide access

for those who do not have access to the journal" (p. 303). Laakso and Björk (2016) maintained that OA versions in repositories "act as substitutes for readers lacking access rights to a subscription-journal" (p. 919). To Laakso (2014), the deposit of OA in repositories is the "only way to make research published in subscription-based journals freely available online" (p. 476).

OA in repositories provides a considerable volume of accessible material (Neylon, 2012). In 2005, there were just over 100 repositories worldwide, while in December 2017, the number stood at over 3,500 (OpenDOAR, n.d.; Pinfield, 2005). Pinfield et al. (2014) described the global repository landscape as "a large number of small repositories (with between 100 and 100,000 items)" (p. 2413). The tremendous growth in digital repositories occurred at a time of rapid scholarly, funder and technological changes (Cassella & Calvi, 2010; Cullen & Chawner, 2010; Greenberg, 2015; Pinfield, 2015; Pinfield et al., 2014; Suber, 2009). Google Scholar facilitates the visibility of repositories (Arlitsch & O'Brien, 2012; De Groote, Shultz, & Smalheiser, 2015; Kennan, 2011).

Disciplinary or subject repositories with resilient and robust preprint cultures date from the 1990s and include Research Papers in Economics (RePEc) and Social Science Research Network (SSRN) (Adamick & Reznik-Zellen, 2010). Notwithstanding the importance of repositories in the social sciences, various studies found that depositing in subject repositories was more common in medicine, natural sciences, and engineering (Björk et al., 2010; Zhu, 2017). Among the most successful disciplinary or subject repositories are arXiv covering physics, astrophysics and mathematics and PMC in medicine (Björk, 2014; Li, Thelwall, & Kousha, 2015; Pinfield, 2005; Ware & Mabe, 2015). For arXiv, the requisite OA version is the "article either in draft or final form SELF-ARCHIVED by the author" (Ginsparg, 1999, 23 July, para. 16). PMC, the nominated repository under the NIH Public Access Policy, facilitates the deposit of author manuscripts by NIH funded authors as well as entire issues of journals under its full participation and special collections publisher programs (PubMed Central, n.d.-a).

The primary purpose of IRs is to preserve the intellectual digital output of institutions. At the time of writing, there are over 3,000 globally (OpenDOAR, n.d.):

a rapid growth since the launch of the DSpace repository at the Massachusetts Institute of Technology in 2002. The main reason given for the increase in IRs is the rising cost of journal subscriptions (Arlitsch & O'Brien, 2012; Burns, Lana, & Budd, 2013; Crow, 2002; Harnad, 2010). Guédon referred to the degree of militancy with which university libraries adopted IRs, waging the "good fight … [to] roll back the effects of enormous price increases in the scientific literature" (Guédon, 2017, p. 13). The Scholarly Publishing and Academic Resources Coalition (SPARC) described IRs as a revolutionary stratagem to accelerate changes in electronic scholarly communication (Crow, 2002).

In Australia, there are over 50 IRs listed on the AOASG website, with around 90% maintained by universities (AOASG, 2016). From 2006 to 2009, universities received funding to establish IRs under various programs. These programs included the Australian Partnership for Sustainable Repositories, Australian Research Repositories Online to the World (ARROW) and the Australian Scheme for Higher Education Repositories (ASHER) program. Tacit government support continues for OA and IRs (DIIS, 2017; Productivity Commission, 2016). IRs also play a pivotal role in the Excellence in Research Australia (ERA) submission process. The Australian Research Council (ARC) requires institutions to report whether a research output submitted to ERA is available in an OA repository (ARC, 2016).

At the institutional level, the Group of Eight Universities (Go8) in Australia recognised the need to provide the IR infrastructure necessary for compliance with OA policies (Go8, 2014). The Council of Australian University Librarians (CAUL) acknowledged the challenges of the NHMRC and the ARC policies:

> The growing emphasis on open access, new compliance standards by the NHMRC and ARC, and the acknowledged role of the libraries in managing repositories will bring new challenges for CAUL members to do more with less (CAUL, 2013, p. 5).

CAUL (2014) also recognised Trove as the central platform for locating NHMRC and ARC funded publications. More than 90% of IR funding is through library budgets (Henty, 2014). The CAUL Australian Institutional Repository Support Service (CAIRSS) ceased in December 2012, although its email list continues as a community of practice for repository managers (Clarke, Harrison, & Searle, 2009;

Huggard et al., 2017; Kennan & Kingsley, 2009; Kingsley, 2013; Steele, 2013). CAUL continues to support IRs through the FAIR policy statement (Universities Australia & CAUL, 2017).

OA versions of journal articles make up much of the content of IRs (OpenDOAR, n.d.; Pinfield et al., 2014) (Figure 1). While some IRs rely on author self-archiving, many used content recruitment strategies, including downloading articles from OAJDs and repositories such as PMC (Duranceau & Kriegsman, 2016; Mackie, 2004). Ghaphery, Byrd and Miller (2017) claimed that most OA versions of journal articles in IRs are AAMs. However, other sources report low deposit of author accepted manuscripts (CIHR, 2017, December 18; Henty, 2014). Borrego (2016) identified the difficulty of distinguishing between the preprint and the AAM where there is no explicit statement in or attached to the manuscript.

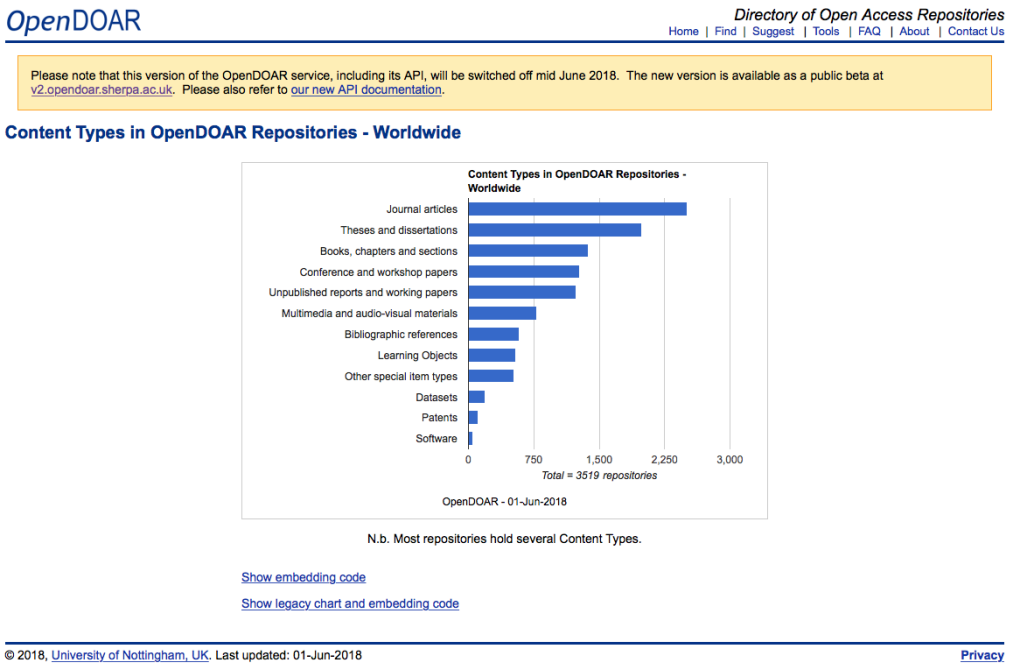


*Figure 1: Content Types in OpenDOAR Repositories. Reproduced under CC BY-NC-ND licence (www.opendoar.org).*

The promotion of IRs is one of the primary roles of academic librarians (Suri, 2018). Promoted are the benefits of depositing in IRs, including increased exposure, readership and citations, as well as access to author services such as citation analyses, research impact and social media reports (Bernal, 2013; Bruns & Inefuku,

2016; Cullen & Chawner, 2010, 2011; Greenberg, 2015; Holmberg, Haustein, & Beucke, 2016; Huggard et al., 2017; Kennan, 2011; Kennan & Kingsley, 2009; Luarte, 2006; Miguel, Chinchilla-Rodriguez, & De Moya-Anegón, 2011; Pinfield, 2005). IR and library staff with specialised knowledge of publishers' repository policies are also "the go-to people" (Poynder, 2017, p. 7). Copyright queries comprised 95% of the advice given by IR staff in Australasia (Huggard et al., 2017). Despite the considerable promotion by IR and library staff, the deposit of OA versions in Australian and global IRs remains low (Bakker et al., 2017; Kingsley, 2013).

## *Barriers to Depositing in Institutional Repositories*

Bakker et al. (2017) identified barriers to depositing OA in repositories that are publisher-related and author-created. There are also institutional barriers, including insufficient financial, technical, and official support for IRs (Borrego, 2016; Henty, 2014; Huggard et al., 2017; Zhu, 2017).

### *Publisher Barriers*

Harnad et al. (2008) argued that compliance with OA policies is theoretically achievable as the majority of journal publishers allow self-archiving. Nevertheless, the conditions imposed by publishers complicate the deposit of OA versions in repositories (Cullen & Chawner, 2011; Gadd, Oppenheim, & Probets, 2003; Henty, 2014; Kennan & Wilson, 2006; Laakso, 2014; Pinfield, 2015). Publishers' embargoes of some hybrid subscription journals are substantial barriers preventing the deposit of articles for as long as four years after publication. Embargo periods longer than12 months are beyond the time frames set by most funder mandates, including the NHMRC OA Policy.

According to Wiley's Self-Archiving Policy, AAMs are subject to embargo periods of 12 to 24 months (Wiley, n.d.-b). Wiley also has separate agreements with some funders, including the NHMRC and the ARC. Information on the Wiley website advises authors on the need to deposit the metadata of all funded publications in Australian IRs and to self-archive the AAMs after an embargo period of 12 months (Wiley, n.d.-a).

For many years, Elsevier allowed authors to self-archive AAMs in IRs without delay, but this changed in April 2015, with the announcement of Elsevier's sharing and hosting policy (Elsevier, 2015). The Elsevier policy imposed long embargo periods of up to 48 months four years on the posting of AAMs in repositories. According to the Confederation of Open Access Repositories (COAR), the Elsevier policy imposed unnecessary barriers:

> This policy represents a significant obstacle to the dissemination and use of research knowledge, and creates unnecessary barriers for Elsevier published authors in complying with funders' open access policies. In addition, the policy has been adopted without any evidence that immediate sharing of articles has a negative impact on publishers subscriptions (COAR, 2015, para. 1).

Gray (2018) discovered that Elsevier's embargo periods were retrospective and included the years 2013 and 2014. The finding of retrospective embargoes impacts on this study as 2013 and 2014 were the first full years of the NHMRC OA Policy.

To Smith (2015), the introduction of the longer embargoes coincided with the establishment of institutional OA policies. Rumsey (2017) argued that publishers' sharing plans are inherently contradictory by promoting and controlling OA dissemination:

> One problem is, that many publishers are promoting two mutually contradictory points at the same time. That is, publishers claim to disseminate work widely, whilst also controlling access to the same works via copyright and permissions" (p. 4).

Bolick (2018) maintained that long embargoes are anathema to the concept of sharing, with Smith (2015) describing embargoes up to four years in duration as "complicated and draconian" (para. 5).

Elsevier's sharing policy also mandated CC BY-NC-ND licensing for all pre-publication versions deposited in repositories. Smith (2015) described the NC-ND licensing requirement as "most restrictive" (para. 4), with COAR (2015) claiming that the licensing inhibits the reuse value and availability of OA versions in repositories:

> It [Elsevier] also requires authors to apply a "non-commercial and no derivative works" license for each article deposited into a repository, greatly inhibiting the re-use value of these articles. Any delay in the open availability of research articles curtails scientific progress and places unnecessary constraints on delivering the benefits of research back to the public (COAR, 2015, para. 2).

Bolick (2018) highlighted the inherent contradiction in Elsevier's decision: the publisher permitting immediate sharing via authors' website or blogs while controlling OA access via repositories.

### *Institutional Barriers*

Approved NHMRC grant administrating institutions include Australian universities and research organisations (see Appendix G: NHMRC Approved Administering Institutions). It is an assumption that the institutions understand the intricacies of the NHMRC OA Policy, especially the requirements for the deposit of metadata and AAMs in IRs. Notwithstanding, many Australian universities appear unconscious of the funding, infrastructure, and staff requirements of managing IRs (CAUL, 2013; Henty, 2014; Huggard et al., 2017).

Huggard et al. (2017) reported that many institutions are "not aware of [the] work required to ensure repositories are high performing and provide value to institutions and researchers" (p. 5). The value institutions place on grants from the NHMRC and the ARC is not evident in the infrastructure funding for IRs to facilitate compliance with OA mandates. University libraries "do more with less" (CAUL, 2013, p. 5) with more than 90% of the funding for IRs derived from library budgets (Henty, 2014).

The NHMRC recognises the NLA's Trove as the central searching platform for locating the Council's OA outputs (NHMRC, 2015). CAUL (2014) highlighted the use of the NLA's portal in finding the metadata and OA versions of publications funded by the NHMRC and the ARC. Notwithstanding, the variable metadata in Australian IRs affects the cross-searching of repository content (Ayres, 2015; Sherratt, 2013). The application of metadata standards across IRs requires adequate funding for IR infrastructure, quality systems, and staff (Barbour, 2018, May 17).

Not all Australian universities provide repository services to affiliated researchers. Nearly two-thirds of Australian universities have affiliated medical research institutes, and of these, the number with access to repository services is almost half (Henty, 2014). The data suggest that several Australian institutions with IRs provide services only to those authors with a direct university affiliation. By not allowing researchers from affiliated research centres to access IRs is a considerable oversight by grant administrating institutions.

Borrego (2017) identified the lack of OA and IR promotion by Spanish institutions and called upon universities to raise awareness among academic staff, especially the critical role played by IRs in scholarly networks:

> … if IRs are to feature as strategic priorities for institutions, there is an obvious need to raise awareness of them amongst academic staff. In particular, clear communication is needed that not only introduces staff to the existence of their IR but also explains the way in which the repository fits into the wider scholarly network, with content deposited in IRs harvested by standard academic search engines and, therefore, visible and searchable globally (Borrego, 2017, p. 192).

Global awareness of the existence of IRs varies from institution to institution according to the degree of institutional promotion (Björk, Laakso, Welling, & Paetau, 2014; Borrego, 2017; Seaman, 2017; Swan & Brown, 2005; Zhu, 2017).

Over a third of Australian universities have OA mandates that require researchers to deposit in IRs (Huggard et al., 2017). Institutional OA mandates have the potential to increase OA in IRs, although enforcement may reinforce the perception that IRs exist to serve the institution (Bakker et al., 2017; 2011; Gargouri, Larivière, Gingras, Carr, et al., 2012; Swan & Brown, 2005). Bakker et al. (2017) recommended incentives for OA compliance. Opportunities to increase organisational awareness include institutional recognition of staff with proven OA publishing records (Zhang, Boock, & Wirth, 2015).

The lack of institutional support for IRs is part of a more significant problem regarding the direction of open scholarship in Australia. Although there is OA promotion through the AOASG, CAUL, ARC, and the NHMRC, there is no one

organisation with the responsibility to provide direction on OA (Barbour, 2018, May 17). Barbour (2018, May 17) called for a coordinated approach to provide leadership across the research sector:

> [W]e need a coordinated national approach to open scholarship – making research available for all to access through structures and tools that are themselves open and not proprietary (Barbour, 2018, May 17, "What we need," para. 3).

A national approach would include directed support for Australian IRs in meeting the requirements of institutional and OA mandates.

### *Authors' Awareness and Attitudes*

Studies reveal the low level of OA in repositories, estimated between 4.1% and 21.8% of total scholarly publications (Bakker et al., 2017; Björk et al., 2010; Borrego, 2016; Elsevier, 2013; Jubb et al., 2015; Laakso & Björk, 2012; Martín-Martín et al., 2018; Piwowar et al., 2017). Gargouri, Larivière, Gingras, Carr, et al. (2012) maintained that the only constraint on OA in IRs is whether the author chooses to self-archive. Björk et al. (2014) also identified author behaviour as the real barrier to the deposit of OA in IRs. Studies also revealed authors' unawareness of IRs as well as confusion concerning publishers' conditions and OA mandates.

Banks and Persily (2010) and Charbonneau and McGlone (2013) examined the NIH policy and found that between 15% and 30% of faculty were unaware of the mandate. According to Charbonneau and McGlone (2013), confusing instructions and unclear journal policies are challenges for NIH funded faculty. Many funder mandates require the deposit of the postprint or AAM in a subject repository or IR, but the identification of the accepted manuscript is sometimes unclear and contributes to indecision about depositing. In a report for CAUL, Henty (2014) quoted an Australian IR manager who acknowledged that: "[a]cquiring post-print copies or articles remains an issue, with academic staff having a limited understanding of what a post-print is and why we require it" (Henty, 2014, p. 31).

Borrego (2017), Swan and Brown (2005) found that most authors who had not self-archived in IRs were unaware of the existence of IRs. Other authors are oblivious to the purpose and usefulness of IRs (Björk et al., 2014; Seaman, 2017). Zhu (2017)

found that author awareness of the existence of IRs varies from institution to institution depending upon the level of promotion of OA policies and repositories.

Zhu (2017) found that senior academics with experience in writing funding applications knew more about OA policies and the main options for compliance, including depositing in IRs. Inexperienced academic staff in junior positions, including women, and early career researchers were less likely to lodge papers in OA repositories (Zhu, 2017). The findings on early career researchers and junior academics contribute to studies reporting upon the lack of knowledge of IR procedures (Bakker et al., 2017; Borrego, 2017; Cullen & Chawner, 2011; Kim, 2007; Swan & Brown, 2005).

Disciplinary differences exist concerning OA. Gargouri, Larivière, Gingras, Carr and Harnad (2012) found that there is a preference in biomedicine to publishing OA in journals. In his study of compliance with the Spanish government's OA policy, Borrego (2016) identified a higher number of compliant articles in arXiv than IRs owing to the significant proportion of authors from the mathematics and physics disciplines. While subject culture theory assumes the transferability of practice, this is a problematic assumption when applied to repositories. Xia (2008) noted that advocates of disciplinary repositories might not be active users of IRs, with authors depositing in their preferred repository but reticent about duplicating the deposit in an IR.

Morris (2009) found that authors underestimate what publishers allow them to do with AAMs and overestimate what the publishers permit with the published article. Lack of awareness and confusion over journal policy requirements constrain authors' decisions to deposit in repositories. Despite the high profile of the NIH public access policy, studies found that a high proportion of faculty members signed the publishers' licensing agreements without reading or understanding the nature of the contracts (Charbonneau & McGlone, 2013; Crummett et al., 2010; Pontika, 2011).

Some authors believe that copyright policies prevent them from depositing (Cullen & Chawner, 2011; Kennan & Wilson, 2006). Other authors fear plagiarism and intellectual property rights violation (Cullen & Chawner, 2011; Seaman, 2017).

Confusion about copyright and licensing sometimes result in the deposit of the wrong version (Charbonneau & McGlone, 2013; Jamali, 2017; Kim, 2007). At Carnegie-Mellon University, Covey (2009) found non-compliant self-archived material on authors' websites. Jamali (2017) argued that depositing the wrong version in repositories "might indicate their lack of understanding of copyright policies and/or complexity and diversity of policies" (p. 241).

IR and library staff with specialised knowledge of publishers' repository policies provide advice to authors on copyright and licensing (Hanlon & Ramirez, 2011; Huggard et al., 2017; Palmer, Teffeau, & Newton, 2008; Poynder, 2017). Despite the value placed on copyright advice, some authors misinterpret the procedures as interference, while others react with suspicion and distrust (Henty, 2014; Huggard et al., 2017). Poynder (2017) recorded the viewpoint of one academic as having "no desire to have any dealings with the bureaucrats [librarians] that run the repository" (as cited in Poynder, 2017, p. 21).

The complexity of the submission process hinders deposits in IRs (Henty, 2014; Huggard et al., 2017; Seaman, 2017). Time constraints on authors reduce the effort involved in depositing (Björk et al., 2014; Charbonneau & McGlone, 2013; Cullen & Chawner, 2011; Kim, 2007). IR staff deposit on behalf of authors, although sometimes this is met with apathy and disinterest (Henty, 2014; Huggard et al., 2017). An IR manager reported on academic staff being "happy for repository staff to deposit on their behalf, but they do not want to be involved in the process" (as cited in Henty, 2014, p. 31).

Cullen and Chawner (2011) identified scepticism about the value of IRs. While Smith (2009) acknowledged that IRs have a useful role in making research information available to the public, Zhu (2017) identified uncertainty among authors about the citation advantage of depositing in IRs. Richardson (2005) also questioned the reliability and usefulness of usage and citation tracking of multiple OA versions of articles held in numerous locations. Researchers prefer to cite the conventionally published version, even if the source document came from an IR. Smith (2009) commented that for some researchers, the "citing of a different version from the one consulted may be a concern" (Smith, 2009, para. 8).

Strategies for greater author engagement in depositing OA in IRs include programs addressing the problem associated with the deposit of the wrong version (Jamali, 2017). Zhu (2017) recommended the focus on early career researchers and academic staff in junior positions, particularly women. The report by Henty (2014) highlighted the lack of understanding among authors of the importance of the AAM, the OA version allowed by most publishers. The promotion of AAMs as the required versions is pivotal to increasing OA in IRs.

### *Social Networking as a Repository*

Kim (2007) found that academics support access to research and teaching materials in repositories and websites in preference to IRs. SCNs, such as ResearchGate, provide a form of repository service through the sharing of metadata and OA versions as well as other features including usage data, citation counts and benchmarking capabilities (Gewin, 2010; Jamali, 2017; Jordon, 2014a, 2014b; Kramer & Bosman, 2016; Mangan, 2012; Megwalu, 2015; Nicholas, Clark, & Herman, 2016; Nicholas, Herman, & Clark, 2016; Thelwall & Kousha, 2015; Webster, 2016). SCNs also stimulate wide dissemination and global visibility that is particularly evident in Google Scholar searches (Borrego, 2017; Nentwich & König, 2012).

Borrego (2017) found that authors preferred to deposit in SCNs over IRs. In a study comparing the availability of the OA research outputs of the top Spanish universities, Borrego (2017) discovered only 11.1% of the articles appeared in IRs compared to 54.8% in ResearchGate. Björk (2017a) calculated that repositories held 15-20% of OA versions compared to SCNs with 50%. Some authors believe that SCNs facilitate greater dissemination of publications and interaction with other scholars (Borrego, 2017). According to Kingsley (2008), authors valued forums of peers and colleagues. Borrego (2017) proposed that IRs emulate some aspects of ResearchGate to increase IR content with the creation of researchers' profiles being an example.

Branded black OA by Björk (2017a) and "gray" OA by Borrego (2016, 2017), there is serious concern about non-compliance of SCNs with copyright (Roman, Fox, Bronicki, & Thompson, 2016; Williams & Woodacre, 2016). Borrego (2017)

commented on the low regard for copyright among some academics, which affects their use of IRs:

> In particular, the immediate availability of articles and comparatively low threshold for confirming any licensing constraints on RG [ResearchGate] would be difficult for most IRs to achieve because of the perceived need to ensure copyright compliance before releasing deposited papers (Borrego, 2017, p. 192).

Jamali (2017) also identified the issue with authors infringing copyright by depositing the wrong version in SCNs. Lack of compliance demonstrates the need for additional and focused copyright and licensing education programs.

## Terminology

One of the main problems in comparing studies on OA is terminology, especially the use of gold and green OA. Gold OA refers to the route to OA by publishing OA in scholarly publications such as journals. Green OA is the approach that involves the deposit of OA versions in repositories and websites. The range of definitions of gold OA include: "OA delivered by journals" (Suber, 2012, p. 6), "journal-mediated open access" (Neylon, 2012, p. 349), "[j]ournal-mediated" (Laakso, 2014, p. 475) and "journal-provided" (Laakso & Lindman, 2016, p. 1168). In Web of Science, the definition of the gold OA category is the "freely accessible final version of an article" (Clarivate Analytics, 2018a, para. 4) and refers to the final published OA version of an article in the various journal OA models. Underlying these definitions is the assumption that gold OA pertains only to journals. Other descriptions are more generic. Tennant and Mounce (2015) defined gold OA as "making the final version of the manuscript freely available immediately upon publication by the publisher" (p. 4). Gold OA can also refer to the free availability of books and book chapters, either entirely OA or within a series (Eve, 2014).

Harnad (2005; 2004) introduced the term gold OA to identify articles published in fully and immediately OA journals listed in the DOAJ, an interpretation that remains in use. Piwowar et al. (2017) defined gold OA as articles published in an "OA journal… in which all articles are open" (Piwowar et al., 2017, "Literature review", para. 3). The special status of OAJDs is also acknowledged in descriptions describing them as "pure gold journals" (Björk et al., 2010, p. 8), "direct OA"

(Laakso et al., 2011, p. 2) and "born open access" journals (Bird, 2010, p. 113; Solomon et al., 2013, p. 649), with converted subscription journals described as "converted gold" (Solomon & Björk, 2012b, p. 649). Researchers who use gold OA to describe OA publishing in OAJDs, usually exclude other forms of OA from their definitions. To accommodate delayed and gratis OA journals, Piwowar et al. (2017) created a new category called bronze OA, with Bosman and Kramer (2018) defining these journals as "[f]ree to read on the publisher page, but without an open license" (p. 4).

The term green OA, coined by Harnad, was originally a metaphor referring to the Association of Learned and Professional Society Publishers giving its "green light" (Harnad et al., 2004, p. 310) to the "self-archiving of *published, peer-reviewed articles"* (Harnad, 2005, para. 5). Harnad (2010; 2004) claimed that 100% OA is achievable through author self-archiving. Piwowar et al. (2017) viewed green OA as self-archived versions of non-OA articles published in journals, while Björk et al. (2014) recognised the usual form as being the "author manuscripts that preceded the finalized article" (p. 237).

Harnad (2005) viewed green OA as synonymous with self-archiving by authors. Laakso (2014) argued that self-archiving should not imply that the author is the only one involved. BOAI (2002) identified author self-archiving in repositories as one of two main strategies to achieve OA for scholarly publications. According to Xia and Sun (2007) "self-archiving has been considered to be an integrated part of the development and practice of digital repositories, both IRs and SRs [subject repositories]" (Xia & Sun, 2007, p. 19).

OA versions on websites are also regarded as green OA (Björk et al., 2010; Borrego, 2016; Laakso, 2014; Laakso & Björk, 2013). Laakso (2014) defined green OA as "indirect free access to an article or an earlier version of the manuscript that is available on the web at a location other than the website of the journal publisher" (p. 476). Björk et al. (2010) identified the websites of authors as the most popular locations for self-archiving. Ware and Mabe (2015) highlighted the complexity of green OA in studies:

> Green: copies of article versions available in institutional or other repositories, or on authors' web pages; often embargoed for a period following the publication date; may exist in multiple archived versions and in multiple copies on different repositories" (Ware & Mabe, 2015, p. 32).

Tennant and Mounce concluded that green OA is a "depreciated term" (Tennant & Mounce, 2015, p. 4). The various definitions of gold and green OA used in the literature conflate two different concepts: the main routes to achieve OA with the different types of OA versions.

There are various names for the types of OA versions. Preprint and postprint evolved from terms such as eprints, offprints, and reprints for print articles provided by publishers to authors for distribution (Harnad, 2000). The entry in the *International Encyclopedia of Information and Library Science* defined the preprint as the "portion of a work, most commonly a journal article, printed and issued before the publication of the complete work" (Feather & Sturges, 2003, p. 518). Harnard (2003), in the *Encyclopedia of Library and Information Science*, sought consensus on the meaning of preprint and postprint:

> In reality, there might be a succession of revised drafts, all preprints, until the final accepted draft. Moreover, even after publication, the draft might be further revised to correct errors and add postpublication updates. The critical milestone is the publication itself. Let us agree to call all prepublication drafts 'preprints' and all postpublication drafts (including the official, accepted, published draft itself) 'postprints' (Harnard, 2003, p. 999).

To Harnad (2003), the term postprints applied to all post-publication drafts. The usual definition of postprint version refers to the version accepted by peer review but before final publication (Suber, 2012). To Swan (2012), the postprint can be a peer-reviewed journal article, book chapter or book "but is still in the format created by the author (i.e. not the publisher's formatted form)" (pp. 60-61).

To resolve the differences in definitions, SHERPA/RoMEO upheld that the preprint is the form before peer review, and the postprint the version of the article after peer review (SHERPA/RoMEO, n.d.). Notwithstanding, Antelman (2006) highlighted the difficulty of distinguishing postprints from preprints:

> The author postprint is not only termed a preprint by some but it looks like one and can only definitively be identified as a postprint by comparing its text with the published article. While an author might make declarations of postprint status, such as 'accepted for publication in . . .', readers know at a glance that such a document is an author-controlled document and scholars trust publishers to assert this provenance, not individual authors (Antelman, 2006, p. 87).

Ware and Mabe (2015) viewed the terms preprint and postprint as "deprecated because they are ambiguous and potentially confusing (e.g. the post-print definitely does not occur post printing)" (p. 18). Bjork et al. (2014) described postprint as a peculiar term: the accepted version never in print form and less likely to be so with digital publishing.

Several studies use the phrase "accepted manuscript" (Björk et al., 2014, p. 238; Rumsey, 2017, p. 5) or "author accepted manuscript" (Rumsey, 2017, p. 2) or "author-accepted manuscript" (Darley et al., 2014, p. 17) in preference to postprint. Publishers also use the terms "author accepted manuscript", "accepted manuscript", and "accepted version" (Elsevier, 2015; Springer, n.d.; Wiley, n.d.-b). The author accepted manuscript (AAM) is the version in publishers' submission systems.

Unclear and inconsistent definitions pose problems for bibliometric studies that require clearly defined units to facilitate analysis. For this reason, this study only uses gold OA, green OA and postprint within a quote or its original context. Instead of postprint, this study uses author accepted manuscript (AAM) as the preferred term. The published article is the final published version or publisher's version.

## Studies into Open Access

A review of studies into OA places this research into perspective as well as informing on methodology. Bibliometric studies apply quantitative methods to a body of literature to explore its patterns and trends (Haddow, 2018). All bibliometric investigations share the need for validity, reliability, and transparency (Cronin & Sugimoto, 2015b). Precise definitions and naming of units used in measurement and analysis are crucial, as too is data cleaning to enable accurate quantification and ensure validity (Ball, 2018; Haddow, 2018).

### *Terminology Used as Units of Measurement*

Although bibliometric research requires precise terminology, the various studies use a plethora of terms. Some studies use gold OA to mean articles published in OAJDs (Archambault et al., 2014; Elsevier, 2013; Piwowar et al., 2017). Other investigations use gold OA to denote all OA articles published in journals, including immediate and delayed OA (Borrego, 2016; Jubb et al., 2015; Laakso & Björk, 2012). Several studies include hybrid OA and delayed OA articles under gold OA, while other investigations exclude these OA versions (Ware & Mabe, 2015). Bronze OA is a term also used to describe OA in journals without open licensing. Piwowar et al. (2017) and Bosman and Kramer (2018) included delayed and gratis OA under their definitions of bronze OA. Martín-Martín et al. (2018) associated bronze with gratis OA with a separate category for delayed OA.

Green OA is the route to achieving OA in repositories or on authors' websites. Björk et al. (2014) viewed the different versions of green OA as the working paper, submitted manuscript, accepted manuscript, and published article. Some studies associate green OA with peer-reviewed articles in repositories (Jubb et al., 2015); others include preprints that precede the peer review process (Bosman & Kramer, 2018). Piwowar et al. (2017) assessed green OA articles are those from toll-access journals but self-archived in OA archives. For their commissioned report, Elsevier (2013) collected data on both accepted versions and preprints in repositories and websites. Archambault et al. (2014) excluded OA content from subject repositories in their results.

Some studies include OA versions on websites as green OA (Björk et al., 2010; Borrego, 2016; Laakso, 2014; Laakso & Björk, 2013). Borrego (2016) included OA in SCNs in his study of compliance with the Spanish government's mandate. Piwowar et al. (2017) excluded social networking platforms from their research owing to concerns about copyright compliance.

### *Methodological Differences*

Sources for the identification of OA data include the databases Web of Science (WoS) and Scopus (Björk et al., 2010; Jubb et al., 2015). Laakso and Bjork (2012)

described Scopus as the “most comprehensive article-level index of scholarly articles” (p. 1). Archambault (2014) searched Scopus with a custom-built harvester to identify OA articles over a period spanning 20 years. Borrego (2016) used the grant number field of WoS to retrieve details of publications under the Spanish Government’s National Programme of Fundamental Research Projects. Other databases used in studies include MEDLINE, PubMed, and PMC (Boyack & Jordan, 2011; Grassano, Rotolo, Hutton, Lang, & Hopkins, 2017; Nariani, 2013).

The DOAJ is a reliable data source for confirming the OAJD component of studies (Björk et al., 2010; Laakso & Björk, 2012). Several reviews reported the difficulty of identifying hybrid and delayed OA articles (Björk et al., 2010; Borrego, 2016; Jubb et al., 2015; Laakso & Björk, 2016; Sotudeh & Ghasempour, 2017). Several investigations identified Google Scholar as a valuable tool for locating hybrid and delayed OA as well as discovering OA in repositories (Björk et al., 2010; Borrego, 2016; Haddaway, Collins, Coughlin, & Kirk, 2015; Jubb et al., 2015; Khabsa & Giles, 2014; Kurata et al., 2013; Laakso & Björk, 2013; Matsubayashi et al., 2009; Piwowar et al., 2017).

To improve the identification of scholarly OA articles, Impactstory developed oaDOI, an open-source system specifically designed to crawl, aggregate, and verify data from many sources (Piwowar et al., 2017). The oaDOI system is the backend of Unpaywall, a web browser extension linking users directly to OA content from OAJDs, hybrid OA, and OA versions in PMC and IRs (Priem, 2018, January 14 ). From December 2017, the Open Access Indicator (OA) became a field tag in WoS.

Bosman and Kramer (2018), the first study to utilise the new OA feature of WoS, discovered that the gold category included OA articles in OAJDs, hybrid subscription and delayed OA journals without differentiation of the journal OA models. The WoS algorithm also prioritises publisher-hosted content over OA versions in repositories with many IRs omitted (Bosman & Kramer, 2018). Ware and Mabe (2015) warned that automated tools or bots occasionally harvest OA versions in breach of copyright.

Studies differ in their data analysis methods, especially the order of counting. Publisher-hosted content usually takes precedence over that in repositories and

websites (Borrego, 2016; Piwowar et al., 2017). After publisher-hosted content, some studies tally OA in subject repositories before adding data from IRs (Borrego, 2016). Studies that include websites and SCNs calculate the findings for subject repositories and IRs before adding SCN data (Borrego, 2016).

## Extent of Open Access Articles in Journals

Most studies determine the extent of OA within a body of journal literature by calculating the number of OA articles as a proportion of the total publications in the sample (Ware & Mabe, 2015). Many studies of OA use gold OA as the central unit for both measurement and analysis, but with different definitions. A better approach involves the categorisation of OA articles based on journal OA models. The main categories of OA articles in journal OA models include:

- OA articles in OAJDs;
- Hybrid OA articles in hybrid subscription journals;
- OA articles in delayed OA journals;
- OA articles in partial OA journals;
- OA articles in gratis OA journals.

Presented in Table 2 are the results of studies into scholarly OA in journals, the number of OA articles expressed as a percentage of total publications in each study. The table also includes percentages for the proportion of OA articles in each journal OA model.

The overall extent of peer-reviewed OA articles in journals ranges from 8.3% in 2009 (Björk et al., 2010) to 23% or more during the years 2016 and 2017 (Borrego, 2016; Piwowar et al., 2017). Most studies identified articles in OAJDs. More difficult is the categorisation of hybrid OA within subscription journals, and articles from delayed and gratis OA journal titles. Archambault et al. (2014) excluded delayed OA from their study. Martín-Martín et al. (2018) used bronze OA for gratis OA with a separate category for delayed OA. Bakker et al. (2017) incorporated delayed and gratis OA in the category "[j]ournals without APC information" (p. 5), with Piwowar et al. (2017) combining the percentages for gratis and delayed OA within their bronze OA category. The presentation of the results from Bakker et al. (2017) and Piwowar et al. (2017) appear across two columns in Table 2.

The studies listed in Table 2 revealed that articles in OAJDs make up between 3.2% and 12.1% of total articles (Archambault et al., 2014; Borrego, 2016; Laakso & Björk, 2012; Piwowar et al., 2017). The studies uncovered low levels of hybrid OA, ranging from 0.5% to 3.6%. The studies showed higher OA in OAJDs compared to hybrid OA, appearing to confirm the consensus within the literature that a small number of authors select OA in hybrid subscription journals (Björk, 2012; Chumbe, Kelly, & MacLeod, 2015; Dallmeier-Tiessen et al., 2010; Kocher & Kelly, 2016).

*Table 2: Studies into Open Access by Journal Open Access Models*

| Study | OAJDs % | Hybrid % | Gratis % | Delayed % | Total % |
|---|---|---|---|---|---|
| Note: % calculated out of total articles in each study | | | | | |
| Björk et al. (2010) | 5.1 | 2.0 | | 1.2 | 8.3 |
| Laakso and Björk (2012) | 11.0 | 0.7 | | 5.2 | 12.0 |
| Elsevier (2013) | 5.5 | 0.5 | 4.2 | 1.0 | 11.2 |
| Archambault et al. (2014) | 12.1 | | | | 12.1 |
| Jubb et al. (2015) | 9.6 | 2.4 | 4.6 | 2.4 | 21.1 |
| Borrego (2016) | 11.4 | 0.5 | 3.4 | 8.6 | 23.8 |
| Martín-Martín et al. (2018) | 7.3 | 1.1 | 13.2 | 1.6 | 23.1 |
| Piwowar et al. (2017) | 3.2 | 3.6 | 16.2 | | 23.0 |
| Bakker et al. (2017) | 7.9 | 2.2 | 23.8 | | 33.9 |

Other research also reported low levels of hybrid OA. Laakso and Björk (2016) uncovered only 3.8%. In their study of 65 multidisciplinary Oxford University Press journals, Bird and Richardson (2009) identified 7% of the articles as hybrid OA. Kocher and Kelly (2016) researched 46,373 articles in subscription journals in agriculture during the years 2014 to 2015 and found 4.7% were OA. The reasons given for the low adoption of hybrid OA include the high cost of APCs and unawareness about the OA option (Kocher & Kelly, 2016). Björk (2012) concluded that hybrid OA "failed as a way of significantly adding to the volumes of OA articles" and "will remain a very marginal phenomenon in the scholarly publishing landscape" (p. 1503).

The impact of delayed OA takes place after the expiry of embargoes: usually between six to 12 months after publication but can be 24 months. Laakso and Bjork (2012) identified 5.2% OA from delayed OA journals within 12 months of publication. Searching for OA 24 months after publication, Jubb et al. (2015), found that the overall extent level of OA in journals increased, which the researchers attributed to the expiry of longer embargoes. Borrego (2016) ascertained that delayed

OA made up 8.6% (rounded from 8.56%) or about a third of the articles in his sample. Björk (2017b) and Laakso and Björk (2013) observed that articles published in delayed OA journals were almost ten times the number of hybrid OA articles.

The studies in Table 2 reported gratis OA at between 3.4% (Borrego, 2016) and 13.2% (Martín-Martín et al., 2018), the figures higher than for hybrid OA apart from Piwowar et al. (2017). Not all studies provided separate data for gratis OA, Bakker et al. (2017) and Piwowar et al. (2017) combining their data with that for delayed OA.

## Extent of Open Access in Repositories

Ware and Mabe (2015) highlighted the complexity of green OA, with some studies including multiple archived versions from different repositories, on authors' webpages, and websites such as SCNs. Other investigations selected only OA in repositories. Table 3 lists major studies into OA in repositories and on websites but excludes data from SCNs. Information specific to AAMs and repositories was not always possible to extract from studies. For example, Björk et al. (2010) combined the data for repositories with that for websites. Martín-Martín et al. (2018) identified the importance of identifying OA versions in repositories that were not OA on publishers' websites. Bakker et al. (2017) provided data on author manuscripts in PMC, IRs holding only final OA published articles. Archambault et al. (2014) excluded content from some subject repositories.

*Table 3: Studies into Open Access in Repositories and Authors' Websites*

| Study | % |
|---|---|
| Björk et al. (2010)[a] | 11.9 |
| Elsevier (2013)[b] | 5.0 |
| Archambault et al. (2014) | 5.9 |
| Jubb et al. (2015) | 6.2 |
| Borrego (2016) | 21.8 |
| Piwowar et al. (2017) | 4.8 |
| Bakker et al. (2017) | 4.1 |
| Martín-Martín et al. (2018)[c] | 10.8 |

[a] Includes data for OA in repositories and websites.
[b] Includes data for AAMs (5.0%). The figure was 11.4 % with preprints (6.4%).
[c] Includes only OA versions in repositories that were not OA at publishers. The figure was 17.6% with published versions.

The results in Table 3 showed that between 4.1% and 21.8% of articles in the studies had OA versions in repositories. The higher figure came from the research of Borrego (2016) and included 15% in subject repositories and 8.9% in IRs. Martín-

Martín et al. (2018) calculated OA in repositories at 17.6%, of which 10.8% was not OA on publishers' websites. Björk et al. (2010), who included authors' websites, commented that authors' homepages were the most popular places for self-archiving: an implication to consider when assessing the extent of OA in repositories.

While the number of accepted manuscripts in repositories is pertinent to this study, data on these OA versions in IRs is scant. The OA articles in repositories found by Borrego (2016) were AAMs and compliant with the Spanish Government OA policy. The Elsevier (2013) study noted that the percentage of accepted author OA versions was 5%.

The proportion of preprints in the data presented in Table 3 is unknown except for the Elsevier (2013) study that recorded the level of preprints at 6.4%. Jubb et al. (2015) estimated that 6.2% of their research was OA in repositories and websites, but there is no indication as to whether they were preprints, AAMs or published versions. Björk et al. (2010) calculated that more than half of OA versions on websites were authors' preprints, and just under half were exact copies of the published version.

Only a few studies explored the extent of OA in different types of repositories. Borrego (2016) found that most of the OA versions in repositories were in subject repositories (15%) mostly in arXiv, with the remainder in IRs (8.9%). Harnad (2011) estimated OA in IRs "at the 15% deposit level or below" (p. 35). Davis and Connolly (2007) commented on the under-population of the IR at Cornell University. Kingsley (2013) also observed that Australian IRs had not experienced a high uptake despite government funding.

Although Borrego (2016) found that almost two-thirds of journal publishers allowed AAMs in IRs, he discovered that scientists preferred to lodge OA versions in SCNs over IRs. Piwowar et al. (2017) collected data on OA in SCNs and estimated this to be as high as 72%. Borrego (2016) identified that 12.8% of the articles in his sample had OA versions in SCNs, compared to 8.9% in IRs.

## Extent of Total Open Access

Relevant to this research are studies that calculate the total extent of OA by combining the data for OA articles in journals with that for OA versions in repositories. The previous section referred to the complexity of studies that combine data on OA on authors' websites with all OA versions in repositories. This review of the literature focussed on AAMs in repositories that were non-OA on publishers' websites, although this information was not always possible to extract.

The upward trend in overall OA levels is evident in the data presented in Table 4. Björk et al. (2010) recorded total OA at 20.4% in 2009, although this data also included OA on authors' websites. The Elsevier (2013) report provided two sets of figures: 22.6% with preprints and 16.2% with AAMs only. Based on the studies by Björk et al. (2010) and Elsevier (2013), overall OA stood at between 16.2% and 22.6% during the years 2009 and 2012. After that time, studies recorded increases in OA of between 27.3% and 45.6% (Bakker et al., 2017; Borrego, 2016; Jubb et al., 2015; Piwowar et al., 2017).

Martín-Martín et al. (2018) identified the need to focus on OA versions in repositories that were not OA on publishers' websites. Bakker et al. (2017) established a percentage of 38% for overall OA, most of which was OA in journals (33.8%) with a smaller component from PMC (4.1%). Borrego (2016) found 23.8% for OA in journals and 21.8% for OA in repositories, with total OA amounting to 45.6%. This percentage is significant, not only because this figure is much higher than other studies, but it also reflected compliance with the Spanish Government's OA mandate.

*Table 4: Studies into Extent of Overall Open Access*

| Study | % |
|---|---|
| Björk et al. (2010)[a] | 20.4 |
| Elsevier (2013)[b] | 16.2 |
| Jubb et al. (2015) | 27.3 |
| Borrego (2016) | 45.6 |
| Bakker et al. (2017) | 38.0 |
| Piwowar et al. (2017) | 28.0 |
| Martín-Martín et al. (2018)[c] | 33.9 |

[a] Includes data for OA in repositories and websites.
[b] Includes data for AAMs (5.0%). Total OA was 22.6% with preprints included (6.4%).
[c] Includes only OA versions in repositories that were not OA at publishers.

## Journal Level Studies

Journal level studies provide quantitative descriptions of journal titles, some undertaken on individual titles (Tiew, 1997; Wan, Anyi, Zainab, & Anuar, 2009). Journal studies impart information about the patterns and trends in the different journal OA models. The analysis of journal titles is also useful in the investigation of the repository or self-archiving policies of journal publishers.

There are various approaches to undertaking studies into journal OA models. For journals listed in DOAJ, the directory provides useful and downloadable data valuable for analysis. Fein (2013) explored the content and citations to articles published in *PLOS ONE* as well as authors' perceptions of the journal and its management. Burns (2015) conducted a study of *PeerJ*, investigating the journal by authors' attributes, the quality of peer review, as well as undertaking usage, social metrics, and citation analyses. Other studies involved comparisons of journal titles. Solomon (2014) undertook a web-based survey of authors who published in *BMJ Open*, *PeerJ*, *PLOS ONE* and *Sage Open*. Björk and Catani (2016) compared the distributions of citations to articles in *PLOS ONE* and *Scientific Reports* with those in several subscription journals.

Björk (2015) identified the more successful OAJD megajournals as having four primary characteristics, including large volume, scientifically sound peer review, subject broadness, and moderate or medium APCs. Other criteria used to assess megajournals include the reputation of publishers and academic editors, the publication rate, and the type of CC licence. Wakeling et al. (2016) conducted a comprehensive bibliometric analysis of eleven OAJD megajournals using the criteria developed by Björk (2015).

Ware and Mabe (2015) highlighted the challenge of comparing journals that range in volume from small quarterly publications with annual outputs of 20 articles to *PLOS ONE* that publishes over 30,000 articles a year. Another major challenge of journal studies is the identification of OA in hybrid subscription journals (Laakso & Björk, 2016). Most investigations of hybrid OA are parts of broader studies into the extent of OA that use article-level information and involve considerable manual data

collection and analysis (Björk, 2012; Dallmeier-Tiessen et al., 2010; Jubb et al., 2015; Laakso & Björk, 2016; Sotudeh et al., 2015).

Laakso and Bjork (2016) undertook an exploratory examination of hybrid OA in subscription journals published by five publishers: Elsevier, Springer, Wiley-Blackwell, Taylor and Francis and Sage. The approach involved the identification of hybrid subscription journals by contacting publishers and consulting the journal lists on publishers' websites. The proportion of OA articles compared to the total number of articles in each journal title provided data for the calculation of hybrid OA. Laakso and Bjork (2016) conceded that studies of hybrid OA involve considerable challenges, especially time-consuming data collection and analysis.

Bakker et al. (2017) analysed the OA cost implications and repository policies of journals frequently used by multiple sclerosis researchers and found that 38% of the articles in the sample were OA. Three large publishers (Elsevier, Wiley, and Springer Nature) dominated the research output publishing 49.7% of all articles but only accounting for 32.2% of OA articles. While there were articles in *PLOS ONE* (1.8%) and other OAJD journals, most researchers published in hybrid subscription journals with high APCs (US$3,000). Bakker et al. (2017) found that researchers based their decision to publish OA on the journal's reputation, JCR Impact Factor, and turnaround time.

To evaluate the degree of openness of 1,728 Spanish scholarly journals listed in the Spanish national DULCINEA database, Melero, Laakso and Navas-Fernández (2017) used the Open Access Spectrum (OAS) Evaluation Tool provided by SPARC (2014). The OAS tool includes four core variables: reader rights, reuse rights, copyright, and author posting rights. Melero et al. (2017) found that 37.5% of the journals used CC licences, but with 72% permitting author reuse and authorisation rights.

Many studies use the SHERPA/RoMEO database for the archiving or repository policies of journals (SHERPA/RoMEO, n.d.). For a list of RoMEO colours and their categorisation, see Table 5. Gadd et al. (2003) undertook a large-scale analysis of publishers' policies using the SHERPA/RoMEO database and found that almost 50%

of journal titles allowed RoMEO green archiving. Miguel et al. (2011) found that only 32% of journals supported the archiving of OA versions. Of the 211 journals in their study, Bakker et al. (2017) found that 56.87% allowed the deposit of the AAMs in repositories.

*Table 5: SHERPA/RoMEO Categories of Publishers' Archiving Policies*

| Colour | Archiving Policy |
|---|---|
| Green | Can archive preprint and postprint or publisher's version/PDF |
| Blue | Can archive postprint or publisher's version/PDF |
| Yellow | Can archive preprint |
| White | Archiving not formally supported |

Although Laakso (2014) described the SHERPA/RoMEO database as the "most comprehensive service of its kind" (p. 481), he found that unstructured and outdated metadata hindered searching. Gadd and Covey (2016) criticised the RoMEO coding as hierarchical, RoMEO green being as the "next best thing" to publishing OA and "RoMEO white the worst … [although some] white publishers actually allow self-archiving" (p. 13). Bakker et al. (2017) queried the value of the RoMEO yellow category as preprints have little value to open research communications. In their study of over 100 journal publishers, Gadd and Covey (2016) found that despite being categorised RoMEO green, many hybrid subscription journals had restrictive conditions on depositing in repositories.

Laakso (2014) recognised that most publishers of journals permit the archiving of the AAMs in repositories: university presses having the highest percentage (96%) followed by commercial (82%) and society/professional publishers (77%). Melero et al. (2017) found that 79.5% of 1,728 Spanish scholarly journals listed in the Spanish national DULCINEA database allowed self-archiving in some form. Borrego (2016) established that 62.9% of the articles in his sample were from journals whose publishers permit the deposit of postprints in repositories. Only 1% of commercial publishers permitted the deposit of published articles in repositories (Laakso, 2014). Notwithstanding, Jamali (2017) reported that most authors preferred to deposit the published version, especially in SCNs.

Another approach to journal studies is by subject. WoS includes subject categorisation known as the WoS Category (WC). Every journal and book covered

by WoS Core Collection includes at least one subject category in the WC field (Clarivate Analytics, 2018b). Several studies conducted journal studies using WC categories to map journals in medical and scientific subjects (Bayoumy, MacDonald, Dargham, & Arayssi, 2016; Leydesdorff, Carley, & Rafols, 2013; Nadri, Rahimi, Timpka, & Sedghi, 2017; Sweileh, Sa'ed, Al-Jabi, & Sawalha, 2014). Other subject studies used Medical Subject Heading (MeSH) (Haustein, Smith, Monegon, Shu, & Larivière, 2016).

## Studies into Funding Acknowledgement

Most publications include acknowledgments: some include simple expressions of appreciation to individuals and colleagues; others are formal recognition of supervisors, institutions, and funders. Funding acknowledgement data are of interest to funders, institutions, and authors. To funders, funding data identify the publications arising from their investment in research (Begum & Lewison, 2017; Butler, 2001, 2003; Butler, Biglia, & Bourke, 1998; Butler, Biglia, & Henadeera, 2005; Goldfarb, 2008; Harter & Hooten, 1992; Lewison & Dawson, 1998). To research institutions, grants are important indicators of success at attracting funds and research impact, with funding acknowledgements highlighting the research projects of institutional researchers (Costas & Van Leeuwen, 2012a; Rigby, 2011, 2013). For authors, funding acknowledgements are not only recognition of the contribution of specific grants to their research and but also record conflicts of interest (Begum & Lewison, 2017; Lewison & Sullivan, 2015; Lexchin, Bero, Djulbegovic, & Clark, 2003).

Funding acknowledgements provide substantial data for bibliometric analysis, especially in the three-way relationship between authorship, citations, and funding known as the reward triangle (Costas & Van Leeuwen, 2012b; Cronin & Weaver, 1995). Nonetheless, there are challenges to using funding data in research, especially textual acknowledgments that often include a diverse range of technical, ethics-related, or research support information (Costas & Van Leeuwen, 2012b; Costas & Van Leeuwen, 2012c; Cronin & Shaw, 1999; Cronin, Shaw, & Barre, 2004; Cronin, Shaw, & La Barre, 2003; Cronin & Weaver, 1995).

## *Funding Information Sources*

Before 2008, most studies relied on time-consuming and manual data collection procedures, funding information obtained from funding agency reports and databases. Lewison and Dawson (1998) accessed a research outputs database and Blume-Kohout, Kumar, and Sood (2009) tapped into datasets from various US government agencies. Giles and Councill (2004) used CiteSeer to collect data from over 400,000 research papers. For medical research areas, PubMed is a supply of funding information (Boyack & Jordan, 2011; Grassano et al., 2017; Kokol & Vošner, 2018). Kokol and Vošner (2018) acknowledged that while funding data in PubMed is more challenging to obtain and analyse, it is freely accessible in contrast to WoS and Scopus.

The addition of acknowledgement fields to WoS in 2008 and Scopus in 2013 created greater possibilities for bibliometric analyses facilitated by the automatic extraction of data (Álvarez-Bornstein, Morillo, & Bordons, 2017). Kokol and Vošner (2018) investigated articles in prominent medical journals and found that WoS indexed substantially more articles with funding information in comparison with PubMed and Scopus. Grassano et al. (2017) showed that WoS identified approximately 93% of funding data for their study, whereas PubMed identified less than 50%. WoS has a wider range of funding acknowledgement fields compared to other databases that give researchers more options (Kokol & Vošner, 2018; Paul-Hus et al., 2017).

## *Funding Information Data in Web of Science*

WoS has three advanced search fields used for funding acknowledgement research: these being Funding Text (FT), Funding Agency (FO) and Funding Grant (FG). For a list of these fields with the corresponding output fields (see Table 6). Researchers have found that the search fields result in different numbers of records. Tang, Hu, and Liu (2017) found that the FT field returned a higher number of records compared to the FO and FG fields. Paul-Hus et al. (2016) also discovered that FO and FG fields contained less funding information. The FT field is based on the acknowledgement in the original publication and considered the more authoritative source of funding acknowledgement (Paul-Hus et al., 2016; Tang et al., 2017).

The lack of standardisation of funding agency names and inconsistencies in indexing are issues with the funding acknowledgement fields of WoS. The range of variations of funder names include the full, abridged, and abbreviated forms in different languages and formats (Begum & Lewison, 2017; Sirtes, 2013). The indexing of funder names also includes spelling or typographic errors, some originating from authors' acknowledgements, while others are transcription errors (Begum & Lewison, 2017; Sirtes, 2013). These inaccuracies hinder both information retrieval as well as the reliability of studies (Álvarez-Bornstein et al., 2017; Lewison & Roe, 2012; Rigby, 2011; Tang, 2013; Wang & Shapira, 2011). Solutions include author guidelines for consistent citing of funder name and grant numbers, and improved coding systems (Álvarez-Bornstein et al., 2017; Begum & Lewison, 2017).

Incomplete or biased indexing is another issue. Wang, Liu, Ding and Wang (2012) uncovered grant numbers without the corresponding funder names: a series of numbers rendered unusable without distinguishable funder codes. Indexing is also limited to articles and reviews with funding statement information in English (Álvarez-Bornstein et al., 2017; Paul-Hus et al., 2017; Tang et al., 2017). Costas and Van Leeuwen (2012b) queried the criteria used by indexers:

> … the lack of information about the details of how acknowledgments are collected and how the possible different traditions and cultures of acknowledging across fields and journals are treated raise the question whether some biases can exist in the coverage of this type of information (Costas & Van Leeuwen, 2012b, p. 1654)

Indexing of funding acknowledgement data for the arts and humanities is also inadequate (Paul-Hus et al., 2016).

The inconsistencies in data within funding acknowledgement fields reinforce the need for bibliometricians to be careful when interpreting data. Rigby (2011) and Tang et al. (2017) warned about the uncritical use of funding acknowledgement data. Wang and Shapira (2011) cleaned their data and created a thesaurus that included combinations of funder agency names to ensure the validity of the data. Numerous studies recorded the issue of authors not always acknowledging their funders (Álvarez-Bornstein et al., 2017; Borrego, 2016; Grassano et al., 2017; Wang, Liu, & Fang, 2015; Yegros-Yegros & Costas, 2013). Notwithstanding the limitations of

funding acknowledgement fields, bibliometric studies using data from these fields are expanding. Wang and Shapira (2011) welcomed the research area as a "new lens that allows us to quantify and investigate the various relationships between funding and publications" (p. 583). An emerging focus is the analysis of compliance of research outputs with funder mandates.

## Studies into Funder Mandates

Quantitative studies into compliance with funder mandates are few, with Borrego (2016) conducting the first comprehensive study into OA compliance under the Spanish Government OA policy. He found 23.8% of his sample was OA in journals, predominantly articles from OAJDs, with 8.56% from delayed OA journals and only 0.5% hybrid OA. Borrego (2016) also discovered that 15% of his sample had OA versions in subject repositories and 8.9% in IRs, all of which were compliant with the Spanish Government OA policy. Another 12.8% of articles had OA versions in SCNs. Bakker et al. (2017) investigated compliance under the non-government OA policy of the Multiple Sclerosis Society of Canada found that 38% of journal articles funded between 2009 and 2014 were OA in journals and PMC. Of this percentage, 7.9% were publishing in OAJDs and 23.8% in non-APC journals, with the remainder published as hybrid OA articles in subscription journals or deposited as author manuscripts in PMC.

Among the strongest funder OA mandates is the NIH Public Access Policy requiring the deposit of NIH research papers in PMC (Boyack, 2009; Boyack & Jordan, 2011; Charbonneau & McGlone, 2013; De Groote et al., 2015; Kurata et al., 2013; Lyubarova, Itagaki, & Itagaki, 2009; Van Noorden, 2014). With the authority of the NIH as a research funder, Björk et al. (2014) assessed PMC as having the bargaining power to negotiate special conditions with publishers. Notwithstanding, Kurata et al. (2013) found the high level of OA in PMC was due to publishers depositing entire journal issues, rather than authors depositing manuscripts. Pontika (2011, 2015) also found that the NIH Policy did not change the publishing habits of authors who already published OA in OAJDs.

The Canadian Institutes of Health Research (CIHR) policy was less successful with only 4% of CIHR funded accepted manuscripts deposited in PMC Canada, the

repository decommissioned in early 2018 (CIHR, 2017, December 18). The study conducted in 2013 by Nariani (2013) indicated greater compliance under the Canadian Institutes of Health Tri-Agency Open Access Policy on Publications with 20% of articles in PMC and 18% in PMC Canada.

Gargouri, Larivière, Gingras, Brody et al. (2012) challenged the argument of the Finch Committee (2012) that claimed the ineffectiveness of funder and institutional policies in increasing OA outputs in UK IRs. Notwithstanding, a vast literature reported on the limited impact of OA mandates in increasing the OA content in IRs (Björk, 2014, 2017a; Björk et al., 2010; Borrego, 2016; Laakso, 2014; Lynch, 2017). To meet mandates and OA policies in the future, Lynch (2017) predicted the growth of funder repositories, while Gargouri, Larivière, Gingras, Brody et al. (2012) recommended the integration of institutional and funder mandates. Lynch (2017) maintained that funders "have shown little interest in enabling or mandating large-scale automatic replication from funder or funder-blessed repositories to institutional ones" (p. 126). Callicott (2016) argued that national repositories were better suited to supporting a comprehensive OA approach.

Gargouri, Larivière, Gingras, Carr, et al. (2012) maintained that the only constraint on OA in IRs is whether the author chooses to self-archive, with Gargouri, Larivière, Gingras, Brody et al. (2012) recommending OA mandates with mechanisms for enforcement. However, Bakker et al. (2017) identified publishers' conditions and APCs as affecting authors' decisions about OA, with a large literature claiming that institutional and publisher barriers inhibit depositing in IRs (Björk et al., 2014; Borrego, 2016; Cullen & Chawner, 2011; Henty, 2014; Huggard et al., 2017; Kim, 2007; Zhu, 2017).

## Conclusion to Literature Review

The literature reviewed for this thesis demonstrates that there is a vast body of research surrounding the extent of scholarly OA, the various journal OA models, and OA in repositories. While the investigation of funding acknowledgement is an emerging area of research, only a small proportion of the literature focussed on compliance with funder policies. The study of Borrego (2016) is significant as the first comprehensive study to examine compliance under a funder OA mandate.

The literature revealed numerous challenges associated with studies into the extent of OA. The diverse definitions of gold and green OA conflate two different concepts: the main OA routes to achieving OA through publishing and depositing OA in repositories, with the various types of OA and journal OA models. Another challenge is identifying and measuring the extent of hybrid OA. The works of Laakso and Bjork (2016) and Borrego (2016) are significant in highlighting the necessity for further research into the extent of hybrid OA in meeting OA compliance.

Relevant to this study is the literature into publishers' policies on the deposit of AAMs in IRs. Laakso (2014) recognised that a substantial number of publishers (79.9%) allow the deposit of AAMs in IRs, with Bakker et al. (2017) calculating that 56.87% journal titles in their study allowed the deposit. Noted is the considerable potential for AAMs to increase the overall extent of OA in IRs (Bakker et al., 2017; Björk et al., 2014; Borrego, 2016; Laakso, 2014). While authors' attitudes and lack of time contribute to low OA in IRs, studies also report unawareness of OA policies and procedures relating to IRs (Björk et al., 2014; Borrego, 2017; Seaman, 2017; Zhu, 2017). Concerning is the widespread unawareness of the AAM (Henty, 2014), the OA version allowed by most publishers and that required under the NHMRC OA Policy.

# Chapter 3: Research Design, Methods and Data Analysis

The NHMRC OA Policy mandated OA for all Council funded journal articles, but the extent of OA compliance is unknown. The literature revealed the range of journal OA models, the low adoption of hybrid OA in subscription journals, and authors' minimal participation in depositing AAMs in repositories. Metadata records of NHMRC publications in Australian IRs are also an essential part of the OA policy, including the acknowledgement of the Council as the funder. The focus of this research is the extent of compliance with the NHMRC OA Policy.

The best method to find answers to the research questions posed by the research problem is the bibliometric method used extensively in the past to explore OA and funding acknowledgement topics. Bibliometrics apply quantitative methods to a body of scholarly literature or communication (Haddow, 2013, 2018). The main body of literature in this study comprises NHMRC funded articles published in 2013 and 2014. The purpose of this research is to collect data on NHMRC articles and analyse the data to ascertain the level of OA compliance with the Council's OA policy.

This chapter begins with the rationale for the research design and explores the bibliometric method in some depth. Accounts of existing bibliometric studies into scholarly OA, funder studies and analyses follow. The next section details the justification for selecting WoS as the primary data source and the methods for determining the population and the sample. Described are the two data collection instruments and the arguments supporting their use and selection. Discussed is the data collection timeline for the completion of each stage and followed by the processes used in data preparation. The chapter concludes with descriptions of data analysis methods and the use of descriptive statistics.

## Research Design

The research questions of this study require the collection and analysis of a large set of publication data, and the research design best suited to answer these questions is quantitative and descriptive. One of the main benefits of quantitative research is its

usefulness in reducing large quantities of data to a manageable form. Another advantage is the investigative nature of the design, enabling an overall description of a phenomenon. Statistical analysis of quantitative data also facilitates broad interpretation of numerical results through graphs, charts, tables and other visualisation (Connaway & Powell, 2010; Gall et al., 1996; Wildemuth, 2009).

Four detailed research questions relating to NHMRC funded peer-reviewed journal articles published in 2013 and 2014 drive this research. The first three questions require a quantitative approach to analysis, these being:

1. What proportion of NHMRC funded articles is open access in journals?
2. What proportion of NHMRC funded articles not open access in journals has author accepted manuscripts in at least one Australian institutional repository?
3. What proportion of NHMRC funded journal article metadata is in Australian institutional repositories?

The policies of journal titles are the subject of the final research question that requires both quantitative and qualitative approaches:

4. What are the open access models and author accepted manuscript policies of the journal titles in which NHMRC grant recipients publish?

## The Bibliometric Method

The bibliometric method applies quantitative methods to a body of scholarly literature or communication (Haddow, 2013, 2018). Bibliometric studies encompass a wide range of scholarly communications. De Bellis defined bibliometrics as the "application of mathematics and statistical tools to an increasingly elusive set of objects: books, science, information" (De Bellis, 2014, p. 23). Pritchard coined the term bibliometrics in the late 1960s to describe the "application of mathematical and statistical methods to books and other media of communication" (Pritchard, 1969, p. 348). A theoretical change in bibliometric research came with the recognition by Eugene Garfield, the founder of the Institute of Scientific Information (ISI), of the pivotal role of bibliographic information in the knowledge production process. De Bellis described the ideas in Garfield's article in *Science* in 1955 (Garfield, 1955) as the "turning point" (De Bellis, 2009, p. 58) in the conceptual development of bibliometrics.

The Science Citation Index (SCI) fundamentally changed the practice of bibliometrics. The original objective of the SCI and other ISI indexes was to improve literature searching through the indexing of journal literature and the provision of citations (De Bellis, 2014; Garfield, 2007). SCI also expanded interest in bibliometrics, especially citation analysis. In 1992, Thomson Corporation merged ISI indexes into WoS (De Bellis, 2009). In 2016, Clarivate Analytics acquired WoS (Clarivate Analytics, 2016, October 3). WoS is a valuable source of datasets for bibliometric studies. Medline, Embase, and Cochrane Reviews are databases also useful in bibliometric studies (Thompson & Walker, 2015). The launch of Scopus and Google Scholar in 2004 provided additional data sources and tools for bibliometric research (Vieira & Gomes, 2009).

There is an extensive literature on bibliometrics (Cronin & Sugimoto, 2014; Cronin & Sugimoto, 2015c; David & Ritchie, 1978; De Bellis, 2009; Narin, 1976; Pritchard, 1969; Van Leeuwen, 2004). All bibliometric analyses begin with descriptive methods (Hertzel, 1987, 2003; Nicholas & Ritchie, 1978). De Bellis argued that the basis of bibliometrics is:

> … "controlled" evidence, shored up by a specific research question, by a set of (theoretical, methodological) assumptions about the phenomena under investigation, and by the resolution of the observation instruments (bibliographic databases, citation indexes, mapping software, surveys, and the like) (De Bellis, 2009, p. xxix).

Van Raan recognised the value of the descriptive bibliometric model for its supply of "information that is uniquely descriptive, locational and relational … not just a bundle of counts" (Van Raan, 2013, p. 359).

To Cronin and Sugimoto, the advantage of descriptive bibliometrics is obtaining overviews of trends and developments:

> At the macro level, descriptive bibliometrics enables us to understand the evolution of knowledge domains, chart the waxing and waning of specialities, monitor shifts in nations' "market share" of world science, and dynamically visualize networks of journals, papers, patents, authors, collaborations, and such (Cronin & Sugimoto, 2015b, p. 936).

Another advantage of the bibliometric method is to provide data on the changing structure of scholarly communication (Cronin & Sugimoto, 2015b; Hertzel, 1987, 2003; Nicholas & Ritchie, 1978). Osterloh and Frey (2015) maintained that bibliometric studies render scholarly literature and communication comprehensible to authors, institutions, funders, and the broader community.

Medical science is very much a part of the history and development of bibliometrics. As a pilot for SCI, Garfield (1955) used an article by pioneering Hungarian-Canadian endocrinologist Hans Selye (1946), published in the *Journal of Clinical Endocrinology*. Bibliometric studies continue to be beneficial in medicine demonstrating trends and developments in the treatment of diseases, viruses and pandemics, as well as in the use of procedures and protocols (Baskaran & Sivakami, 2014; Gao et al., 2017; Munuswamy & Jeyasekar, 2018; Thompson & Walker, 2015). These examples are practical and objective applications of bibliometrics.

The World Wide Web created more opportunities for alternative metrics (known as altmetrics) that are complementary to traditional bibliometric data. Altmetrics include discussions on research blogs, citations from public policy documents, media coverage, and comments on social networks such as Twitter (Cronin & Sugimoto, 2014). Nonetheless, Cronin and Sugimoto (2015a) commented that the new measures come with the old concerns relating to validity and transparency. All bibliometric studies share the need for reliability and transparency (Cronin & Sugimoto, 2015a; Cronin & Sugimoto, 2015b).

## Literature Informing on Methods

The literature reviewed for this thesis (Chapter 2) demonstrated the range of studies that investigated the extent of OA in journals and repositories, some under OA funder OA policies. Borrego (2016) undertook the first comprehensive study on OA compliance with a funder policy. Bakker et al. (2017) also investigated compliance under the non-government OA policy of the Multiple Sclerosis Society of Canada. Notwithstanding the importance of the research undertaken by Borrego (2016) and Bakker et al. (2017), the design of the data collection instruments for this study evolved during the period 2013 to 2015 before the publication of the other research. Also unavailable was the OA output field added to WoS in late 2017. Therefore, this

section focusses on the methods cited in the literature published before 2016, with the methodology used by Borrego (2016) and Bakker et al. (2017), and the developments in WoS described later in this chapter.

Studies into funding acknowledgement data discovered that the search fields in WoS result in different numbers of records (Paul-Hus et al., 2016; Tang et al., 2017). The lack of standardisation in funding agency names is a common cause of different results. Other reasons include typographical errors and indexing oversights (Lewison & Roe, 2012; Rigby, 2011; Sirtes, 2013; Tang, 2013; Wang & Shapira, 2011). Wang and Shapira (2011) highlighted the importance of data cleaning, ordering their data and creating a thesaurus to include all variations of funder agency names to ensure the validity of the data. The representativeness of the sampling is necessary to ensure the reliability of the data (Babbie, 2014; De Bellis, 2009, 2014; Haddow, 2013; Williamson, 2013).

With OA studies into the extent of OA, Ware and Mabe (2015) counselled about the issues of definitions, methodology and measurement:

> Counting open access is, however, complicated by issues of definition, and by methodological and measurement challenges. Different researchers use different definitions for categories of OA articles, sometime for ideological reasons, which makes comparisons of their difference estimates hard or impossible" (Ware & Mabe, 2015, p. 31).

Ill-defined or variously defined units of measurement, especially for green and gold OA, affect studies (Ware & Mabe, 2015). Bibliometric research requires accurate and precise units of measurement and analysis (Haddow, 2013; McGrath, 1996).

Ware and Mabe (2015) reported that most studies into the extent of OA in journals measure the number of OA articles as a percentage of the total in the sample or body of literature. Many studies reported the challenge of identifying OA in hybrid subscription journals, some utilising Google Scholar and publishers' websites to find OA information (Björk et al., 2010; Haddaway et al., 2015; Jamali & Nabavi, 2015; Jubb et al., 2015; Khabsa & Giles, 2014; Kurata et al., 2013; Laakso & Björk, 2013; Matsubayashi et al., 2009). Useful in identifying OA in Australian IRs is Trove, the

portal for the National Library of Australia's online discovery services, including the ARROW project (Ayres, 2015; Sherratt, 2013).

Most studies use the SHERPA/RoMEO database to determine the archiving policies of journal publishers, with RoMEO colours identifying publishers' archiving policies. RoMEO green allows the deposit of the preprint, postprint, and publishers' versions in repositories, with RoMEO blue permitting AAMs/postprints or final published articles. While widely used to categorise publishers' policies, SHERPA/RoMEO does not have a specific category for policies relating to AAMs/postprints. Laakso (2014) identified 79.9% of publishers that allowed the deposit of AAMs in IRs.

WoS Categories (WCs) promote disciplinary foci that are useful in journal studies. Leydesdorff et al. (2013) created global maps of science using WCs. The survey of Sweilah et al. (2014) is noteworthy in researching the extent of OA within the subjects of urology and nephrology.

## Population

Descriptive bibliometric studies rely on the quality of the source databases. Essential considerations include coverage, specialised fields, and advanced search capabilities to facilitate accurate data retrieval. This study required a source that included search fields to identify NHMRC grant recipients. While Elsevier started adding funding acknowledgement data to Scopus in March 2017 (Beatty, 2017), WoS holds funding information dating back to 2008. Compared to other databases, WoS has the most substantial proportion of funding acknowledgement information covering the first years of the NHMRC OA Policy. The funding acknowledgement coverage provided by WoS for the years 2013 and 2014 was the reason for its selection as the source database for the population of this study.

It was the original intention to begin the study from July 2012 when the NHMRC OA Policy came into effect, but this proved problematic for two reasons. Firstly, sorting articles into those published before and after 1 July 2012 proved too problematic owing to the different definitions of the date of publication and VoRs.

Secondly, a half-year study complicated the investigation. Therefore, the first two full years of the NHMRC OA Policy became the focus.

## Search Strategies

In deciding upon search fields, Wang et al. (2012) cautioned about the shortcomings of some WoS funding acknowledgement fields. Conscious of these limitations, the search strategy to identify the population for this study included both the FO (Funding Agency) and FT (Funding Text) search fields. Table 6 provides a list of WoS advanced search fields and the corresponding output fields.

*Table 6: Web of Science Search and Output Field Tags*

| **Advanced Search Field Tags** | **Output Field Tags** |
|---|---|
| FO = Funding Agency<br>FG = Funding Grant | FU Funding Agency and Grant Number |
| FT = Funding Text | FX Funding Text |
| PY = Year Published | PY Year Published<br>PD Publication Date |

The literature into funding acknowledgement reported on the lack of standardisation of funding agency names within WoS (Lewison & Roe, 2012; Rigby, 2011; Sirtes, 2013; Tang, 2013; Wang & Shapira, 2011). A requirement of the search strategy was the retrieval of variations of funder names and acronyms. A trial using truncation combined with wildcards found that even with a fair amount of control, search queries captured funder names such as the United Kingdom and South African Medical Research Councils. Using the NOT operator in the search queries was also problematic, as many funding agency names include the phrases “national health” and “research council”.

Wang and Shapira (2011) emphasised the need for clean data relating to funding agencies and recommended the creation of a thesaurus of funder names. Figure 2 demonstrates the variation in funding information provided by NHMRC funded authors, mostly originating from the acknowledgement sections of published articles. For this study, the Refine Results Panel in WoS and checkboxes under Funding Agencies were useful tools to bring together the wide variations of funding agency names.

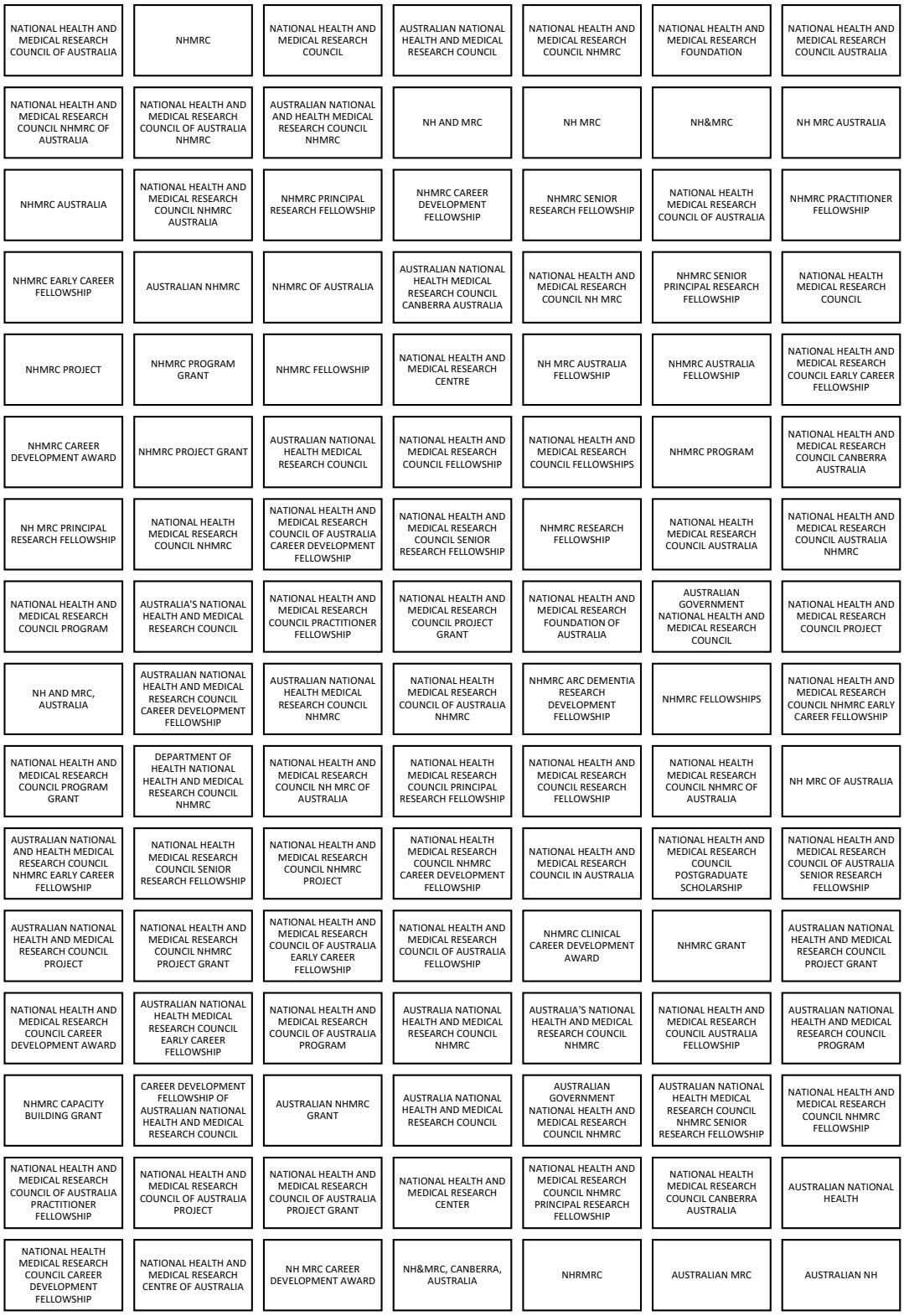


*Figure 2: Funding Information Provided by NHMRC Funded Authors*

Selecting all alternatives of the National Health and Medical Research Council and NHMRC under Funding Agencies from the Refine Results panel of WoS created a comprehensive list of funder name variants. The next step combined the list of

NHMRC funder names with the Advanced Search field tags FO and FT. The subsequent stage linked the FO and FT sets. Publication year (PY) for 2013 and 2014 further refined the search strategy to produce the population for the study.

The results of the WoS search included duplicate journal articles. The download of publication data from WoS to Microsoft Excel created the master-spreadsheet for the population that also facilitated de-duplication. Other publications removed from the master-spreadsheet included:

- The *Cochrane Database of Systematic Reviews* that are a series of continually updated reviews and protocols, and not journal articles;
- Journal articles in which the reference to the NHMRC was to the Council's ethics codes;
- Articles solely authored by NHMRC Postgraduate Scholarship holders, who are exempt from the Council's OA Policy.

### Population Results

The population for this study comprised 12,753 Council funded articles with 6,293 published in 2013 and 6,460 in 2014. The large number of articles and the time frame for a Master of Philosophy thesis influenced the decision to use probability sampling.

## Sample

### Sampling Methods

Probability sampling facilitates the creation of a sample that closely represents the population with a level of high confidence level and minimal bias (Connaway & Powell, 2010; Wilson, 2014). A foundation of probability sampling is the use of random selection to select units from the population to create the representative sample, each unit having an equal chance or probability of selection (Connaway & Powell, 2010).

The sample size is important as it affects the quality and the validity of the results. According to Baker (1999) and Williamson (2013), the largest possible sample is desirable, especially in statistical sampling. While Wilson (2014) advised "larger the better" (p. 46), she acknowledged that time, funding, and other issues also influenced

the selection of sample sizes. Williamson (2013) recommended sampling sizes of 30% for populations under 1,000 and 10% for populations of 10,000 or more. With a population of 12,753 journal articles, a sample size of 25% comprised just over 3,188 articles. Notwithstanding the adequate size of a sample of 25%, the study required further statistical tests to confirm that information drawn from the sample could be true of the population.

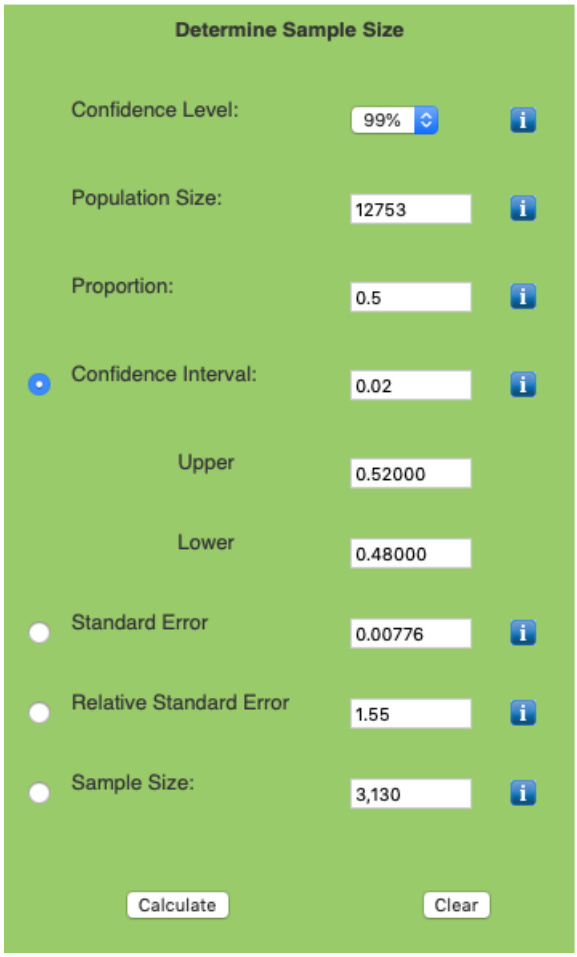


*Figure 3: Sample Size Calculation Using the ABS Calculator*

Wilson (2014) suggested sampling formulas such as the method devised by Cochran (1997) and the Australian Bureau of Statistics (ABS) sample size calculator (ABS, n.d). The ABS sample size calculator (see Figure 3) allows the calculation of the sample size for a stated population to reflect confidence levels of 95% and 99%. While the default proportion estimate is 0.5 or 50%, the percentage entered may be based on the proportions set by the sample sizes used in previous studies. The

calculator facilitates experimentation with various sample sizes to determine the preferred confidence level, standard and Relative Standard Error (RSE).

The ABS calculator provided a technique to verify the sample size for this study, with the population (*N*=12,753) being the known criteria. As the proportion of OA in the sample was unknown at the time of sampling, the calculation used the default ABS proportion of 50% (0.5%). Combining the test proportions with the confidence level of 99% and the confidence interval of 0.02, the sample size for 50% (0.5%) was 3,130 (24.54%) as illustrated in Figure 3.

The sample size formula of Cochran (1997), $n_0=(Z^2pq)/e^2$ and $n= n_0/(1+((n\ n_0-1))/N)$, verified the result provided by the ABS calculator. The population of NHMRC funded articles was *N*=12,753: the main value used for calculating the sample size. Combined with the population size (*N*=12,753) were the values Z=2.576 for the confidence level of 99%, e=0.02 for the confidence interval, and the sample proportion of p=0.5. The Cochran formula determined the sample size as 3129.78 (24.54%).

The three approaches to calculating the sample size for this study provided similar results. A sample size of 25% based on a population of 12,753 amounted to just over 3,188 articles (Williamson, 2013). Using the ABS calculator with the population (*N*=12,753), a confidence level of 99% and the confidence interval of 0.02, the sample size for the proportion of 50% (0.5%) was 3,130 articles or 24.54%. The Cochran formula determined the sample size of 3129.78 or 24.54%. Rounding the sample size to 25% of the population confirmed a sample size of 25% (*n*=3,190) that had a confidence level of 99%, confidence interval of 0.02 or 2%, and a low RSE of 1.67%.

The process of creating the random sample included the following steps:

- The assignment of numbers (1 to 12,753) to all articles in the population;
- The generation of a unique list of random numbers between 1 and 12,753 that totalled 25% of the population;
- The identification of article assigned random numbers in the population;

- The creation of the sample representing 25% of randomly selected articles from the population.

Figure 4 outlines the steps involved in the process of selecting the sample.

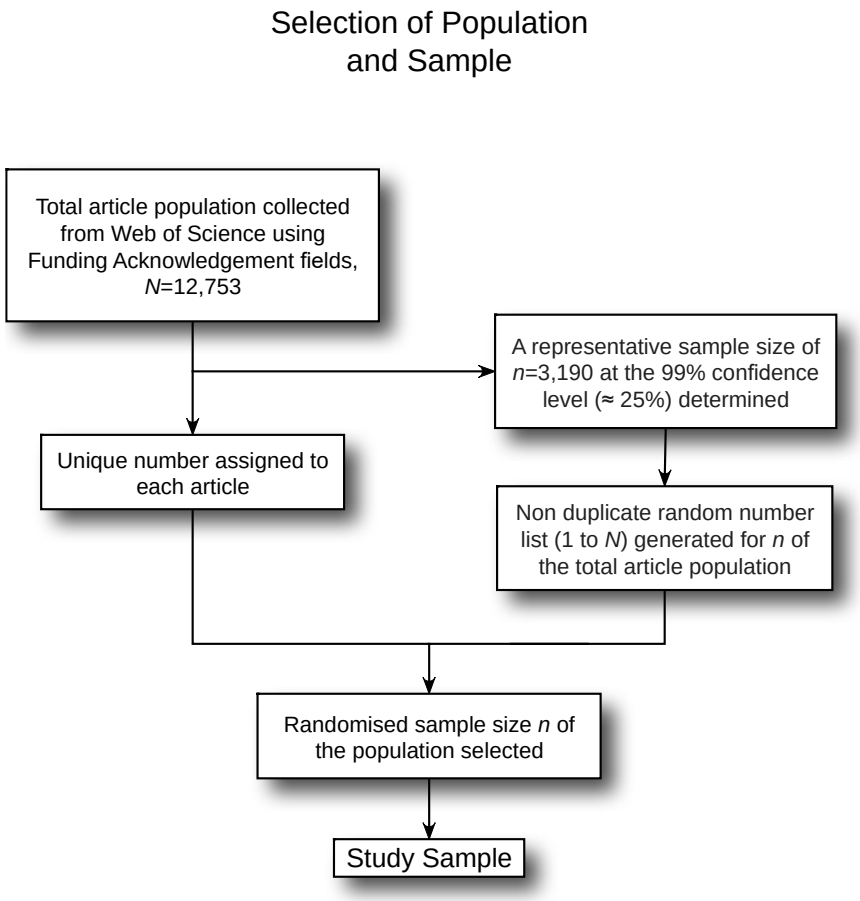


*Figure 4: Methods: Selection of the Population and Sample*

## Sample

The sample comprised 3,190 articles representing 25.013 % of the overall population of 12,753 NHMRC funded articles published during 2013 and 2014. The articles for 2013 and 2014 numbered 1,574 and 1,616, representing just over 25% for each year. A summary of the population and sample statistics appears in Table 7.

*Table 7: Population and Sample Statistics*

| Year | Population by year | Sample size | % |
|---|---|---|---|
| 2013 | 6,293 | 1,574 | 25.01 |
| 2014 | 6,460 | 1,616 | 25.02 |
| 2013 & 2014 | 12,753 | 3,190 | 25.01 |

Further examination showed that the sample of 3,190 articles comprised 1,137 journal titles. The journal titles provided the data for the journal study and were representative of the article sample with no further sampling undertaken. The article sample and the corresponding list of journal titles provided the primary data for the article and journal studies required to answer the Research Questions.

## Research Instruments

Research instruments are the data collection tools designed to collect and store research data as well as provide the basis for data analysis. In bibliometric research, the research instruments collect numeric data on a body of literature (De Bellis, 2009). In this study, NHMRC funded journal articles published during 2013 and 2014 made up the body of publications. The design of the research instruments required the incorporation of elements to collect statistics on OA articles in journals and repositories, metadata in Australian IRs, as well as the categorisation of publishers' policies relating to the deposit of AAMs in repositories.

In the design of instruments in quantitative research, Connaway and Powell (2010) highlighted the importance of coding of data to numerical codes. Coding instruments include codebooks, scoring guides, and coding keys. The assignment of numerical values to bibliometric data creates greater control over the structure of the data and allows for stronger generalisations. Bibliometric research requires consistent units of measurement to ensure validity and reliability (Haddow, 2013; McGrath, 1996).

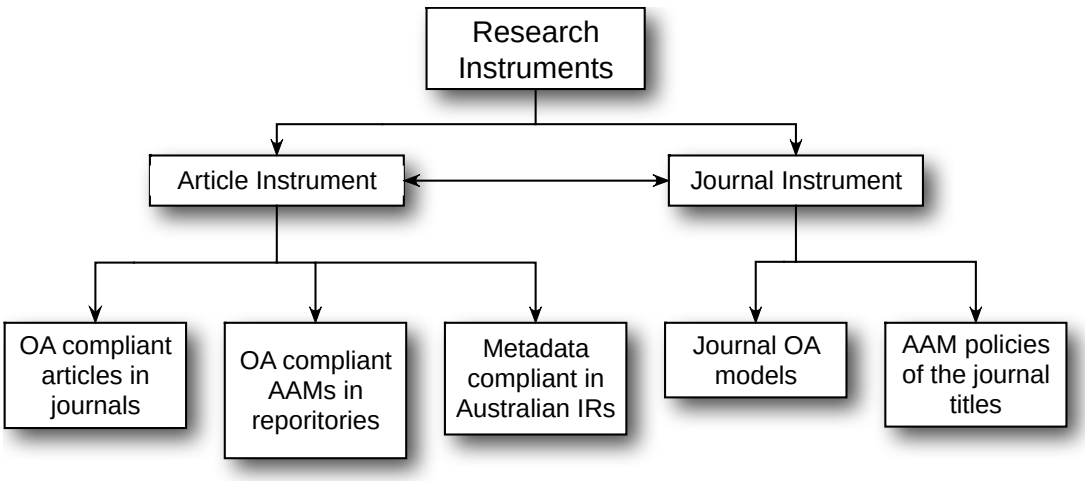


*Figure 5: Outline of Article and Journal Research Instruments*

This study included the Article Study Instrument to collect data on articles and the Journal Study Instrument to pull together data on journal titles. Both instruments were Excel spreadsheets that were simple and practical tools for data entry and descriptive statistics for data analysis. Excel also supported the generation of graphical and other presentation formats. Figure 5 provides an outline of the structure of the two main research instruments. A pilot study of NHMRC funded articles published in 2012 tested the research instruments, validated the coding, and provided the basis for procedures and the order of data collection.

## Codes for Journal Open Access Models

Both instruments identified journal OA models. To enable classification of articles by journal OA model, the units of measurement comprised the following codes:

- **OAJD**: a journal OA model in which all content is fully and immediately OA, the journal titles listed in the DOAJ.
- **Hybrid OA**: a journal OA model that provides immediate OA at the article level in a subscription journal upon payment of an APC.
- **Delayed OA**: a journal OA model providing access after an embargo period.
- **Partial OA**: a journal OA model in which some articles, usually research articles, are freely available.
- **Gratis OA**: a journal OA model in which articles are free to the public but usually without open licensing and the right to reuse.

## Checklists of Australian Institutional Repositories

The collection of data on metadata and AAMs in IRs required the identification of Australian IRs. The two checklists used in this study included the list of Australian repositories available from the AOASG website (Appendix F: List of Australian Open Access Repositories) and the Register of Approved Administering Institutions compiled by the NHMRC (Appendix G: NHMRC Approved Administering Institutions).

## Article Study Instrument

The Article Study Instrument comprised the sample of 3,190 articles along with the original metadata from WoS. Coding columns in the Article Study Instrument

recorded the types of OA publications identified as compliant under the NHMRC OA Policy, the units of measurement being:

- Published OA articles;
- AAMs in IRs;
- Author manuscripts in PMC.

Other units of measurement included:

- Metadata in Australian IRs;
- Acknowledgement in the metadata of the NHMRC as the funder and the Council grant ID.

*Table 8: Coding for the Article Study Instrument*

| **Units of Measurement** | **Numeric Code** |
|---|---|
| OA on publisher's website | 0 = No<br>1 = Yes |
| Type of journal OA model | 0 = Subscription-only (no OA)<br>1 = OAJD<br>2 = Hybrid OA<br>3 = Delayed OA<br>4 = Partial OA<br>5 = Gratis OA |
| OA articles in each journal OA model | Subscription-only = 0<br>OAJD = *n*<br>Hybrid OA = *n*<br>Delayed OA = *n*<br>Partial OA = *n*<br>Gratis OA = *n* |
| OA articles in each WoS Category | *n* in each WC |
| Metadata in Australia IR | 0 = No<br>1 = Yes |
| Acknowledgement of NHMRC | 0 = No<br>1 = Yes |
| NHMRC grant ID | 0 = No<br>1 = Yes |
| OA version in Australian IR | 0 = No OA<br>1 = AAM<br>2 = Published<br>3 = Preprint |
| Author manuscript in PMC | 0 = No<br>1 = Yes |
| Metadata in PubMed | 0 = No<br>1 = Yes |

The Article Study Instrument included headings for number of OA articles in each journal title and journal OA model, the extent of metadata and AAMs in Australian IRs, and the existence of author manuscripts in PMC. For the codes used for the journal OA models and their respective definitions see Codes for Journal Open Access Models in the previous section. The notation for the number of articles was *n*.

Table 8 outlines the headings used in the Article Study Instrument. For the journal study, different notation was necessary to differentiate the number of articles (*n*) from the number of journal titles ($n_j$) in Table 9.

*Table 9: Coding for the Journal Study Instrument*

| **Units of Measurement** | **Numeric Coding/Numbers of Articles/Name(s)** |
|---|---|
| Journal Title | Name |
| Total articles for each journal title (from Article Study Instrument) | Total Articles in journal = *n* |
| Total OA articles for each journal title (from Article Study Instrument) | OA articles in journal = *n* |
| Publisher (Commercial, University, Society) | C = Commercial<br>U = University<br>S = Society/Association |
| Society/Association | Name |
| Society/Association published by commercial publisher | 0 = No<br>1 = Yes |
| Type of journal OA model | 0 = Subscription-only (no OA)<br>1 = OAJD<br>2 = Hybrid OA<br>3 = Delayed OA<br>4 = Partial OA<br>5 = Gratis OA |
| Extent of OA in each journal OA model (from article study) | Subscription-only = 0<br>OAJD = *n*<br>Hybrid OA = *n*<br>Delayed OA = *n*<br>Partial OA = *n*<br>Gratis OA = *n* |
| RoMEO Archiving Policy | 1 = Green<br>2 = Blue<br>3 = Yellow<br>4 = White<br>5 = Ungraded |
| The deposit of AAMs permitted in IRs | 0 = No<br>1 = Yes |
| CC BY licensing permitted for AAMs in IRs | 0 = No<br>1 = Yes |
| Embargo period (months) on the deposit of AAMs in IRs | 0 = None<br>1 = 6<br>2 = 12<br>3 = 12-24<br>4 = >24<br>5 = Unknown |
| WoS Category (WC) | $n_j$ in each WC |
| OA (*n* OA) in each WC | *n* OA in each WC |
| Journal OA model ($n_j$ ) in each WC | In each WC:<br>0 = Subscription-only (no OA)<br>1 = OAJD<br>2 = Hybrid OA<br>3 = Delayed OA<br>4 = Partial OA<br>5 = Gratis OA |

### Journal Study Instrument

The Journal Study Instrument comprised 1,137 journal titles. Data included the total and OA articles for each journal derived from the Article Study Instrument, as well as additional information on the following:

- The primary publisher, noting also journals published by commercial publishers on behalf of societies or associations;
- The OA model for each journal title (see Codes for Journal Open Access Models);
- The RoMEO colour denoting the SHERPA/RoMEO archiving policy;
- Journal policies allowing AAMs in repositories;
- Publisher's embargo period on the deposit of AAMs in IRs;
- The main subject area for each of the journal titles using the WoS Category (WC) along with the extent of OA and journal OA models in each WC.

For the headings used in the Journal Study Instrument, see Table 9.

## Data Collection

### Time Frames

The NHMRC OA Policy requires funded researchers to make their journal articles OA by either publishing in a journal or depositing the AAMs of non-OA articles in repositories. Publishing an OA article in a journal is either immediate or delayed with embargoes on OA. For non-OA articles in journals, the NHMRC OA Policy requires the deposit of the AAMs in appropriate repositories. The period for OA compliance is within 12 months of publication. The designated repositories in this study are Australian IRs and PMC.

The original timing for data collection for this study was 12 months after publication, but the decision to use sampling delayed this plan. Instead, data collection occurred 24 months after the last possible publication date for the respective year. Data collection for the 2013 articles took place during January 2016; the data for the 2014 publications collected in January 2017. The possible consequences of searching two years after publication included a larger quantity of articles with elapsed embargoes from delayed OA journals, as well as a greater number of AAMs in IRs. All

searching occurred off-campus to ensure that the results excluded subscription-only access.

## Article Study Data

To answer Research Questions 1 to 3, the article study focussed on OA articles in journals, the AAMs of non-OA articles in repositories, and the inclusion of metadata in IRs. Google Scholar and NLA's Trove were the primary search tools. The use of Google Scholar was a decision informed by previous studies; the search engine able to search across multiple websites including repositories (Arlitsch & O'Brien, 2012; Björk et al., 2010; De Groote et al., 2015; Haddaway et al., 2015; Jubb et al., 2015; Khabsa & Giles, 2014; Kurata et al., 2013; Matsubayashi et al., 2009). As the portal for the NLA's online discovery services, Trove is the central searching platform for Australian content (Ayres, 2015; Sherratt, 2013). Having hosted the ARROW project, Trove is a valuable search tool for finding OA content in Australian IRs. Figure 6 describes the steps for locating data on OA in journals, AAMs, and metadata in IRs.

During January 2016 and January 2017, data collection involved searches of Google Scholar for information on articles published in 2013 and 2014. Exact title searches in the advanced search box usually produced precise hits. When a title search failed to locate an article, the most common reason was the existence of Greek, Latin, or chemical symbols. Subsequent attempts at searching necessitated either the omission of a portion of the title or a short title combined with an author search. The display of matched articles usually included the publisher's link. The publisher's link either confirmed the final published journal article as OA or a request for payment substantiated non-OA. Also examined were links to OA versions in Australian IRs and PMC. For articles not found in Google Scholar, searches of Trove provided locations, especially for AAMs in Australian IRs. Most searches of Trove combined an author search with an exact phrase or short title. Data entry involved the recording of numeric codes under the relevant headings in the Article Study Instrument spreadsheet, as shown in Table 8.

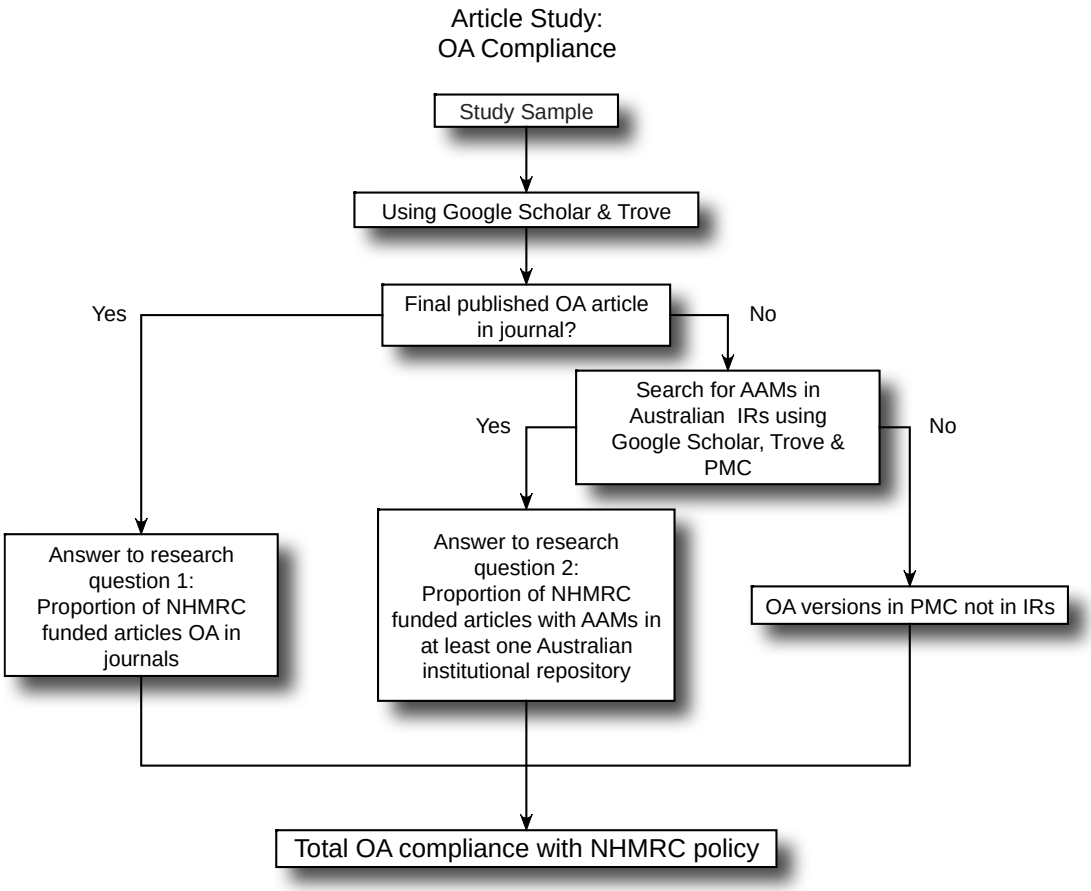


*Figure 6: Methods: Total Open Access Compliance*

## Metadata in Australian Institutional Repositories

Google Scholar and Trove were the primary search tools used to collect information on the metadata of NHMRC funded articles in Australian IRs. The simultaneous timing of data collection on metadata and OA versions in Australian IRs made sense owing to the relationship between the entities. The timing of data collection for metadata in Australian IRs was 24 months after publication: the data on the metadata for 2013 articles collected during January 2016, and that for the 2014 articles in January 2017. The flowchart in Figure 7 outlines the data collection process for metadata in Australian IRs.

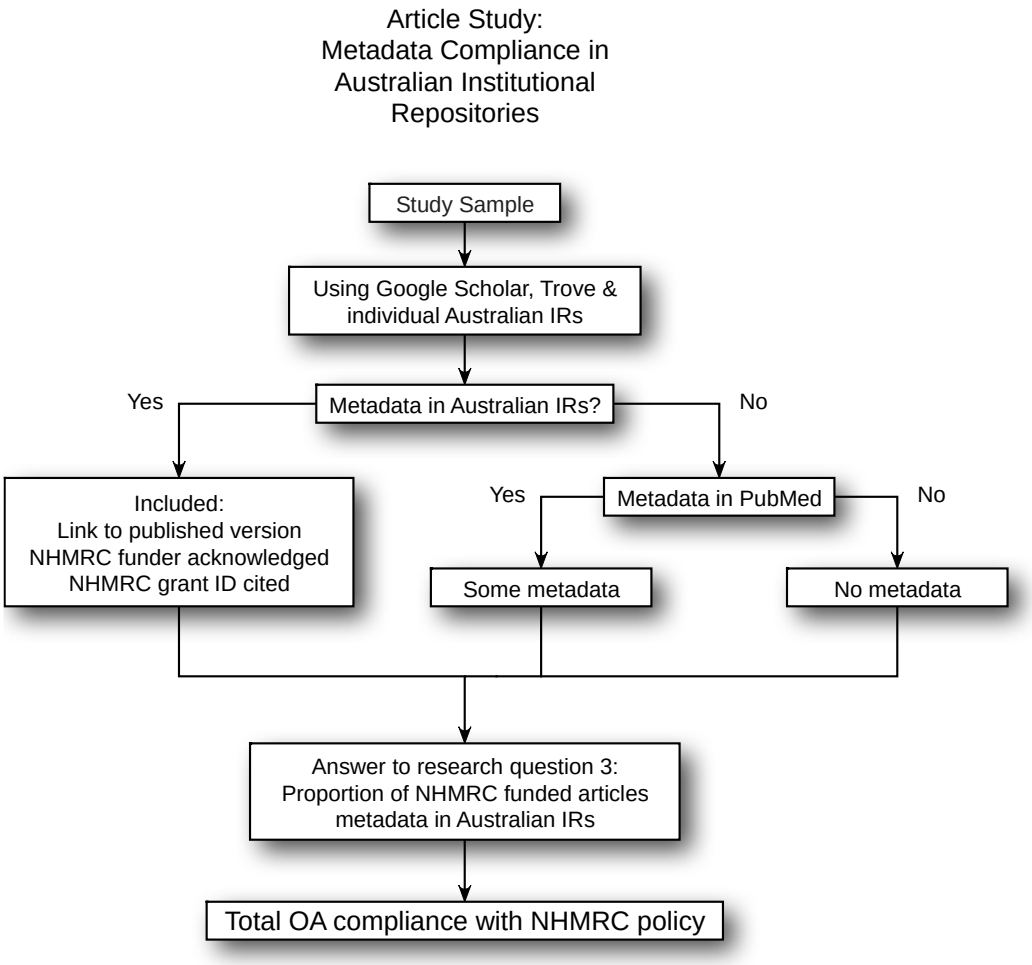


*Figure 7: Methods: Data on Metadata in Australian Institutional Repositories*

Data collection on metadata in Australian IRs involved the confirmation, verification, and the examination of links in Google Scholar and Trove to entries in Australian IRs. The elements of metadata gathered during the data collection process included:

- Acknowledgement(s) of the NHMRC as funder;
- Reference to the NHMRC grant ID(s);
- Information on the OA version (the published article, the AAM or the preprint version) in the respective Australian IRs;
- Link to the published article, including DOIs.

With the discovery of article metadata in multiple IRs, the practical solution was to select the most comprehensive record. Criteria for the selection included the attachment of an OA version, especially an AAM, the acknowledgement of the NHMRC, and the citation of the grant ID. For the methods used to collect the data on metadata in Australian IRs, see Table 8.

The NHMRC OA Policy requires the deposit of metadata either immediately or soon after the date of publication. Data on metadata in Australian IRs collected 24 months after publication had the likelihood of a higher result than that gathered in the months following the date of publication.

## Journal Study Data

The purpose of the journal level study was to answer the research question:

> What are the open access models and author accepted manuscript policies of the journal titles in which NHMRC grant recipients publish?

One of the main aims of the journal study was to distinguish the OA models of journals in which NHMRC grant recipients published. Another objective was to ascertain the extent to which publishers' policies supported the deposit of AAMs in IRs. The study also sought to explore the distribution of OA within these journals and identify patterns of OA publishing based on publisher and subject category.

The Article Study sample provided the basis for the Journal Study, especially the identification of the journal titles. Before the removal of the article information to create the journal sample, it was necessary to calculate the frequency of total articles and OA articles for each journal title. The main reason for calculating the quantity of OA articles in each journal before the commencement of the journal study was to facilitate the calculation of OA within the respective journal OA models, especially hybrid OA.

With the removal of the article metadata, the Journal Study sample comprised 1,137 journal titles together with the data relating to the frequency of total and OA articles for each title. For the headings used in the Journal Study Instrument, see Table 9. While the identity of OAJDs was known, the verification of other journal OA models was an essential part of the journal study. For the flowchart of the methods used to collect data of the OA models of journals, see Figure 8.

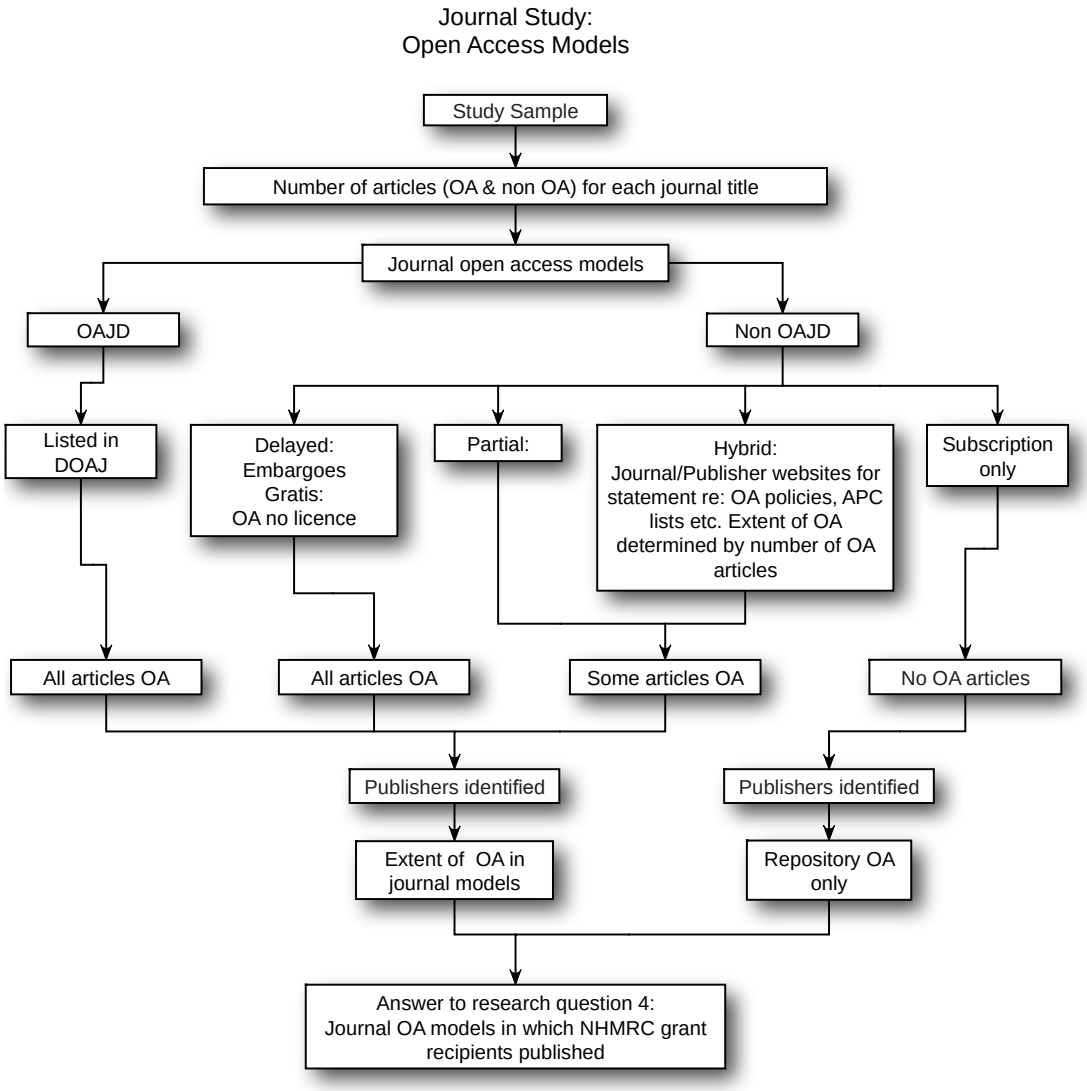


*Figure 8: Methods: Identification of Journal Open Access Models*

## *Verification of Journal Open Access Models*

The journal study included the identification of the journal OA models for all journal titles. For the definitions of the journal OA models used in this study see the section entitled Codes for Journal Open Access Models. The DOAJ confirmed the identity of OAJDs, the coding for these journals transferred from the Article Study Instrument to the Journal Study Instrument. The identification of other journal OA models proved problematic at the article-level with a journal-level approach more appropriate. The methods for identifying journal OA models, other than for OAJDs, included manual searches of a variety of sources.

The existence of embargo periods on journal web pages was indicative of delayed OA journals. Statements on journal web pages identified subscription-only journals.

Some journals gave reasons for not providing hybrid OA, while others referred to their repository or self-archiving policies.

As there is no index of hybrid OA articles, the verification of hybrid subscription journals proved the most challenging. Publishers' lists of hybrid OA journals were useful, especially uniquely branded OA programs such as Wiley's OnlineOpen, the American Chemical Society's AuthorChoice, Karger's Author's Choice™ and Taylor and Francis' iOpenAccess. Notwithstanding, the verification of other hybrid subscription journals proved difficult. Sources included publishers' websites promoting OA, lists of APCs, and instructions for authors. Publishers' websites and journal web pages also provided data on CC licensing. The processes involved in the identification of journal OA models were diverse and listed in Table 10.

*Table 10: Criteria for the Identification of Journal Open Access Models*

| Journal OA model | Identification of journal title |
|---|---|
| OAJDs | In DOAJ |
| Hybrid OA | In publisher's hybrid open access brand (such as Wiley's OnlineOpen, Karger's Author's Choice™ and Taylor and Francis' iOpenAccess) or list of APCs. |
| Delayed OA | On journal website with a statement referring to the embargo on OA. |
| Partial OA | On journal website with a statement that the article is OA but the remainder of the content is not. |
| Gratis OA | On journal website with a statement that the article or issue is freely available although no reference made to Creative Commons licensing or similar. |
| Subscription-only | On journal website with a statement on the unavailability of hybrid OA. |

## *Methods to Collect Data on Article Processing Charges*

The following sources provided data on APCs:

- The DOAJ for OAJDs;
- Lists of APCs on the websites of hybrid subscription journals.

Required was a standard currency, with the US$ selected. Some cases required the conversion of other currencies to US$: the conversion rate being that at the time of data collection. For some hybrid subscription journals, APCs varied according to CC licensing. For society journals, there were also membership and non-membership rates.

### *Methods to Collect Data on Author Accepted Manuscript Policies*

For NHMRC funded journal articles not published OA on publishers' websites, the authors had the option of being compliant with the Council's OA Policy by depositing the AAMs in IRs. A method to identify publishers' policies specific to AAMs was necessary. The DOAJ was a valuable source for information on OAJDs. However, the identification of the AAM policies of subscription journals proved more complicated.

*Table 11: Publishers' Archiving Policies Based on RoMEO Categories*

| Colour | Archiving Policy | Code |
|---|---|---|
| Green | Can archive preprint and postprint or publisher's version/PDF | 1 |
| Blue | Can archive postprint or publisher's version/PDF | 2 |
| Yellow | Can archive preprint | 3 |
| White | Archiving not formally supported | 4 |
| - | Uncategorised | 5 |

The SHERPA/RoMEO database is a useful tool for the identification of publishers' repository policies by RoMEO colours listed in Table 11. Many journal studies use the RoMEO categories for journal repository policies (Bakker et al., 2017; Gadd & Covey, 2016; Gadd et al., 2003; Laakso, 2014; Melero et al., 2017; Miguel et al., 2011). Notwithstanding, the generic RoMEO colours lack a specific category for AAMs or postprints, as illustrated in Table 12. While RoMEO green includes postprints/AAMs, this category also encompasses the publisher's version/PDF and the preprint. Similarly, RoMEO blue includes postprints/AAMs and the publisher's version/PDF. The absence of a category specifically relating to AAMs posed a problem for this study, as the NHMRC OA Policy requires this version.

*Table 12: Open Access Versions Covered by RoMEO Categories*

| Colour | Publisher's Version PDF | Postprint or AAM | Preprint |
|---|---|---|---|
| Green | √ | √ | √ |
| Blue | √ | √ | × |
| Yellow | × | × | √ |
| White | × | × | × |

The need for specific data on AAMs necessitated a review of the methods to collect data on the publishers' policies concerning the deposit of AAMs in IRs. Each journal entry in the SHERPA/RoMEO database contains valuable data under the Author's Post-print heading relevant to the deposit of AAMs in IRs. The information also

included details of embargo periods and CC licensing. While some of the data was textual, it was manually quantifiable. The Author's Post-print section is identifiable in the entry for the *British Journal for Pharmacology* shown in Figure 9.

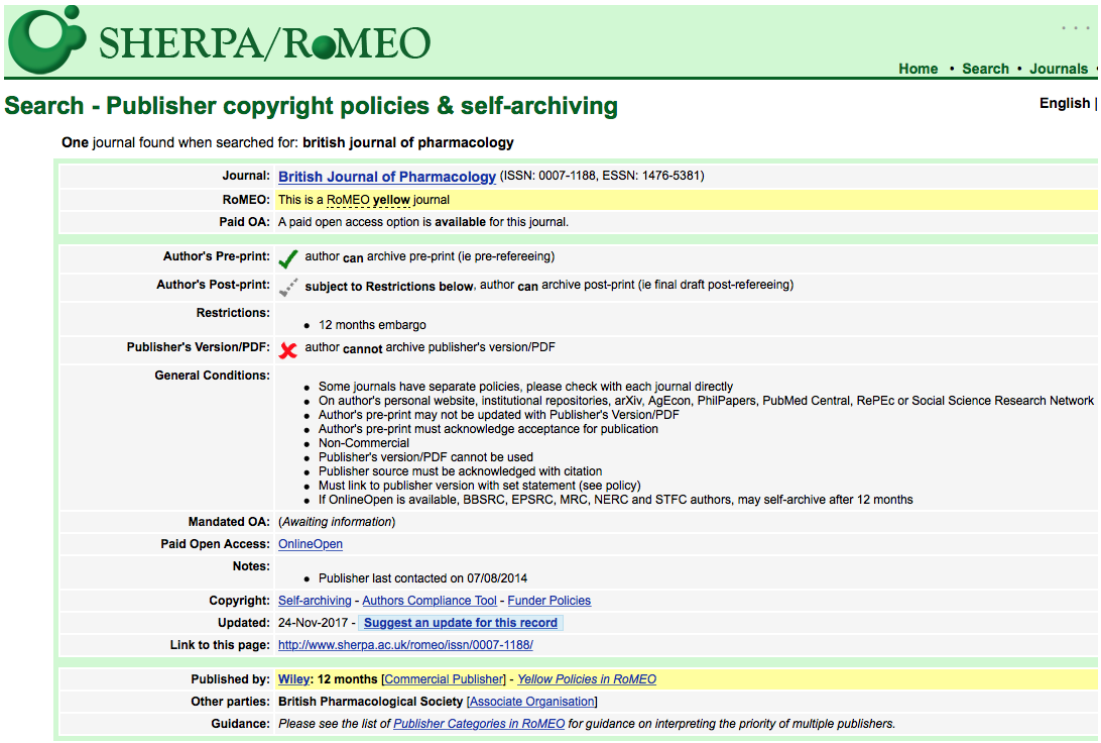


*Figure 9: British Journal of Pharmacology in SHERPA/RoMEO. Reproduced under CC BY-NC-ND licence (https://sherpa.ac.uk/romeo/)*

The Author's Post-print field in SHERPA/RoMEO was the primary source of data on publishers' policies on the deposit of AAMs in repositories. Entered in the Journal Study Instrument (see Table 9) was data on the existence of embargo periods and their duration, the coding details shown in Table 13. Also recorded was the requirement for licensing for the deposit of AAMs in repositories and any specific condition for IRs. Data collection also noted publishers' policies permitting the final published version in IRs.

*Table 13: Journal Study Instrument: Coding for Policies and Conditions*

| AAM | Published Article/PDF | Embargo | Embargo Period (months) | CC Licence Required |
|---|---|---|---|---|
| 0 = No<br>1 = Yes | 0 = No<br>1 = Yes | 0 = No<br>1 = Yes | 0 = None<br>1 = 6<br>2 = 12<br>3 = 12-24<br>4 = >24<br>5 = Unknown | 0 = No<br>1 = Yes |

Figure 10 provides a flowchart of the methods used in identifying the AAM policies of publishers. The diagram includes the initial investigation that used the default RoMEO archiving policies. The chart also incorporates the revised method to collect AAM information from the Author's Post-print heading in the SHERPA/RoMEO entry for each title.

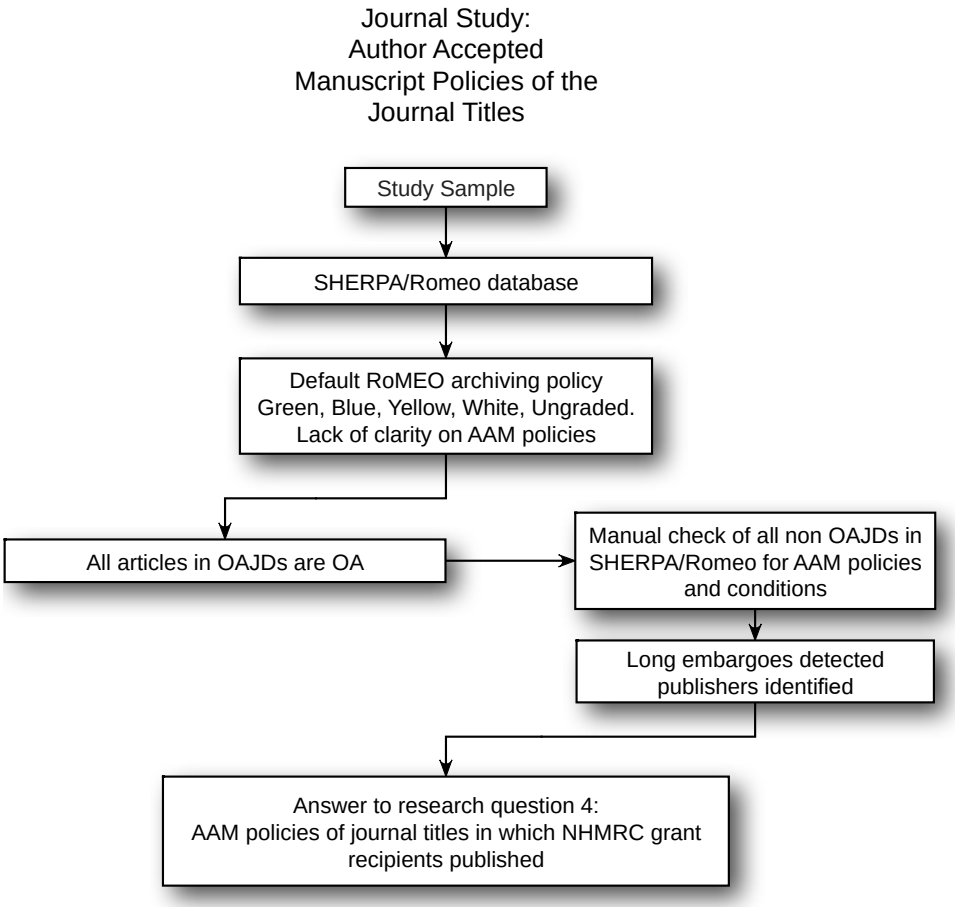


*Figure 10: Methods: Author Accepted Manuscript Policies of Journals*

## *Methods to Collect Data on Web of Science Categories*

Every journal in the WoS Core Collection includes at least one subject category known as the WoS Category (WC) (Clarivate Analytics, 2018b). The WC categories offered the opportunity to explore a further pattern of OA publishing by NHMRC grant recipients within subject categories. While there are several WCs for some journal titles, the first subject category was the focus of data collection for this study. Figure 11 outlines the methods for collecting data on WCs for journal titles and journal OA models.

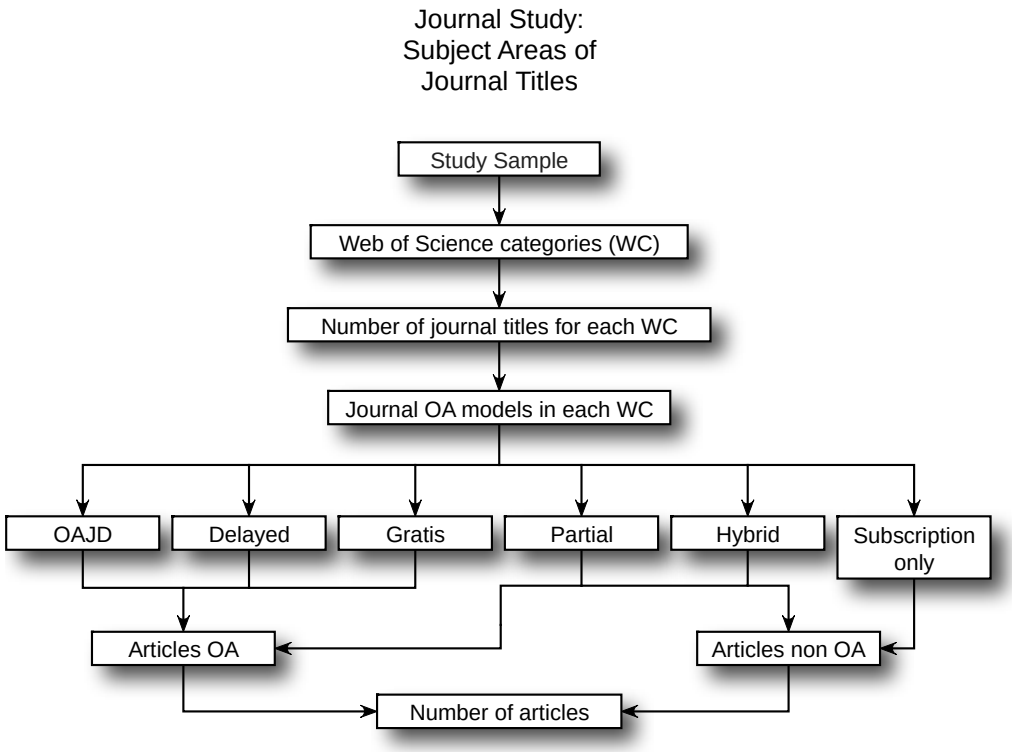


*Figure 11: Methods: Subject Categorisation of Journals*

Calculating the extent of publishing by NHMRC grant recipients within a wide range of WCs proved a methodological challenge. The Journal Study Instrument included data on the number of journal titles, the extent of OA within each journal title, and the journal OA model within each WC. A worksheet based on the Journal Study Instrument stored the data for the WC study.

## Developments in Open Access Research

Several developments in OA research occurred during and after data collection for this study. The first was the publication of critical research by Borrego (2016) into compliance with the Spanish government OA policy. The second development was the study of Bakker et al. (2017) that investigated compliance under the non-government OA policy of the Multiple Sclerosis Society of Canada. The third development was the introduction of the OA field in WoS in late 2017.

Borrego (2016) published the results of his study of OA compliance under a Spanish Government's OA policy after the completion of data collection for this study. The

methods required further scrutiny owing to the similarity of the research and the methodology. Borrego used the following criteria in the classification of articles:

1. Not available if the full text was available only via subscription or not available at all online.
2. Gold OA if the full text could be openly accessed at the journal website. These articles were further classified as follows.
    2.1. Published in journals that charge article processing charges (APCs).
    2.2. Published in journals free of charge to authors and readers.
    2.3. Delayed OA: articles in subscription journals available in OA on the publisher's website at the end of an embargo period.
    2.4. Hybrid OA: individual author-paid OA articles in subscription journals.
    2.5. Complementary OA: articles in subscription journals made OA by the publisher.
3. Green OA if the full text was available in a repository. When metadata were available in the repository but access to the full text was restricted, the records were not considered. These publications were further classified as being available in
    3.1. Disciplinary repositories.
    3.2. Institutional repositories.
4. Gray OA if the full text could be accessed at any other website. These publications were further classified as available on
    4.1. Social networks: Academia.edu, ResearchGate, etc.
    4.2. Websites: personal, departmental, etc. (Borrego, 2016, p. 749).

The data collected in the instrument used in the Spanish study are comparable to those identified in the Article Study Instrument (Table 8). The design of the instrumentation was similar but independently conducted: confirmation that the approach used in the NHMRC study was appropriate. The main difference in the methods related to SCNs. Borrego included OA in SCNs, these OA versions omitted from this study as they are not compliant under the NHMRC OA Policy. The other difference was that Borrego counted subject repositories before IRs in determining overall OA.

The second development was the study of Bakker et al. (2017) that was especially relevant owing to its medical focus. The Multiple Sclerosis Society of Canada's OA policy requires the funded publications of the Society to be OA within six months of publication. Bakker et al. (2017) obtained their population from the Society's annual Research Summaries that provided researchers' names and funding information. The search strategy involved the keyword "multiple sclerosis" with author names, with searches conducted in WoS, Scopus, Embase, and Medline (Bakker et al., 2017). Google, PubMed, and PMC provided data on the extent of OA and APCs. SHERPA/RoMEO was the source on the self-archiving policies of the journal titles.

The third development was the introduction of the OA field in WoS, which evolved out of a partnership between Clarivate Analytics and Impactstory. The OA field in WoS uses oaDOI, an open-source system, to aggregate and verify OA versions from many sources including hybrid OA and green_accepted versions in IRs (Bosman & Kramer, 2018; Piwowar et al., 2017). While this development occurred after the completion of data collection, the search in WoS was re-run during February 2018 and added to the existing dataset. An additional column created in the Article Study Instrument used the following WoS categories:

- Gold - articles provided free to the public on a publisher's website;
- Green_published - published versions in repositories;
- Green_accepted - author accepted manuscripts.

The WoS OA data had no impact on the research questions. The data provided additional information about sources of OA data: this topic further discussed under Data Analysis in the Results chapter.

## Data Analysis

Bibliometric data analysis utilises summary statistics to encapsulate a body of scholarly literature or communications. The previous section described the methods of data collection that created two primary datasets centred on NHMRC funded articles and the journals in which Council grant recipients published. This section describes the methods of data analysis that captured patterns within the article and journal datasets.

Data analysis in this study utilised descriptive statistics ranging from simple counts of numbers of articles (*n*) to the computation of proportions expressed as percentages (%). In some cases, the combination of numbers and percentages (for example, *n*=2,168, 67.96%) provided greater clarity. This study used a combination of simple fractions, such as one-fifth and three-quarters, with numbers (*n*) and percentages (%). Although the same statistical principles applied to the data analysis of articles and journal titles, different notation was necessary to differentiate the number of articles (*n*) from the number of journal titles ($n_j$). The notations ($n$, $n_j$) also permitted the simultaneous analysis of article and journal data.

The built-in statistical and database functions within Microsoft Excel enabled the analysis of both datasets to create graphical and tabulated forms of results. The built-in statistical and database features within Excel (for example, SUM, COUNT, AVERAGE, MIN, MAX, COUNTIF, SUMIF and VLOOKUP) facilitated the analysis in graphical and tabulated forms. Graphs, tables, and other charts using Excel functions also provided visual interpretations of numerical results.

## Analysis of Article Data

The research questions provided the parameters for the analysis of data in the Article Study Instrument, with the summary statistics collected under the following headings:

- OA articles in journals;
- AAMs in Australian IRs;
- Author manuscripts in PMC;
- Metadata in Australian IRs;
- OA policies of journal titles:
    - Journal OA models;
    - OA distribution of journals by publishers;
    - Policies regarding the deposit of AAMs in IRs;
    - OA distribution by subject.
- Overall compliance with the NHMRC OA Policy.

The NHMRC identified Australian IRs as essential locations for AAMs, and for this reason, the counting of AAMs in Australian IRs had priority over author manuscripts in PMC. The order of counting for this study was:

- OA articles published in journals;
- AAMs deposited in Australia IRs;
- Author manuscripts in PMC.

Omitted from this count were OA versions in SCNs owing to these being non-compliant with the NHMRC OA Policy.

## *Open Access in Journals*

Google Scholar was the primary search tool for locating links to articles on publishers' websites. The examination of each link confirmed the existence of the final OA published journal article; a request for payment was proof that the article was not OA. OA articles on publishers' websites supplied the data used in the analysis of the extent of OA in journals published by NHMRC grant recipients.

Data analysis involved the calculation of the number of OA articles and expressing the total as a percentage of total articles (*n*=3,190). The analysis also included the calculation of OA articles within each journal OA model; all sub-totals expressed as percentages of total articles. For an outline of the units of analysis for calculating OA in journals, see Table 14. The proportion of OA and non-OA articles outlined the pattern of OA publishing among NHMRC grant recipients and presented the opportunity to graphically display the percentages of OA and non-OA articles (see Figure 12).

*Table 14: Units of Analysis: Articles in Journal Open Access Models*

| **Units of Analysis** | ***Numeric Code*** | ***n*** | ***% of Total (n=3,190)*** |
|---|---|---|---|
| OA on publisher's website | 0 = No<br>1 = Yes | | |
| Type of journal OA model | 0 = Subscription-only (no OA)<br>1 = OAJD<br>2 = Hybrid OA<br>3 = Delayed OA<br>4 = Partial OA<br>5 = Gratis OA | | |
| OA articles in each journal OA model (for OA on publishers' website Numeric Code 1) | 0 = Subscription-only (no OA)<br>1 = OAJD<br>2 = Hybrid OA<br>3 = Delayed OA<br>4 = Partial OA<br>5 = Gratis OA | | |

OA data located by the oaDOI algorithm in WoS facilitated the comparison of the number of articles categorised gold (free to the public on a publisher's website for articles) with the number of OA articles in journals found in this study.

## *Author Accepted Manuscripts in Australian Institutional Repositories and PubMed Central*

The units of analysis used to code numeric information collected on AAMs in Australian IRs appear in Table 15. The analysis comprised a count of AAMs, the number expressed as a percentage of the total number of articles in the sample. Counted also were author manuscripts in PMC that were neither OA in journals nor AAMs in Australian IRs.

*Table 15: Units of Analysis: Author Accepted Manuscripts in Repositories*

| **Units of Analysis** | ***n*** |
|---|---|
| OA version in Australian IR | 0 = No OA<br>1 = AAM<br>2 = Published<br>3 = Preprint |
| Author manuscripts in PMC | 0 = No<br>1 = Yes |

OA data in WoS generated by oaDOI algorithm facilitated the comparison of the number of articles categorised green_accepted with the number of AAMs found in Australian IRs and PMC in this study. While the comparison was beneficial, the journal OA models of the green_accepted versions were unclear.

### *Metadata in Australian Institutional Repositories*

The NHMRC OA Policy mandates the deposit of journal article metadata in Australian IRs. Data analysis included the calculation the total number of articles with metadata, as well as the quantity that included acknowledgements of the NHMRC and citations of the grant ID(s). For the units of analysis for metadata see Table 16.

*Table 16: Units of Analysis: Metadata in Repositories*

| **Unit of Analysis** | ***n*** |
|---|---|
| Metadata in Australia IR | 0 = No<br>1 = Yes |
| Acknowledgement of NHMRC | 0 = No<br>1 = Yes |
| NHMRC grant ID | 0 = No<br>1 = Yes |
| Link to published article | 0 = No<br>1 = Yes |
| Metadata in PubMed | 0 = No<br>1 = Yes |

## Analysis of Journal Data

Journal data analysis based on the journal study provided solutions to answer the final research question:

> *What are the open access models and author accepted manuscript policies of the journal titles in which NHMRC grant recipients publish?*

Journal titles in this study numbered 1,137 titles. The analysis of journal data was in three parts. The first part analysed the number of journal titles in each journal OA model, as well as the extent of OA. The second part of the analysis covered the AAM policies of journals, with the third analysing journal titles by subject categories (WC) and the extent of OA within the respective subject areas. For the units of analysis covering journal titles, see Table 17.

*Table 17: Units of Analysis: Journal Models, Policies and Subject Categories*

| **Units of Analysis** | ***Numeric Code*** | $n_j$ | **% of 1,137** |
|---|---|---|---|
| Journals ($n_j$) in each journal OA model | 0 = Subscription-only<br>1 = OAJD<br>2 = Hybrid OA<br>3 = Delayed OA<br>4 = Partial OA<br>5 = Gratis OA | | |
| Journals ($n_j$) in each RoMEO Category | 1 = Green<br>2 = Blue<br>3 = Yellow<br>4 = White<br>5 = Ungraded | | |
| Journals ($n_j$) allowing AAMs in IRs | 0 = No<br>1 = Yes | | |
| Journals ($n_j$) with embargo period (months) linked to journal policy re: AAMs in IRs | 0 = None<br>1 = 6<br>2 = 12<br>3 = 12-24<br>4 = >24<br>5 = Unknown | | |
| Licensing documentation required for deposit of AAM | 0 = No<br>1 = CC BY licence<br>2 = Statement of version<br>3 = CC BY-NC-ND licence | | |
| Journals ($n_j$) in each WoS Category (WC) | $n_j$ = for each WC | | |
| Journals ($n_j$) in each journal OA model within all WCs | 1 = OAJD<br>2 = Hybrid OA<br>3 = Delayed OA<br>4 = Partial OA<br>5 = Gratis OA | | |

The extent of publishing in each journal OA model involved the analysis of total and OA articles for each model. The analysis enabled the building of a statistical picture about the extent and the pattern of OA publishing and was particularly useful in describing the extent of OA articles in hybrid subscription journals. Data for all journal titles derived from the Author's Post-print field of journal entries in the SHERPA/RoMEO database were also subject to analysis. Counted were the number of journals with policies allowing the deposit of AAMs in IRs, the lengths of embargoes, and the types of CC licence permitted by these policies.

The existence of WC categories for all journal titles provided the opportunity to analyse OA publishing by NHMRC grant recipient by subject categories. The WC categories provided a wealth of data for analysis, including:

- The number of journals within each WC;

- The number of journal OA models within each WC, noting also numbers of OA articles;
- The number of OA articles in each WC.

Analysing the extent of OA within subject areas proved a challenge, with multiple journal OA models in some and only hybrid subscription journals in others.

### *Overall Open Access Compliance with NHMRC Policy*

The NHMRC identified the following as compliant with its OA policy:

- OA articles published in journals;
- AAMs in Australian IRs;
- Author manuscripts in PMC.

These OA formats comprised the units of analysis for determining the overall OA compliance with the NHMRC OA Policy.

## Conclusion to Research Design, Methods and Data Analysis

The NHMRC OA Policy requires OA for all Council funded journal articles, but the extent of OA during the first two years was unknown at the beginning of this research. The research questions provided the parameters for the application of the bibliometric methodology to data collection and analysis. The Article and Journal Study Instruments incorporated the full range of journal OA models through which OA compliance was achievable. Systematic data analysis using descriptive statistics facilitated the identification and interpretation of patterns about the data, especially in providing answers to the research questions.

# Chapter 4: Results

The primary research problem of this study is that while the NHMRC OA Policy mandated OA for all Council funded journal articles, the extent of OA compliance is unknown. OA is achievable through a range of journal OA models and the deposit of accepted manuscripts in repositories. Notwithstanding, the literature records the low adoption of hybrid OA and AAMs in Australian IRs, as well as inconsistency in authors' acknowledgements of funding.

Addressing the research problem relating to NHMRC funded peer-reviewed journal articles published 2013 and 2014 are four research questions:

1. What proportion of NHMRC funded articles is open access in journals?
2. What proportion of NHMRC funded articles not open access in journals has author accepted manuscripts in at least one Australian institutional repository?
3. What proportion of NHMRC funded journal article metadata is in Australian institutional repositories?
4. What are the open access models and author accepted manuscript policies of the journal titles in which NHMRC grant recipients publish?

The research questions provided the parameters for data analysis. The questions also guided the presentation of the findings under the following headings:

- OA articles in journals;
- Author manuscripts in repositories;
- Metadata in Australian IRs;
- OA policies of journal titles:
    - Journal OA models;
    - Journal publishers' OA distribution;
    - Journal publishers' repository policies and conditions;
    - OA distribution by the subject categorisation of journals.
- Overall OA compliance under the NHMRC OA Policy.

Bibliometric research uses quantitative methods to describe a body of literature or communication. This study applied the bibliometric method to the journal articles

published by NHMRC grant recipients during 2013 and 2014. Data analysis involved descriptive statistics that ranged from simple counts of numbers (*n*) to the calculation of percentages (%). In the results, a different notation was necessary to differentiate the number of articles (*n*) from the number of journal titles ($n_j$). While the data is numerical and statistical, the analysis of bibliometric data identifies patterns of publishing and OA that provide answers to the research questions.

## Open Access Articles in Journals

The number of OA articles in journal titles revealed the extent of OA publishing among NHMRC grant recipients in journals. Google Scholar proved useful in identifying OA articles and providing the links to articles on publishers' websites. A request for payment substantiated that the article was not OA. Data analysis included the calculation of the number of verified OA articles in journals and expressing this as a percentage of total articles (*n*=3,190). Also assessed was the extent of OA articles in each journal OA model. The proportion of OA and non-OA articles outlined the pattern of OA publishing among NHMRC grant recipients as well as compliance with the Council's OA Policy.

The results of data analysis established that the number of OA articles in journals represented 56.24% (*n*=1,794) of the sample, while 43.76% (*n*=1,396) were not OA. The pie chart in Figure 12 illustrates the split between OA and non-OA articles in the sample of NHMRC funded articles. The results found that the majority of NHMRC grant recipients published in subscription journals, with one-fifth of articles published in fully OA journals (OAJDs).

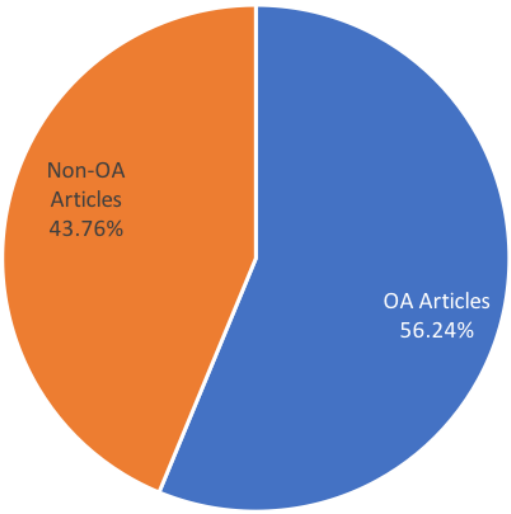


*Figure 12: Extent of Open Access Publishing in Journals*

Of OA articles published immediately, 25.58% were hybrid OA, 20.85% from OAJDs, and the remainder from gratis and partial OA journals. Delayed OA journals contributed 8.75% (*n*=279) to OA. Table 18 lists the number of OA articles within each journal OA model and the percentage of these expressed as a proportion of total articles in the sample (*n*=3,190).

*Table 18: Open Access Articles in Journal Open Access Models*

| **Journal OA Model** | **Articles (*n*)** | **% of Total (*n*=3,190)** | **Articles OA (*n*)** | **OA % of Total (*n*=3,190)** | **Non-OA% of Total** |
|---|---|---|---|---|---|
| Hybrid | 2,168 | 67.96 | 816 | 25.58 | 42.38 |
| OAJDs | 665 | 20.85 | 665 | 20.85 | 0.0 |
| Delayed | 279 | 8.75 | 279 | 8.75 | 0.0 |
| Partial | 20 | 0.63 | 20 | 0.63 | 0.0 |
| Gratis | 14 | 0.44 | 14 | 0.44 | 0.0 |
| Subscription-only | 44 | 1.38 | 0 | 0.00 | 1.38 |
| **Total** | **3,190** | **100.00** | **1,794** | **56.24*** | **43.76** |

* Rounded from 56.238

A finding of the study was that 43.76% (*n*=1,396) of the NHMRC funded journal articles in the sample were not OA, with Figure 12 illustrating the extent of non-OA articles. Non-OA articles published in hybrid subscription journals comprised 42.38% (*n*=1,352) of the sample. The remainder of non-OA articles (1.38%; *n*=44) were from a small number of subscription-only journals.

The availability of OA data in WoS from December 2017 provided the opportunity to compare the oaDOI-generated data for gold OA with the results of this study. The WoS OA algorithm identified 50.69% (*n*=1,617) of the articles in the sample as published OA articles, compared to 56.24% (*n*=1,794) found by this study. The WoS algorithm did not identify 5.5% of the NHMRC sample, all of which were hybrid OA articles.

## Author Manuscripts in Repositories

The NHMRC OA Policy identifies the AAM as a compliant OA version. This study found a substantial component of non-OA NHMRC funded articles with the potential to increase the quantity of AAMs in IRs depending on the policies of the journal publishers. According to SHERPA/RoMEO, 63.47% of the non-OA articles in the sample were from journals with RoMEO green or blue policies that supported the deposit of AAMs in repositories (see Table 19).

*Table 19: RoMEO Policies of the Journals of Non-Open Access Articles*

| **RoMEO Colour** | **RoMEO Legend** | *n* | **% of total non-OA articles (*n*=1,396)** | **% of total articles (*n*=3190)** |
|---|---|---|---|---|
| Green | Can archive preprint and postprint or publisher's version/PDF | 873 | 62.54 | 27.3 |
| Blue | Can archive postprint or publisher's version/PDF | 13 | 0.93 | 0.41 |
| Yellow | Can archive preprint | 425 | 30.44 | 13.32 |
| White | Archiving not formally supported | 82 | 5.87 | 2.57 |
| Uncategorised | Not categorised by RoMEO | 3 | 0.21 | 0.09 |
| | **Total non-OA articles** | **1,396** | **100.00** | **43.76** |

### Author Accepted Manuscripts in Australian Institutional Repositories

This study uncovered 231 AAMs in Australian IRs, representing 7.24% of the sample. For the most part, the AAMs were of non-OA articles published in hybrid subscription journals, although a few were from subscription-only journals. With the commencement of the NHMRC OA Policy on 1 July 2012, the deposit of accepted manuscripts in IRs was not a requirement until July 2013 (NHMRC, 2014b). The number of Council funded AAMs in Australian IRs for articles published in 2013

was 118, compared to 113 for 2014 (see Table 20). The number of AAMs deposited in IRs during 2013 was slightly higher than that for 2014. The similarity of the results for both years suggests that the Council's policy had little effect on the deposit of Council funded articles in IRs during the first years of the NHMRC OA Policy.

*Table 20: Author Accepted Manuscripts in Australian Institutional Repositories by Year*

| | **2013** | **2014** | **2013-2014** |
|---|---|---|---|
| Articles (*n)* | 118 | 113 | 231 |
| % of Articles (*n*=3190) | 3.7 | 3.54 | 7.24 |

*Table 21: Author Accepted Manuscripts in Australian Institutional Repositories: RoMEO Policies*

| **RoMEO Colour** | **RoMEO Legend** | *n* | **% of 231** | **% of total articles (*n*=3190)** |
|---|---|---|---|---|
| Green | Can archive pre-print and post-print or publisher's version/PDF | 154 | 66.67 | 4.83 |
| Blue | Can archive post-print (ie final draft post-refereeing) or publisher's version/PDF | 5 | 2.16 | 0.15 |
| Yellow | Can archive pre-print (ie pre-referring) | 66 | 28.57 | 2.07 |
| White | Archiving not formally supported | 6 | 2.6 | 0.19 |
| Uncategorised | Not categorised by RoMEO | 0 | 0 | 0.0 |
| | **Total articles** | **231** | **100.00** | **7.24** |

Of AAMs in Australian IRs, over two-thirds were from journals categorised by SHERPA/RoMEO as RoMEO green with a few RoMEO blue. Over one-quarter of the AAMs were from journals classified as RoMEO yellow: a repository policy supportive of the deposit of preprints in repositories but branded as unsupportive of other versions including AAMs. For the analysis of the RoMEO classification of the AAMs in Australian IRs, see Table 21.

## Author Manuscripts in PubMed Central

Author manuscripts in PMC that were neither OA nor located in Australian IRs amounted to 3.82% (*n*=122) of the sample. Data analysis for this study prioritised the counting of AAMs in Australian IRs before author manuscripts in PMC. The reason

for doing so was the NHMRC's emphasis on Australian IRs. Research that calculates OA content in subject repositories before IRs will produce different results.

### Overall Extent of Author Manuscripts in Repositories

AAMs in Australian IRs and PMC contributed 11.06% (*n*=353) to OA compliance under the NHMRC OA Policy, as shown in Table 22. The author manuscripts in IRs and PMC were mostly of non-OA articles from hybrid subscription journals with a few from subscription-only journal titles. The WoS OA algorithm identified 93 non-OA articles in PMC as green_accepted, which represented 0.6% of the sample compared to 11.06% found by this study.

*Table 22: Author Accepted Manuscripts in Repositories*

| **NHMRC funded AAM in repositories** | ***n*** | **% of total (*n*=3,190)** |
|---|---|---|
| Australian IRs (not OA at publisher) | 231 | 7.24 |
| PMC (not OA at publisher; not in Australian IRs) | 122 | 3.82 |
| **Total** | **353** | **11.06** |

## Metadata in Australian Institutional Repositories

The NHMRC OA Policy requires the deposit of the metadata of all funded articles in Australian IRs as soon as possible after publication or within three months (NHMRC, 2012a; NHMRC, 2014a; NHMRC, 2014b; NHMRC, 2014c; NHMRC, 2018). With simultaneous searches undertaken for metadata and AAMs in Australian IRs, the timing of data collection was 24 months after publication. The finding was that 74.92% (*n*=2,390) of articles published during 2013 and 2014 by NHMRC grant recipients had metadata in at least one Australian IR, the statistics provided in Table 23.

Metadata fields and attachments provided details of acknowledgements of NHMRC funding, the grant ID(s), and the nature of the OA version attached to the metadata. A quarter of the publications with metadata in Australian IRs included acknowledgements of the NHMRC, although only a few cited the grant ID. Most metadata included DOIs, although only 4.92% contained a statement, icon or URL indicating that the publication was OA.

*Table 23: Metadata of Articles in Australian Institutional Repositories*

| 2013-2014 | All Articles | Metadata | % Metadata |
|---|---|---|---|
| OA Articles | 1,794 | 1,365 | 42.79 |
| Non-OA Articles | 1,396 | 1,025 | 32.13 |
| **Total** | **3,190** | **2,390** | **74.92** |

The proportions of metadata for OA and non-OA articles in Australian IRs were similar. The analysis of the metadata also included results by publication year, outlined in Table 24. Metadata for non-OA articles were slightly higher during 2013, the first year of the NHMRC OA Policy, and most likely attributable to the work of IR staff. Sources of publication metadata include publishers' websites, PubMed and WoS, the origin of the sample used in this study. Unawareness of the metadata requirement of the NHMRC OA Policy was the most likely reason for authors not depositing metadata in IRs.

*Table 24: Metadata of Articles in Australian Institutional Repositories by Year*

| Metadata | 2013 | 2014 | 2013-2014 | % of Metadata in IRs (*n*=2390) |
|---|---|---|---|---|
| OA articles | 643 | 533 | 1,176 | 49.21 |
| Non-OA articles | 722 | 492 | 1,214 | 50.79 |
| **Total** | **1,365** | **1,025** | **2,390** | **100.00** |

# Open Access Policies of Journal Titles

This study examined the OA models and AAM policies of the journal titles in the sample to gain a better understanding of the publishing patterns of NHMRC grant recipients. A characteristic of the distribution of journal titles was the wide gap between the number of articles published in *PLOS ONE* compared to other journal titles. The long-tail distribution of the journal titles meant that 89.9% ($n_j$ =1,022) of journal titles published between one and five articles. Table 25 and Figure 13 illustrate the distribution of the journal titles in this study.

*Table 25: Distribution of Journal Titles Grouped by the Number of Articles*

| Article Range | $n_j$ | % of Total Journals ($n_j$ =1,137) | $n$ | % of Total Articles ($n$=3,190) |
|---|---|---|---|---|
| 1-5 | 1,022 | 89.89 | 1,896 | 59.44 |
| 6-10 | 86 | 7.56 | 640 | 20.06 |
| 11-15 | 19 | 1.67 | 238 | 7.46 |
| 16-20 | 5 | 0.44 | 91 | 2.85 |
| 21-25 | 1 | 0.09 | 24 | 0.75 |
| 26-30 | 2 | 0.18 | 55 | 1.72 |
| 31-35 | 1 | 0.09 | 35 | 1.10 |
| >36 | 1 | 0.09 | 211 | 6.61 |
| **Total** | **1,137** | | **3,190** | |

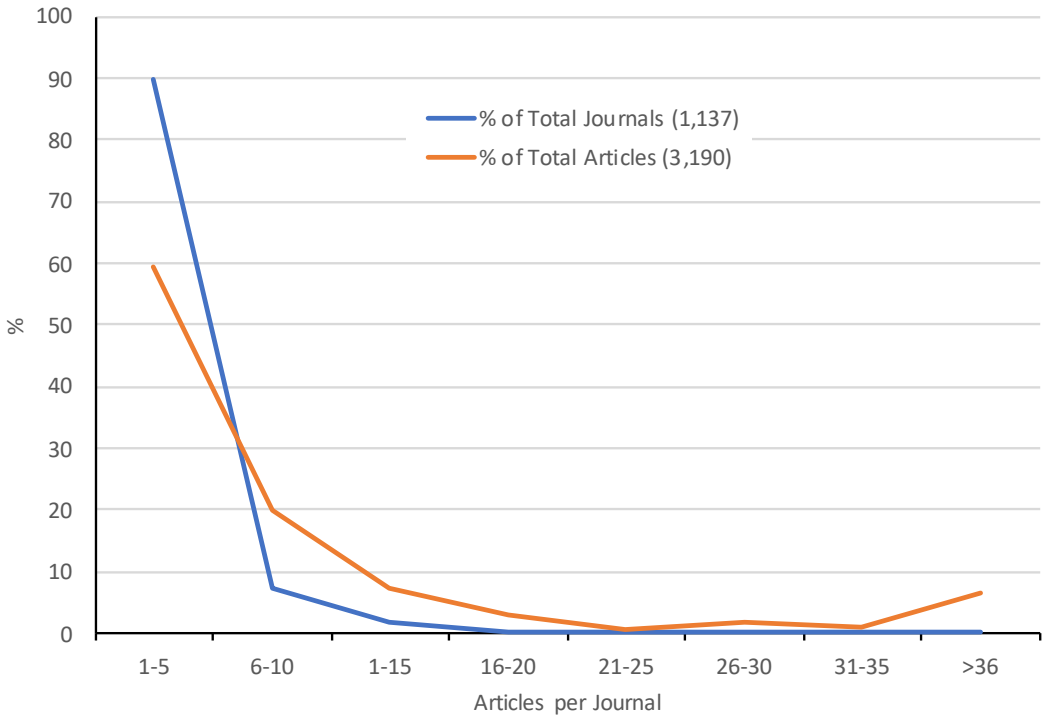


*Figure 13: Graph Showing the Distribution of Journal Titles*

The time frame of this thesis and the number of journals ($n_j$=1,137) prevented a full investigation of all titles. An alternative approach to analysis was the grouping of the journals by publishers that provided the opportunity to identify patterns of OA. A limitation to the methodology was the focus on larger publishers.

## Journal Open Access Models

The dataset for the journal study was the 1,137 journal titles in which NHMRC grant recipients published articles. Fully OA journals listed in the DOAJ (OAJDs) comprised 12.4% ($n_j$ =141) of the sample and produced 20.85% of OA. Hybrid

subscription journals were the largest category of subscription titles comprising 81.62% ($n_j$ =928) and generating 25.58% of OA. Delayed OA journals made up only 3.52% ($n_j$ =40) of the journal titles but contributed 8.75% to OA. For the data on the extent of publishing and OA within all journal models, see Table 26.

*Table 26: Journal Open Access Models by Number, Percentage and Open Access*

| **Journal OA Model** | $n_j$ | **% of Total Journals ($n_j$=1,137)** | **% OA (based on total OA articles *n*=3,190))** |
|---|---|---|---|
| Hybrid | 928 | 81.62 | 25.58 |
| OAJD | 141 | 12.40 | 20.85 |
| Delayed | 40 | 3.52 | 8.75 |
| Partial | 1 | 0.09 | 0.63 |
| Gratis | 10 | 0.88 | 0.44 |
| Subscription-only | 17 | 1.50 | 0.00 |
| **Total** | **1,137** | **100** | **56.24*** |
| | | | * Rounded from 56.238 |

The combination of information from the article and journal studies provided an outline of OA publishing by NHMRC grant recipients, as seen in Table 27. Also evident was the high level of non-OA in hybrid subscription journals.

*Table 27: Results: Article and Journal Studies*

| **Journal OA Model** | **Journal Titles ($n_j$)** | **% of Total $n_j$=1,137** | **Articles (*n*)** | **% of Total *n*=3,190** | **Articles OA (*n*)** | **OA % (*n*=3,190)** | **Non-OA%** |
|---|---|---|---|---|---|---|---|
| Hybrid | 928 | 81.62 | 2,168 | 67.96 | 816 | 25.58 | 42.38 |
| OAJDs | 141 | 12.40 | 665 | 20.85 | 665 | 20.85 | 0.0 |
| Delayed | 40 | 3.52 | 279 | 8.75 | 279 | 8.75 | 0.0 |
| Partial | 1 | 0.09 | 20 | 0.63 | 20 | 0.63 | 0.0 |
| Gratis | 10 | 0.88 | 14 | 0.44 | 14 | 0.44 | 0.0 |
| Subscription-only | 17 | 1.50 | 44 | 1.38 | 0 | 0.00 | 1.38 |
| **Total** | **1,137** | **100.00** | **3,190** | **100.00** | **1,794** | **56.24*** | **43.76** |
| | | | | | | | * Rounded from 56.238 |

## Open Access Distribution by Publisher

The grouping of the journal titles by publishers required decisions about the primary publisher or publishing group. Many societies collaborate with commercial publishers, with half of the journals published by Oxford University Press/Oxford Academic in this study associated with professional organisations or medical societies. The analysis of the degree of OA publishing between societies and commercial publishers, necessitated the aggregation of data under the publishing houses, at the same time recognising societies' influence on policies and APCs. The

combination of the data of parent and imprint publishers was expedient in the instance of Wolter Kluwer and Lippincott, Williams, and Wilkins (LWW). However, in the case of Cell Press, an imprint of Elsevier, the level of OA was higher than the parent company, with the results for both publishers presented separately. Despite the merger of BioMed Central, Springer and Nature, these publishers have distinct histories and warranted separate examination.

The publishers listed in Table 28 were responsible for publishing almost three-quarters of the articles in the study and included commercial publishers, Elsevier and Wiley, as well as OAJD publishers, PLOS and BioMed Central, and Oxford University Press/Oxford Academic. Commercial publishers operate under the subscription business model, with hybrid subscription journals also offering optional hybrid OA upon payment of APCs. Elsevier and Wiley published one-third of the articles in over 440 journal titles. In contrast to commercial publishers, there were fewer journal titles published by OAJD publishers: PLOS had six and BioMed Central 60 titles.

While the publishers in Table 28 published over 70% of the journals in this study, OA amounted to only 36.14% (*n*=1,153). Figure 14 lists a subset of publishers selected by the quantity of total and OA articles. PLOS and BioMed Central were responsible for 14.55% (*n*=464) of OA articles in the sample. Despite having published the substantial proportion of journal titles, Wiley and Elsevier journals contributed 9.72% (*n*=310) to overall OA: Wiley provided 6.46% (*n*=206) and Elsevier 3.26% (*n*=104). NHMRC grant recipients published 5.49% (*n*=175) of articles in Oxford journals in which there was a comparatively high level of OA contributing 5.27% (*n*=168) to total OA.

PLOS published six journal titles that contributed 7.81% (*n*=249) to OA: the highest figure for OA for any publisher in this study. The journal, *PLOS ONE,* published the most significant proportion of articles by NHMRC grant recipients and the highest amount of OA for a single journal title (6.6%, *n*=211). The 60 journal titles published by BioMed Central delivered 6.74% (*n*=215) to total OA. Journals published by PLOS and BioMed Central published more OA articles than other publishers.

*Table 28: Subset of Publishers by Extent of Open Access*

| **Publisher** | ***n*** | **% of total articles (*n*=3,190)** | **OA *n*** | **% OA of total articles (*n*=3,190)** | **$n_j$** | **% of total journals ($n_j$=1,137)** |
|---|---|---|---|---|---|---|
| PLOS | 249 | 7.81 | 249 | 7.81 | 6 | 0.53 |
| BioMed Central | 215 | 6.74 | 215 | 6.74 | 60 | 5.28 |
| Wiley | 453 | 14.20 | 206 | 6.46 | 180 | 15.83 |
| Oxford | 175 | 5.49 | 168 | 5.27 | 52 | 4.57 |
| Elsevier | 610 | 19.12 | 104 | 3.26 | 260 | 22.87 |
| Nature | 130 | 4.08 | 71 | 2.23 | 40 | 3.52 |
| BMJ | 76 | 2.38 | 44 | 1.38 | 20 | 1.76 |
| Cell Press | 45 | 1.41 | 30 | 0.94 | 22 | 1.93 |
| Springer | 164 | 5.14 | 25 | 0.78 | 94 | 8.27 |
| Wolter Kluwer & LWW | 97 | 3.04 | 23 | 0.72 | 49 | 4.31 |
| Taylor & Francis | 69 | 2.16 | 12 | 0.38 | 43 | 3.78 |
| Sage | 50 | 1.57 | 6 | 0.19 | 25 | 2.20 |
| Total for subset | 2,333 | 73.13 | 1,153 | **36.14** | **851** | **74.85** |

The *BMJ* published 2.38% (*n*=76) articles by NHMRC grant recipients, of which almost 60% were OA, especially in *BMJ Open* (*n*=28). The Nature Publishing Group, well known for its highly cited journals, contributed 2.23% (OA *n*=71) to total OA. The conversion of subscription-only journals to the fully OA model likely contributed to a higher level of OA from Nature-branded journals. Five articles published in *Nature Communications* during 2013 were initially not OA. By the time of data collection, all content from the journal was OA and added 0.5% (*n*=16) to OA.

The cost of APCs is a critical consideration in an author's decision to publish OA. High profile OAJDs such as *PLOS ONE* charge APCs as part of their business model (Björk, 2015; Solomon & Björk, 2012b). APCs for hybrid OA are additional to the subscription business model of hybrid subscription journals and often higher than for OAJDs (Bakker et al., 2017). Table 29 outlines a range of APCs charged by a selection of publishers that published over 50% of the articles in this study and contributed just under 30% to OA. The APCs for publishing in journals published by PLOS and BioMed Central appeared to be low-cost compared to hybrid subscription journals. The APC of US$1,495 to publish in *PLOS ONE* most likely contributed to the high level of publishing in that journal by NHMRC grant recipients, along with other factors such as quality peer-review.

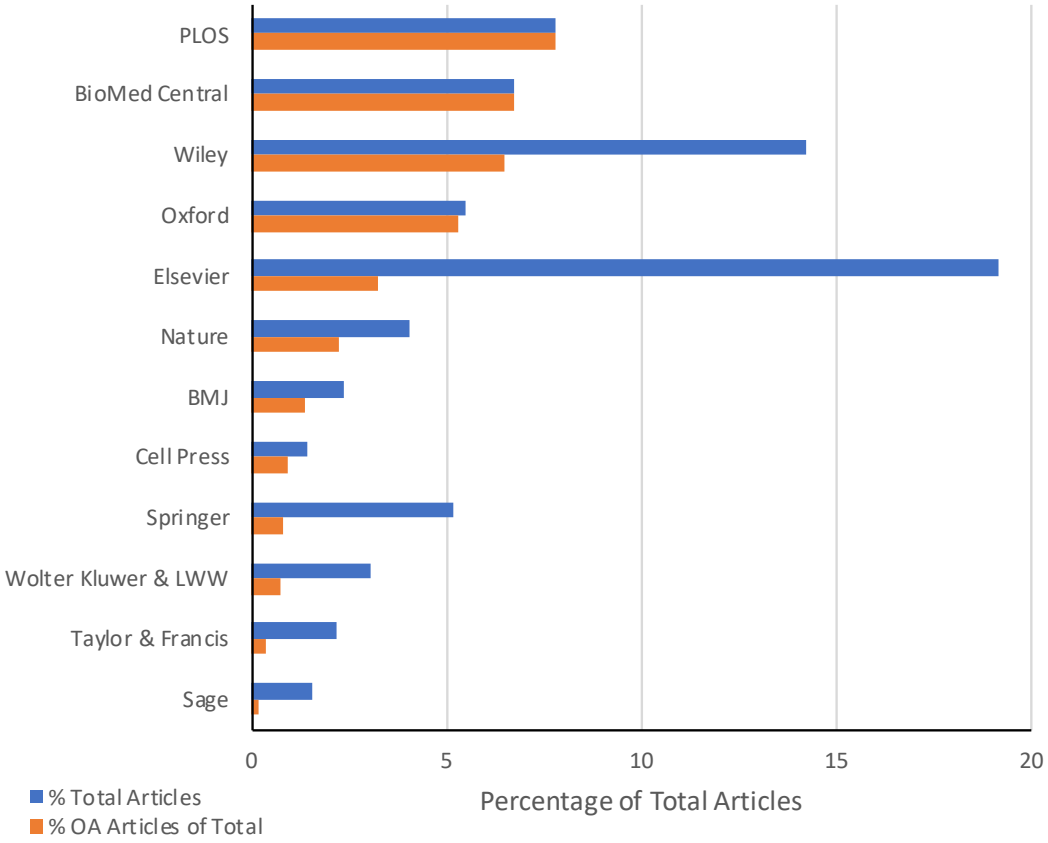


*Figure 14: Subset of Publishers by Extent of Open Access Compared to Total Articles*

Higher APCs to publish in hybrid subscription journals (as shown in Table 29) likely contributed to the lower rate of hybrid OA. At the same time, this study also found scales of charges for publishing in some hybrid subscription journals. Many society journals published by commercial publishers have as many as six APC rates for members, non-members, and the type of CC licence. The reduced rates for members of societies was probably a factor contributing to the relatively high proportion of OA in journals published by Oxford on behalf of associations.

Society publishers significantly contributed to the direct or indirect publishing of NHMRC funded articles. Some societies, either independently or with commercial publishers, provided hybrid OA by charging APCs. Other society publishers delivered public access without APCs, although with some restrictions on the reuse of content. The journal of the Australian Medical Association (AMA), the *Medical Journal of Australia* (*MJA*), provides OA to research articles and is unique in this study as the only partial OA journal. Among the findings was that NHMRC grant

recipients published 20 OA research articles in the *MJA* during 2013 and 2014, to which non-members have access through registration.

*Table 29: Select Subset of Publishers by Extent of Open Access and Article Processing Charges*

| **Publisher** | **% articles of total (*n*=3,190)** | **% OA articles of (*n*=3,190)** | **% journal titles of total ($n_j$=1,137)** | **APC Min. (US$)** | **APC Max. (US$)** |
|---|---|---|---|---|---|
| PLOS | 7.81 | 7.81 | 0.53 | 1,495 | 2,900 |
| BioMed Central | 6.74 | 6.74 | 5.28 | 1,370 | 1,370 |
| Wiley | 14.20 | 6.46 | 15.83 | 1,500 | 5,000 |
| Oxford | 5.49 | 5.27 | 4.57 | 1,400 | 5,500 |
| Elsevier (excluding Cell Press) | 19.12 | 3.26 | 22.87 | 1,700 | 5,000 |

NHMRC grant recipients published in 40 membership subscription journals that provided delayed OA. While delayed OA journals comprised only 3.52% of the journal titles in the study, the articles in these journals contributed 8.75% to overall OA. Table 30 shows the extent of publishing by NHMRC funded author in journals published by society publishers, all of which provided OA within 12 months of publication. Most of the society publishers in this selection also offered hybrid OA that included open licensing.

*Table 30: Society Publishers using the Delayed Open Access Model*

| **Publisher** | ***$n_j$*** | ***n*** | **Embargo Period (months)** | **Hybrid OA option** |
|---|---|---|---|---|
| American Society for Microbiology | 7 | 46 | 6 | Y |
| American Society for Biochemistry & Molecular Biology | 3 | 45 | 12 | Y |
| American Physiological Society | 9 | 35 | 12 | Y |
| National Academy of Sciences of the United States | 1 | 27 | 6 | Y |
| American Association for Cancer Research | 7 | 26 | 12 | Y |
| American Association of Immunologists | 1 | 18 | 12 | Y |
| Association for Research in Vision and Ophthalmology | 2 | 18 | 6 | N |
| American Society of Hematology | 1 | 15 | 6-12 | N |
| **Total $n_j$ *or* *n*** | 34 | 209 | | |
| **% of Total $n_j$ *or* *n*** | 3.0 | 6.55 | | |

## Journal Publishers' Repository Policies and Conditions

The first tool used to identify journal publishers' repository policies was the SHERPA/RoMEO database. SHERPA/RoMEO utilises RoMEO colours to identify publishers' policies. The RoMEO colours for the 1,137 journal titles in this study

indicated that 64.11% ($n_j$ =729) of the journal titles had green or blue repository policies. The figure was similar to that found by Borrego (2016). RoMEO green and blue categorisation reflect supportive journal publishers' policies towards depositing in repositories.

Notwithstanding, Gadd and Covey (2016) found that many hybrid subscription journals categorised RoMEO green and blue have restrictive conditions. This study also found that one-third of the AAMs in Australian IRs were from RoMEO yellow and white journals, their classification indicating unsupportive policies towards depositing AAMs in repositories. According to Gadd and Covey (2016), some RoMEO white journals allow archiving in repositories.

The lack of specific categorisation for journal policies on AAMs in the SHERPA/RoMEO database proved problematic to this study, as the NHMRC OA Policy requires the deposit of AAMs in repositories. RoMEO green includes postprints/AAMs but also encompasses the publisher's version/PDF article and the preprint. RoMEO blue includes postprints/AAMs and the publishers' versions/PDFs.

This study identified policies specific to AAMs by collecting information from the Author's Post-print heading under each journal entry in the SHERPA/RoMEO database. The results showed that the publishers of 95.38% ($n_j$=950) of subscription journals allowed the deposit of AAMs in IRs (see Table 31). This finding confirmed the research of Laakso (2014) who argued that most publishers permit the deposit of AAMs in IRs. A relatively small number of subscription journals ($n_j$=32) appear to disallow AAMs in IRs, but closer scrutiny revealed that some of these journals came under the mandate of the NIH Public Access Policy requiring author manuscripts in PMC.

*Table 31: Subscription Journals Permitting Author Accepted Manuscripts/ Postprints in Repositories*

| **Permission** | **$n_j$ Subscription** | **% of total ($n_j$=996)** |
|---|---|---|
| Allowed | 950 | 95.38 |
| Not Allowed | 32 | 3.21 |
| Unknown | 14 | 1.41 |
| **Total** | **996** | **100.0** |

By collecting information from the Author's Post-print heading under each journal entry in the SHERPA/RoMEO database, this study found that most publishers allow the deposit of AAMs in IRs. The same source also provided information that pointed to publishers' conditions being considerable barriers to the deposit of AAMs in IRs.

## *Publishers' Conditions on the Deposit of Author Accepted Manuscripts in Repositories*

To deposit AAMs in Australian IRs, publishers require licensing documentation. Among the publishers listed in Table 28, there are three different approaches associated with the deposit of AAMs in IRs, including:

- Embedded CC BY licences (PLOS, BioMed Central);
- Statements verifying AAM version (Wiley, Oxford);
- CC BY-NC-ND licensing on all pre-publication OA versions (Elsevier).

Author manuscripts in PMC are also identifiable by clear branding, the banner at the top of the display indicating the primary funding organisation for the research.

OAJD publishers such as PLOS and BioMed Central embed machine-readable CC licensing information in all articles and receive the DOAJ seal (DOAJ, n.d.) Some publishers require statements of version. Wiley's Self-Archiving Policy requires the following statement for the accepted peer-reviewed version:

> This is the peer reviewed version of the following article: [FULL CITE], which has been published in final form at [Link to final article using the DOI]. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Use of Self-Archived Versions (Wiley, n.d.-b, "Accepted (peer-reviewed) version", para. 4).

Oxford also requires a statement describing the accepted manuscript:

> This is a pre-copyedited, author-produced version of an article accepted for publication in [insert journal title] following peer review. The version of record [insert complete citation information here] is available online at: xxxxxxx [insert URL and DOI of the article on the OUP website] (Oxford University Press, n.d., "What use of the accepted manuscripts is allowed?", para. 7)

Elsevier's sharing policy stipulates CC BY-NC-ND licensing for all pre-publication versions of articles (Elsevier, 2015). The paperwork involved in the preparation of

CC BY-NC-ND licences is substantial and delays the deposit of AAMs in repositories (COAR, 2015; Smith, 2015).

Publishers' embargoes also influence the timing of deposits in IRs. For authors who publish in journals without funder agreements, Wiley's Self-Archiving Policy allows the self-archiving of the accepted versions in IRs after embargo periods of 12 to 24 months, depending on the discipline (Wiley, n.d.-b). Wiley also has agreements with funders. The agreement with the NHMRC and the ARC allows the self-archiving of AAMs after an embargo period of 12 months (Wiley, n.d.-a). The Council does not have an agreement with Elsevier, although the publisher has agreements with other funders. Elsevier has embargoes of up to 48 months after publication (Elsevier, 2015). Long embargo periods beyond 12 months make it impossible for authors to be compliant with the NHMRC OA Policy within the time frame required by the Council.

## Open Access Distribution by Subject Categorisation of Journals

Data analysis of the WoS categories (WC) of the journal titles in this study focussed on the first allocated WC, although multiple WCs existed for some journals (Clarivate Analytics, 2018b). Even so, there were 99 WCs for the 1,137 journals in the sample. Time constraints prevented the full analysis of data by subject categorisation, with snapshots providing fundamental points for future research.

Table 32 lists the WCs in which there were eight or more journals published by NHMRC grant recipients. Two WCs, biochemistry and molecular biology and multidisciplinary sciences, reflected widely different levels of OA. In biochemistry and molecular biology, Council funded authors published 280 articles in 95 journals, which included a higher proportion of hybrid subscription journals, and delivered 55.71% OA for that category. In multidisciplinary sciences, grant recipients published 271 articles in eight journals. OA within the multidisciplinary sciences was 97.42% owing to the inclusion of *PLOS ONE* in this category.

*Table 32: Web of Science Categories: Eight or More Journal Titles*

| WC | $n_j$ | $n$ | $n$=OA | % of OA within WC |
|---|---|---|---|---|
| Biochemistry & Molecular Biology | 95 | 280 | 156 | 55.71 |
| Oncology | 61 | 166 | 101 | |
| Clinical Neurology | 58 | 153 | 54 | |
| Neurosciences | 44 | 140 | 52 | |
| Cell Biology | 41 | 91 | 56 | |
| Endocrinology & Metabolism | 40 | 125 | 74 | |
| Cardiac & Cardiovascular Systems | 39 | 79 | 38 | |
| Public, Environmental & Occupational Health | 38 | 111 | 57 | |
| Immunology | 37 | 136 | 89 | |
| Pharmacology & Pharmacy | 35 | 78 | 35 | |
| Genetics & Heredity | 24 | 58 | 33 | |
| Psychiatry | 24 | 71 | 25 | |
| Gastroenterology & Hepatology | 23 | 44 | 22 | |
| Geriatrics & Gerontology | 21 | 40 | 14 | |
| Biochemical Research Methods | 21 | 38 | 14 | |
| Health Care Sciences & Services | 20 | 58 | 43 | |
| Obstetrics & Gynecology | 19 | 50 | 24 | |
| Pediatrics | 17 | 59 | 22 | |
| Infectious Diseases | 16 | 53 | 39 | |
| Nutrition & Dietetics | 16 | 42 | 32 | |
| Ophthalmology | 16 | 49 | 25 | |
| Hematology | 15 | 34 | 28 | |
| Medicine, General & Internal | 14 | 93 | 77 | |
| Biotechnology & Applied Microbiology | 14 | 33 | 27 | |
| Microbiology | 13 | 41 | 34 | |
| Urology & Nephrology | 13 | 28 | 18 | |
| Chemistry, Multidisciplinary | 13 | 23 | 1 | |
| Medicine, Research & Experimental | 12 | 32 | 20 | |
| Orthopedics | 12 | 20 | 14 | |
| Critical Care Medicine | 12 | 30 | 14 | |
| Cell & Tissue Engineering | 12 | 27 | 9 | |
| Behavioral Sciences | 12 | 31 | 7 | |
| Developmental Biology | 11 | 25 | 20 | |
| Dentistry, Oral Surgery & Medicine | 11 | 17 | 3 | |
| Physiology | 10 | 35 | 33 | |
| Rheumatology | 10 | 25 | 20 | |
| Engineering, Biomedical | 10 | 20 | 3 | |
| Psychology, Clinical | 10 | 26 | 1 | |
| Respiratory System | 9 | 18 | 12 | |
| Rehabilitation | 9 | 17 | 2 | |
| Multidisciplinary Sciences | 8 | 271 | 264 | 97.42 |
| Peripheral Vascular Disease | 8 | 33 | 14 | |
| Parasitology | 8 | 18 | 9 | |
| Radiology, Nuclear Medicine & Medical Imaging | 8 | 18 | 6 | |
| Chemistry, Medicinal | 8 | 25 | 2 | |
| **Totals** | **967** | **2,861** | **1,643** | |

NHMRC grant recipients published in 140 OAJDs over 54 subject areas. OAJDs provided higher OA than hybrid OA in several subject areas, including multidisciplinary sciences, general and internal medicine, health care sciences, and infectious diseases. Authors also published a small number of delayed OA journals ($n_j$=40) over 24 WCs, the subject categories reflecting critical medical disciplines. In 43 WCs, hybrid OA was the only OA option (see Table 33), which was probably a factor contributing to lower OA within some disciplines.

*Table 33: Web of Science Categories: Hybrid Open Access Only*

| WC | $n_j$ | $n_j$ | *n* | *n*=OA |
|---|---|---|---|---|
| Peripheral Vascular Disease* | 7 | 7 | 33 | 14 |
| Dermatology | 5 | 5 | 9 | 7 |
| Reproductive Biology | 1 | 1 | 6 | 6 |
| Biophysics | 6 | 6 | 11 | 5 |
| Anesthesiology | 6 | 6 | 18 | 4 |
| Pathology | 5 | 5 | 7 | 4 |
| Surgery | 3 | 3 | 6 | 4 |
| Dentistry, Oral Surgery & Medicine | 11 | 11 | 17 | 3 |
| Rehabilitation | 9 | 9 | 17 | 2 |
| Chemistry, Medicinal | 8 | 8 | 25 | 2 |
| Nursing | 7 | 7 | 12 | 2 |
| Sport Sciences | 5 | 5 | 13 | 2 |
| Chemistry, Physical | 3 | 3 | 4 | 2 |
| Computer Science, Information Systems | 2 | 2 | 3 | 2 |
| Transplantation | 2 | 2 | 3 | 2 |
| Andrology | 1 | 1 | 2 | 2 |
| Chemistry, Multidisciplinary | 13 | 13 | 23 | 1 |
| Psychology, Clinical | 10 | 10 | 26 | 1 |
| Audiology & Speech-Language Pathology* | 5 | 5 | 9 | 1 |
| Economics | 3 | 3 | 3 | 1 |
| Food Science & Technology | 3 | 3 | 3 | 1 |
| Entomology | 2 | 2 | 3 | 1 |
| Statistics & Probability | 2 | 2 | 2 | 1 |
| Agriculture, Dairy & Animal Science | 1 | 1 | 1 | 1 |
| Cardiovascular System & Cardiology | 1 | 1 | 2 | 1 |
| Chemistry, Analytical | 1 | 1 | 1 | 1 |
| Materials Science, Biomaterials | 1 | 1 | 3 | 1 |
| Optics | 1 | 1 | 1 | 1 |
| Engineering, Industrial | 3 | 3 | 5 | 0 |
| Ethics | 3 | 3 | 4 | 0 |
| Otorhinolaryngology | 3 | 3 | 3 | 0 |
| Psychology, Biological | 3 | 3 | 5 | 0 |
| Acoustics | 2 | 2 | 2 | 0 |
| Chemistry, Inorganic & Nuclear | 2 | 2 | 2 | 0 |
| Computer Science, Cybernetics | 2 | 2 | 2 | 0 |
| Computer Science, Interdisciplinary Applications | 2 | 2 | 2 | 0 |
| Materials Science, Multidisciplinary | 2 | 2 | 2 | 0 |
| Veterinary Sciences | 2 | 2 | 2 | 0 |
| Anthropology | 1 | 1 | 1 | 0 |
| Emergency Medicine | 1 | 1 | 2 | 0 |
| Ethnic Studies | 1 | 1 | 1 | 0 |
| Fisheries | 1 | 1 | 1 | 0 |
| Hospitality, Leisure, Sport & Tourism | 1 | 1 | 1 | 0 |
| **Column Totals** | **155** | **153** | **298** | **75** |

*Subscription-only journals also in these WCs but not counted in journal total

# Overall Open Access Compliance with the NHMRC Policy

The NHMRC identifies the following OA versions as compliant with its OA policy:

- OA articles published in journals;
- AAMs in Australian IRs;
- Author manuscripts in PMC.

*Table 34: Overall Compliance with the NHMRC Open Access Policy*

| Locations/Formats of OA Articles | *n* | % of total (*n*=3,190) |
|---|---|---|
| OA articles in journals | 1794 | 56.24 |
| AAMs in Australian IRs | 231 | 7.24 |
| Oa versions in PMC (not in Australian IRs) | 122 | 3.82 |
| **Total** | **2,147** | **67.3** |

The overall extent of OA compliance under NHMRC OA Policy was 67.3% (*n*=2,147). OA articles published in journals made up the largest component of OA compliance comprising 56.24% (*n*=1,794) with OA in repositories making up a further 11.06% (*n*=353). OA in repositories included 7.24% (*n*=231) in Australian IRs and 3.82% (*n*=122) in PMC. For an overview of the results on compliance under the NHMRC OA Policy, see Table 34.

The study also found that 74.92% (*n*=2,390) of Council funded articles published during 2013 and 2014 had metadata in at least one Australian IR. Notwithstanding, only a quarter of the metadata entries included funding acknowledgement of the NHMRC, with the grant ID rarely cited.

## Conclusion to Results

The results provided answers to the research questions regarding the extent of compliance with the NHMRC OA Policy during the years 2013 and 2014. In response to the first research question, 56.24% (*n*=1,794) of articles published by NHMRC grant recipients in journals were OA and compliant with the Council's policy. NHMRC authors published OA articles in the following journal models:

- 25.58% (*n*=816) in hybrid subscription journals;
- 20.85% (*n*=665) in OAJDs;
- 8.75% (*n*=279) in delayed OA journals;
- 0.63% (*n*=20) in partial OA journals;
- 0.44% (*n*=44) in gratis OA journals.

The relatively small number of OAJDs ($n_j$=141) produced one-fifth (20.85%) of the OA by NHMRC grant recipients, with noteworthy OA output from delayed OA journals (8.75%). While the results show a relatively high level of hybrid OA (25.58%) compared to other journal OA models, 42.38% (*n*=1,352) of the journal articles published in hybrid subscription journals were not OA. Council funded authors also published 1.38% (*n*=44) of articles in subscription-only journals, for which the only option to be OA compliant was to deposit AAMs in repositories.

The second research question explored the extent that authors of non-OA articles deposited AAMs in IRs or subject repositories to be OA compliant. The results

showed that the quantity of AAMs in repositories amounted to 11.06% (*n*=353): 7.24% (*n*=231) in Australian IRs and 3.82% (*n*=122) in PMC. While author manuscripts in repositories increased compliance with the NHMRC OA Policy, non-OA articles that were neither OA in journals and repositories made up almost one-third (32.7%) of the sample. The third research question investigated the extent of metadata in Australian IRs, the results showing a high level of success (74.92%, *n*=2,390). Notwithstanding, only a quarter of the metadata entries included funding acknowledgement of the NHMRC, with the grant ID rarely cited.

The final research question aimed to identify publishing patterns within journals as well as uncovering specific information on journal publishers' policies about the deposit of AAMs in repositories, especially IRs. The results revealed the following characteristics of OA publishing by NHMRC recipients:

- A relatively small number of OAJDs ($n_j$=141) produced one-fifth (20.85%) of OA articles;
- *PLOS ONE* was the journal in which grant recipients published most articles (6.6%, *n*=211);
- Hybrid subscription journals published over two-thirds of the articles (67.96%) and supplied 25.58% to total OA;
- Elsevier (excluding Cell Press) and Wiley directly published or co-published one-third (33.32%) of the articles and contributed 9.72% to overall OA;
- A small number of delayed OA journals ($n_j$=40) added 8.75% to OA compliance.

APCs were generally higher for hybrid OA compared to OAJDs, although many society journals, some co-published with commercial publishers, had lower APCs for members. The subject study found no OAJDs in some areas, in which hybrid OA was the only OA option.

A key finding of this study was that over two-thirds (67.3%) of the articles were OA, most published in journals (56.24%) with a small number of accepted manuscripts located in Australian IRs (7.24%) and PMC (3.82%). The extent of overall OA was greater than other studies, but the opportunity to deposit AAMs in IRs was substantially below its potential.

# Chapter 5: Discussion

The benefits of OA publishing include research sharing among researchers and the dissemination of publicly funded health information to the community (Spedding, 2016). In implementing OA policies, government funders aim to demonstrate taxpayers' money advances research by serving the public good (Butler, 2001, 2003; Butler et al., 1998; Butler et al., 2005; Pinfield, 2015). For NHMRC grant recipients publishing during 2013 and 2014, OA compliance was achievable through:

- OA published articles in journals;
- The deposit of AAMs of non-OA articles in repositories;
- The inclusion of all publication metadata in Australian IRs.

Factors identified in the literature as influencing the decisions to publish OA include the quality of peer review, the relevance of the journal, as well as the cost of APCs. The research recognised several issues affecting the deposit of AAMs in IRs, including authors' unawareness of the required OA version, complicated IR procedures, and some publishers' embargoes and other conditions. Publishers' embargo periods longer than 12 months on the deposit of AAMs in IRs compromise compliance under the NHMRC OA Policy.

The purpose of the discussion is to relate the statistical findings to the research questions designed to cover compliance under the NHMRC OA Policy. The primary research problem of this study was the unknown extent of compliance under the Council's policy, especially during the first two full years. The research problem led to the following research questions:

1. What proportion of NHMRC funded articles is open access in journals?
2. What proportion of NHMRC funded articles not open access in journals has author accepted manuscripts in at least one Australian institutional repository?
3. What proportion of NHMRC funded journal article metadata is in Australian institutional repositories?
4. What are the open access models and author accepted manuscript policies of the journal titles in which NHMRC grant recipients publish?

## Summary of Key Findings

The NHMRC OA Policy mandated OA for all Council funded journal articles from July 2012, but the extent of OA compliance was unknown during the first years of the mandate. This study utilised descriptive bibliometrics to collect and quantify a large body of data relating to NHMRC funded journal articles publishing during 2013 and 2014. The reduction of the data to manageable forms created a picture of the OA scholarly publishing of the Council's grant recipients.

A key finding of this study was that over two-thirds (67.3%) of the articles were OA, most published in journals (56.24%) with a small number of accepted manuscripts located in Australian IRs (7.24%) and PMC (3.82%). OA articles published in journals was higher than that reported by other studies, especially in hybrid subscription (25.58%) and fully OA (20.85%) journals. Articles in delayed open access journals (8.75%) also significantly contributed to overall OA compliance.

Four detailed research questions relating to NHMRC funded peer-reviewed journal articles published 2013 and 2014 drove this study. Presented below as raw data are the key findings that answer the research questions:

1. *What proportion of NHMRC funded articles is open access in journals?*

   NHMRC funded articles published OA in journals during 2013 and 2014 comprised 56.24% (*n*=1,794) of the sample, which included:

   - 25.58% (*n*=816) hybrid OA articles in hybrid subscription journals;
   - 20.85% (*n*=665) articles in OAJDs;
   - 8.75% (*n*=279) articles in delayed OA journals;
   - 0.63% (*n*=20) articles in the *MJA*, the sole partial OA journal;
   - 0.44% (*n*=14) in journals offering gratis OA.

2. *What proportion of NHMRC funded articles not open access in journals has author accepted manuscripts in at least one Australian institutional repository?*

   NHMRC funded articles not OA in journals comprised 43.76% (*n*=1,396) of the study. Of this quantity, author manuscripts in repositories comprised:

   - 7.24% (*n*=231) in Australian IRs;
   - 3.82% (*n*=122) in PMC.

   The total quantity of compliant OA articles in repositories was 11.06% (*n*=353).

3. *What proportion of NHMRC funded journal article metadata is in Australian institutional repositories?*

   The metadata of 74.92% (*n*=2,390) of NHMRC funded articles appeared in at least one Australian IR, of which a quarter acknowledged the Council as the funder.

4. *What are the open access models and author accepted manuscript policies of the journal titles in which NHMRC grant recipients publish?*

   Of the journal titles ($n_j$=1,137), NHMRC grant recipients published in journals with the following OA models:

   - 81.62% ($n_j$=928) in hybrid subscription journals;
   - 12.4% ($n_j$=141) in fully OA journals (OAJD);
   - 3.52% ($n_j$=40) in delayed OA journals;
   - 0.09% ($n_j$ =1) in the only partial OA journal, the *MJA*;
   - 0.88% ($n_j$=10) in gratis OA journals.

   Authors also published in 17 subscription-only journals that comprised 1.5% of the journal titles in the sample.

   The default RoMEO colours for the 1,137 journal titles in this study indicated that 64.11% ($n_j$ =729) had green or blue policies that nominally supported the

deposit of AAMs in repositories. Data collected from the journal title entries in the SHERPA/RoMEO database demonstrated that the publishers of 95.38% ($n_j$=950) of subscription journals allowed the deposit of AAMs in IRs (see Table 31). Long embargo periods and other conditions of some publishers hindered the deposit of AAMs in IRs within 12 months required by the NHMRC OA Policy.

## Compliance with Funder Open Access Policies

A comparison with other investigations of funder OA policies leads the discussion. Borrego (2016) undertook the first comprehensive study into compliance with the Spanish Government OA policy. Bakker et al. (2017) investigated the Multiple Sclerosis Society of Canada's OA policy requiring the funded publications of the Society to be OA within six months of publication.

While the study of Borrego covered multiple disciplines, Bakker et al. (2017) focussed on the chronic neurological disease of multiple sclerosis. This study into compliance under the NHMRC OA Policy spanned a wide range of medical research areas. All three funder OA studies identified OA articles in journals and AAMs in repositories as compliant with the respective policies. Borrego (2016) also included OA articles in SCNs. The NHMRC study omitted OA versions from social networking platforms as these were non-compliant with the Council's OA Policy.

Funder studies utilised different methods to obtain their populations of funded publications. Borrego (2016) identified a random sample from the Spanish Government's National Programme of Fundamental Research Projects and searched WoS using the grant numbers. Bakker et al. (2017) retrieved funding information from the Multiple Sclerosis Society of Canada Research Summaries and determined the population by conducting keyword searches of "multiple sclerosis" in WoS, Scopus, Embase, and Medline. The NHMRC study used funding acknowledgement fields in WoS to locate journal articles funded by the Council.

This study into the NHMRC OA Policy found over two-thirds (67.3%) of the articles published by the Council's grant recipients were OA. Of this amount, 56.24% were OA articles in journals, and 11.06% were author manuscripts in Australian IRs and

PMC. Excluding OA in SCNs, Borrego (2016) found that 45.6% of articles funded by the Spanish Government were OA, comprising 23.8% OA in journals and 21.8% OA in repositories. The study of Bakker et al. (2017) found that 38% of journal articles funded between 2009 and 2014 were OA: 33.9% in journals and 4.1% in PMC. A summary of the results of the three funder OA studies appears in Table 35, the extent of OA considerably more than that recorded for other studies listed in Table 2.

*Table 35: Comparison of Funder Open Access Studies*

| Study | % | OA Locations | % |
|---|---|---|---|
| **Borrego (2016)** | | | |
| Spanish Government OA Mandate | 45.60 | OA articles in journals | 23.80 |
| | | AAMs in repositories | 21.80 |
| **Bakker et al. (2017)** | | | |
| Multiple Sclerosis Society of Canada | 38.0 | OA articles in journals | 33.91 |
| | | AAMs in repositories | 4.09 |
| **Kirkman (2018)** | | | |
| NHMRC OA Policy | 67.3 | OA articles in journals | 56.24 |
| | | AAMs in repositories | 11.06 |

The common link between Borrego (2016) and this study was that both investigations examined compliance under national funder OA mandates. Other parallels between the Spanish Government and NHMRC OA studies included:

- The significant part played by OAJDs in meeting OA compliance despite the lower number of journal titles compared to hybrid subscription journals;
- Grant recipients published most articles in *PLOS ONE*.

In contrast, Bakker et al. (2017) found a lower rate of publishing in OAJDs (7.92%). All funder studies commented upon the substantial contribution to overall OA by delayed OA journals, Borrego (2016) and the NHMRC study reporting delayed OA of over 8%. Bakker et al. (2017) found that one-quarter of OA articles in their research were from gratis and delayed OA journals.

The funder studies differed in their results for hybrid OA articles. The NHMRC study placed the level of hybrid OA at 25.58%: a result also much higher than other studies (see Table 2). Borrego (2016) identified a negligible number of hybrid OA articles (0.5%). Bakker et al. (2017) attributed low hybrid OA to the high cost of APCs and the monopoly of three commercial publishers (Elsevier, Wiley, and Springer Nature) over hybrid subscription journal ownership.

Borrego (2016) identified a relatively high level of OA in repositories, especially in arXiv, a disciplinary repository covering physics, astrophysics and mathematics. Grant recipients under the Spanish OA policy included a significant number of authors from mathematics and physics: these disciplines having established cultures of depositing in arXiv (Borrego, 2016). Bakker et al. (2017) found that author manuscripts in PMC contributed 4.1% to total OA.

All funder studies confirmed the low deposit of AAMs in IRs. Bakker et al. (2017) found that all OA versions in IRs were final published articles from OAJDs, already counted in total OA. All funder studies used SHERPA/RoMEO colour categories as benchmarks to measure journal publishers' repository policies. For RoMEO green and blue, Bakker et al. (2017) found 56.87%, Borrego (2016) identified 62.9%, and the NHMRC study calculated 64.11%. The NHMRC study also ascertained that the although publishers of 95.38% ($n_j$=950) of subscription journals allowed the deposit of AAMs in IRs (see Table 31), a large proportion had embargoes of 12 months or more on the deposit of AAMs in IRs, making compliance difficult under the time frame set by Council's OA Policy.

While Borrego (2016) identified unawareness of the existence of IRs as a factor in the low level of deposits, the NHMRC study recognised the issue of authors lacking knowledge of the required OA version. All funder studies acknowledged the need for the strategic promotion of AAMs to increase the extent of OA (Bakker et al., 2017; Borrego, 2016).

## Open Access in Journals

A key finding of this study was that NHMRC funded authors achieved most compliance under the Council's OA Policy by publishing OA articles in journals (56.24%). The extent of OA in journals was more than that found by other studies listed in Table 2. An explanation for the comparatively high level of OA articles is likely to be disciplinary, several studies demonstrating the higher levels of OA in biomedicine and medicine (Archambault et al., 2014; Björk et al., 2010; Solomon & Björk, 2012a; Ware & Mabe, 2015). Other explanations include authors' experience

in meeting funder OA requirements and high regard for the importance of OA to disseminate research findings (Pontika, 2011, 2015; Zhu, 2017).

Of total OA in journals, Council funded authors published 25.58% hybrid OA and 20.85% in fully OA journals. NHMRC grant recipients published more articles in *PLOS ONE* than any other single journal: a result paralleling that of Borrego (2016) for achieving OA compliance under the Spanish Government OA policy. Higher publishing in *PLOS ONE* implied the relevance of OA to the authors who selected the journal. For OA advocates, PLOS journals embody the core principle of OA "that scientific ideas and discoveries are a public good" (PLOS, n.d.).

The use of grant money for APCs under the NHMRC Direct Costs Guidelines likely contributed to the relatively high level of immediate OA in this study. The use of grants to pay for APCs is common practice especially in medical research areas (Gargouri, Larivière, Gingras, Carr, et al., 2012; Kocher & Kelly, 2016; Pinfield et al., 2016; Solomon & Björk, 2012a). The Council allows grants to pay for APCs on condition that the publications stem from approved research activities (NHMRC, 2014a). Notwithstanding, it is likely that not all NHMRC journal articles stemmed from approved research activities, making the cost of APCs pertinent to the authors' decision-making concerning OA.

APCs for publishing in OAJDs published by PLOS and BioMed Central were lower than for hybrid OA hybrid subscription journals. The lower APC of US$1,495 to publish in *PLOS ONE* most likely contributed to the high level of publishing in that journal by NHMRC grant recipients, along with other factors such as quality peer-review and journal reputation. In the PLOS business model, APCs "offset the cost of peer review management, journal production and online hosting and archiving of articles" (PLOS, n.d.).

The comparatively high level of hybrid OA in this study suggests that the authors of those articles either used Council grants to defray the cost or were in the position to pay. Pinfield (2015) argued that some authors are willing to pay higher publishing charges in well-established subscription journals. This study also found scales of charges for publishing in some hybrid subscription journals, especially society

journals published in collaboration with commercial publishing-houses. Reduced APCs for members of societies probably contributed to the relatively high level of hybrid OA.

NHMRC grant recipients published in several medical society and association journal titles that use delayed OA to provide value to their members. Factors influencing decisions to publish in delayed OA titles included memberships of societies, the subject specialties of society journals, and the prospect of eventual OA. The length of most embargoes of delayed OA journals in this study was 12 months or shorter (American Diabetes Association, n.d.; American Physiological Society, n.d.; American Society for Biochemistry and Molecular Biology, n.d.; American Society for Microbiology, 2017; American Thoracic Society, n.d.). Under the NHMRC OA Policy, articles with embargoes on OA of less than 12 months were compliant with the mandate. Council grant recipients published articles in delayed OA journals comprising 8.75% of OA (Table 30). The result was comparable to Borrego (2016) and confirmed the contribution of delayed OA to the total extent of OA (Borrego, 2016; Laakso & Björk, 2013; Laakso & Lindman, 2016; Piwowar et al., 2017; Willinsky, 2003).

A finding of this study was that some membership subscription journals provided hybrid OA to facilitate immediate OA as well as delayed OA. The American Physiological Society explained the rationale and scope of its AuthorChoice option as:

> The APS AuthorChoice program was developed to allow researcher authors the ability to provide immediate, open and free access to their work without the standard 12-month embargo that applies to subscription access …. Articles published with the AuthorChoice option are covered by the Creative Commons Attributions license (CC BY 4.0) … under which all are eligible for reuse and distribution under the condition that the original work published by APS must be cited (American Physiological Society, n.d., paras. 1-2).

The availability of hybrid OA option provides authors with the opportunity to publish articles under an open licence. The categorisation of bronze OA assumes the absence of licensing permitting reuse (Bosman & Kramer, 2018; Piwowar et al., 2017). While data collection for this study occurred after the expiry of embargoes,

the extent of hybrid OA within membership subscription journals is a potential topic for further investigation.

NHMRC grant recipients also published OA in gratis and partial OA journals, the primary examples being the professional journals of Australian medical associations. The Royal Australian College of General Practitioners (RACGP) publishes the *Australian Family Physician* (*AFP*) that provides immediate OA to research articles. The aim of *AFP* is the wide dissemination of research to practitioners and patients:

> As the journal is open access, readership of the publicly available online version extends more broadly into the international healthcare and education sectors as well as patients and carers (RACGP, 2017).

The Australian Medical Association's journal, the *MJA*, published 20 research articles in 2013 and 2014 authored by NHMRC grant recipients. The *MJA* was the only partial OA journal in this study, with access provided to research articles only. According to the *MJA* Access Policy, OA to research articles is immediate to encourage the "highest quality of research … easily and rapidly disseminated to all who might benefit from it" (AMA, n.d.).

The NHMRC has a funder policy with Wiley, the publisher informing authors of the requirements of the Council's OA Policy (Wiley, n.d.-a). The AOASG (2015) commended the publisher for making authors aware of their rights, including the option to self-archive the AAMs of their non-OA articles in IRs. Wiley contributed 6.46 % to overall OA compliance under the NHMRC OA Policy. The higher APCs for publishing hybrid OA in some of the journals, including those published by Wiley, probably contributed to authors' decisions not to publish OA (see Table 29). An extensive literature supported the argument that the higher APCs of hybrid subscription journals discourage the uptake of the OA option (Bakker et al., 2017; Gargouri, Larivière, Gingras, Carr, et al., 2012; Housewright, Schonfeld, & Wulfson, 2013; Solomon & Björk, 2012b).

While the costs of APCs affect decisions about OA, Bakker et al. (2017) maintained that the hybrid OA model is a compromise on the part of subscription publishers to appease OA advocates. Evident in Elsevier's hybrid OA policy is the advice for authors to publish in subscription journals while deciding upon the route to OA.

> This [hybrid OA option] allows you to continue to publish in important journals in your field, while also deciding how you want to broadcast your research. These journals provide an alternative way for authors to comply with open access policies of their institution and/or funding body (Elsevier, 2015, p. 3).

Elsevier published or co-published 19.12% of the articles in this study, but only 3.26% was OA.

Low OA within the journals of some commercial publishers may be due to the traditional publishing practices of some authors. A vast literature maintained that OA is a secondary factor in some authors' decisions, with high JCR Impact Factors considered more prestigious (Nicholas et al., 2017; Ware & Mabe, 2015; Zhu, 2017). According to an equally large body of literature, the sheer range of OA publishing options overwhelms authors and contributes to indecision about OA publishing and licensing (Darley et al., 2014; Gargouri, Larivière, Gingras, Carr, et al., 2012; Nicholas et al., 2014; Pinfield, 2015; Poltronieri et al., 2013; Rohrich & Sullivan, 2013; Rowley et al., 2017; Schmidt et al., 2015; Zhu, 2017). The future pattern of OA publishing in journals is also challenging to predict. During the lifetime of this study, the journal, *Nature Communications*, became a fully OA journal with its legacy subscription content converted to OA (Clark, 2014, Sep 23).

The greatest challenge to OA publishing is author unawareness that varies according to experience and institutional support (Zhu, 2017). Authors need more detailed information concerning the range of journal OA models, the scale of APCs, and viable OA options. Also required are better guidelines about OA publishing and funder OA policies, such as the NHMRC OA Policy.

## Metadata and Open Access in Repositories

The NHMRC expects author engagement with the Council's OA Policy even when the articles are not OA. The Council requires the deposit of the metadata of all funded journal articles into Australian IRs as soon as possible after acceptance. For the deposit of metadata, the NHMRC recognised the existence of the network of Australian IRs (NHMRC, 2015). The Council also identified Trove as the central platform for locating metadata and OA content in IRs (NHMRC, 2015). CAUL

(2014) promoted the use of Trove in finding publications under the NHMRC and ARC OA Policies.

The NHMRC OA Policy also stipulates the deposit of the AAMs in IRs. According to the AOASG (2015), the deposit of metadata soon after acceptance coincides with that part of the publishing process at which researchers have access to AAMs. The NHMRC has a funder policy with Wiley, one of the largest commercial publishers. Information on the Wiley website advises authors on the need to deposit the metadata of all funded publications in Australian IRs and to self-archive the AAMs after an embargo period of 12 months (Wiley, n.d.-a). At the time of writing, the NHMRC had no agreement with Elsevier, the largest publisher of hybrid subscription journals in this study (AOASG, 2015; Elsevier, n.d.).

## Metadata in Australian Institutional Repositories

The rationale for the deposit of the metadata of all journal articles into Australian IRs is to engage researchers in the Council's policy (AOASG, 2015). The Chief Investigator A on the NHMRC grant is responsible for providing the publication metadata (NHMRC, 2014b; NHMRC, 2014c). This study found that Australian IRs held the metadata for three-quarters of NHMRC funded journal articles. Much of the credit for adding metadata is due to IR and library staff. The sources of metadata include publication lists either provided by researchers or electronically harvested from subject repositories and databases (Callan, Gregson, Burn, & McCall, 2014; Henty, 2014; Organ & O'Hea, 2013).

The inclusion of the NHMRC as the funder and the grant ID(s) in the metadata is a condition of the Council's funding agreements and a requirement for articles accepted for publication. Standardised fields in IR systems have the potential to track OA compliance and provide research data for audits of funded research and delivery (AOASG, 2015). This study found that only a quarter of the metadata of NHMRC funded articles published in 2013 and 2014 included funding acknowledgement of the Council. An even smaller number of records cited the NHMRC grant ID(s). The findings appeared to confirm the global issue of authors not acknowledging their funding even under funder OA mandates (Álvarez-Bornstein et al., 2017; Borrego, 2016; Grassano et al., 2017; Wang et al., 2015; Yegros-Yegros & Costas, 2013).

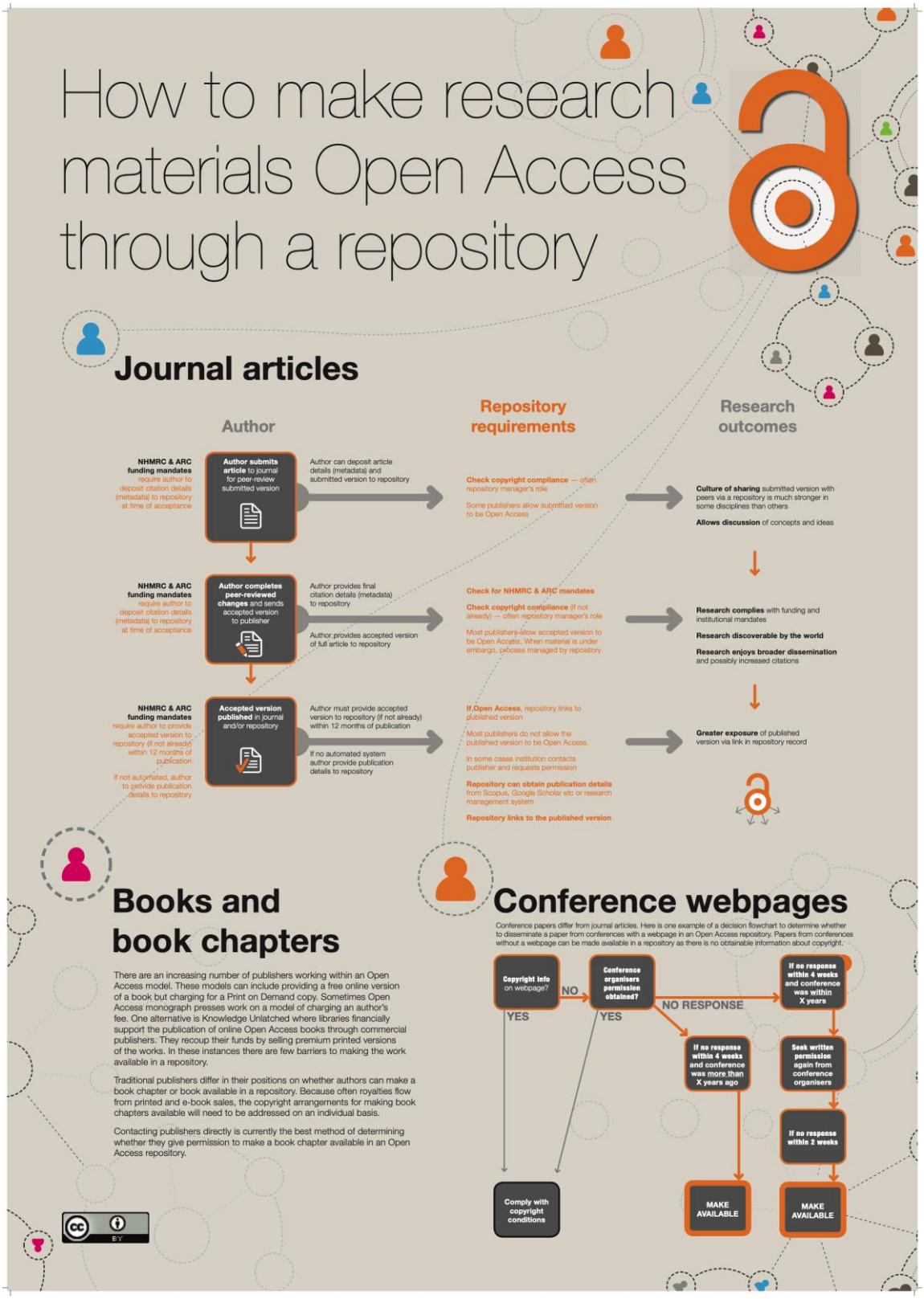


*Figure 15: Making Research Materials Open Access in Repositories (AOASG, 2013). Reproduced under CC BY licence (https://aoasg.org.au)*

Technical issues with Australian IR systems probably contributed to the finding of the low level of funder acknowledgement in the metadata of NHMRC funded publications published during 2013 and 2014. In the early stages of the NHMRC OA Policy, some Australian IR systems were technically incapable of tagging Council funded metadata (Huggard et al., 2017). Since the implementation of the NHMRC OA Policy, there have been advances in technologies and networked research information systems capable of pushing metadata into IRs (Bryant et al., 2017; Henty, 2014). As of 2017, six IRs have tagged records to ARC and NHMRC OA policies (Huggard et al., 2017).

Metadata is a crucial aspect of the NHMRC OA Policy. This study confirmed the discoverability of IR content via Google databases and Trove for locating the metadata of NHMRC funded articles in Australian IRs. The staff of Australian IRs continue to play pivotal roles in enriching the metadata (UWA, 2018a; UWA, n.d.). For the metadata of all NHMRC publications to be discoverable to the broader community requires adequate levels of infrastructure funding to IRs (Barbour, 2018, May 17; Bryant et al., 2017; Henty, 2014; Kingsley, 2013).

## Author Accepted Manuscripts in Australian Institutional Repositories

The NHMRC requires the deposit of the AAMs of non-OA articles in repositories. The Council recognises Australian IRs as the locations for AAMs, although also acknowledges author manuscripts in PMC (NHMRC, 2015). In this study, 43.76% of the articles in the sample were not OA, mostly published in hybrid subscription journals. For NHMRC grant recipients who publish in subscription-only journals, the deposit of AAMs in repositories was the only option to be OA compliant.

This study found that authors of one-quarter of non-OA articles (11.06%) deposited AAMs in repositories, 7.24% in Australian IRs and 3.82% in PMC. For the deposit of a Council funded article in PMC, either one or more of the authors received funding from the NIH or affiliated organisation, or an agreement existed between the journal publisher and PMC. Overall, the deposit of author manuscripts in repositories reduced the level of non-OA under the NHMRC OA Policy to just under one-third (32.7%) of the sample. A possible explanation for the low deposit of AAMs was the

Council not requiring AAMs in IRs until July 2013 (NHMRC, 2014b). However, the similarity of the results for 2013 than 2014 suggested that the NHMRC policy had little effect on the rate of deposit (see Table 20).

Misunderstanding about the required version probably contributed to the low deposit of AAMs in IRs. To the NHMRC, the accepted version is the "author's accepted manuscript version … that has been peer reviewed and accepted for publication" (NHMRC, 2018, p. 9). Authors are also familiar with the term author accepted manuscript or AAM as part of publishers' submission systems (AOASG, 2015). An alternative name for AAM is postprint, a term criticised as being ambiguous and confusing (Antelman, 2006; Björk et al., 2014; Ware & Mabe, 2015). A report to CAUL confirmed the confusion over the postprint, referring to "academic staff having a limited understanding of what a post-print is and why we require it" (Henty, 2014, p. 31). The use of other terms, such as author's version, add to the confusion.

Another explanation for the low deposit of AAMs in Australian IRs is uncertainty among authors about the procedures for submission. The AOASG flowchart in Figure 15 includes the steps required to deposit OA versions of journal articles in IRs under the NHMRC policy. Notwithstanding, the processes for the deposit of AAMs in Australian IRs are diverse. In some cases, the requirement is for authors to email the AAMs to IRs for copyright checking and deposit. Other IRs facilitate self-deposit, with authors attaching the AAMs to the metadata record in IRs. While some guides are specific to AAMs and the requirements of the NHMRC OA policy (UWA, 2018a; UWA, 2018b), other resources are general.

A further reason for the low deposit of AAMs in Australian IRs is authors' lack of understanding of publishers' policies. Many IRs use the SHERPA/RoMEO database to determine the archiving policy of journals. Some IR systems incorporate the RoMEO categories into their self-deposit systems (University of Melbourne, n.d.; UWA, 2018b; UNSW, 2018). The default SHERPA/RoMEO colour categorisation is a valuable quick reference for journal archiving policies. More accurate in identifying publishers' AAM policies is the information under the Author's Post-print section of the RoMEO entry for each journal title. Data collected for this study

indicated that most subscription journals allowed the deposit of AAMs in IRs, including RoMEO yellow and white journals.

Publishers' conditions are major causes of low deposits of AAMs in IRs. While some publishers allow the deposit of AAMs in IRs at 12 months after publication, others have embargo periods of up to 48 months. Under an agreement with the NHMRC and the ARC, Wiley advises authors that they may self-archive the accepted version of their article after an embargo period of 12 months (Wiley, n.d.-a). Elsevier has embargo periods of between 12 and 48 months that were retrospective to 2013 (Elsevier, 2015, n.d.; Gray, 2018). The years 2013 and 2014 were also the first two years of the NHMRC OA Policy.

Non-compliance with the OA policy requires the NHMRC Chief Investigator A to record the reasons in the Council's grant management system. The NHMRC (2018) identified embargoes beyond 12 months as a significant cause of non-compliance with its OA policy. This admittance on the part of the Council is confirmation that long embargo periods affect authors' compliance with funders' OA policies (COAR, 2015; Gray, 2018). A recommendation for further research is the investigation of the effects of long embargoes on the deposit of AAMs in repositories, especially IRs, and the impact on compliance with funders' OA policies.

Non-commercial and no-derivative licences required by some publishers further complicate the deposit of AAMs in IRs. Elsevier's sharing policy stipulates CC BY-NC-ND licensing for all pre-publication versions of articles as a condition of depositing in repositories (Elsevier, 2015). The documentation for CC BY-NC-ND licensing is substantial and delays the deposit of AAMs in IRs by creating more paperwork for authors and IR staff (COAR, 2015; Smith, 2015).

Some society publishers also have complex policies that make it difficult or impossible for NHMRC grant recipients to deposit AAMs of their work in IRs. The journal *Neurology*, published by the American Academy of Neurology, does not allow self-archiving but deposits on behalf of authors (Neurology, 2017). The archiving policy of *Pediatrics* is intricate, with an initial one-year embargo, followed by OA for four years (American Academy of Pediatrics, n.d.). While only a small

number of NHMRC authors published in *Pediatrics* and *Neurology*, the policies reduced the overall figure for OA in repositories.

Institutional policies also contributed to the low deposit of AAMs in Australian IRs. The NHMRC recognises that some grant recipients do not have access to IRs, recommending arrangements with affiliated institutions or the IR of another Chief Investigator (NHMRC, 2018). Although almost two-thirds of Australian universities have affiliations with medical research centres, only half provide repository services to authors of the centres (Henty, 2014). The main reason for not giving access to repository services is that the grants received by the centres are not the responsibility of the universities (Henty, 2014). Lack of access to repository services is a factor in understanding the low deposit of NHMRC funded AAMs in Australian IRs.

Although this study did not investigate scholarly collaboration networks, Borrego (2017) established that authors' preference for depositing in SCNs over IRs contributed to low deposits in IRs. The growth in the popularity of social networking platforms persists despite funders not recognising these websites. The NHMRC confirmed that SCNs are "not acceptable repositories for the purposes of this policy" (NHMRC, 2018, p. 9). Borrego (2017) proposed that IRs emulate some aspects of SCNs to increase IR content, such as researchers' profiles. Jamali (2017) identified the need for focused copyright and licensing education programs.

## Researchers' Engagement with Institutional Repositories

The NHMRC Chief Investigator A is responsible for the deposit of metadata in IRs (NHMRC, 2014b; NHMRC, 2014c). The deposit of metadata is a way of engaging grant recipients under the Council's OA Policy (AOASG, 2015). Notwithstanding, IR staff noted the disinterest and apathy of researchers about the processes (Henty, 2014; Huggard et al., 2017). Undeniably, some Australian IR systems were technically incapable of tagging Council funded metadata during the first years of the NHMRC OA Policy (Huggard et al., 2017). Since then, there have been considerable improvements in IR systems, although adequate infrastructure funding for all IRs is necessary to ensure ongoing capability (Barbour, 2018, May 17; Bryant et al., 2017; Henty, 2014; Huggard et al., 2017; Kingsley, 2013).

Other reasons for authors' disengagement with IRs, discussed in the previous section, included:

- Confusion over the nature of the publisher's accepted version (Henty, 2014);
- The complexity of IR submission processes (Henty, 2014; Huggard et al., 2017);
- Long embargoes and CC BY-NC-ND licensing (COAR, 2015; Gray, 2018);
- Lack of access to IRs by researchers of affiliated research centres (Henty, 2014);
- Authors' preference for depositing in SCNs over IRs, despite issues with copyright (Borrego, 2017; Jamali, 2017).

Copyright and other education programs need to address the problems of confusion over the nature of author accepted manuscripts and unawareness about the licensing conditions for the deposit of AAMs in IRs (Henty, 2014). Research indicates that OA unawareness is most evident among inexperienced and early career researchers, although experienced authors also find publishers' contracts problematic (Charbonneau & McGlone, 2013; Crummett et al., 2010; Gargouri, Larivière, Gingras, Carr, et al., 2012; Pontika, 2011; Zhu, 2017).

Reviews of IR submission processes will result in better procedures for the deposit of AAMs in IRs. University policies require reassessment to ascertain whether they provide access to researchers of affiliated centres. The issue of scholarly collaboration networks and funder mandates needs addressing in information programs and guides; the NHMRC (2018) assessing SCNs as inappropriate locations for Council funded articles.

## Conclusion to Discussion

This study examined OA compliance under the NHMRC OA Policy by collecting and quantifying a large body of data relating to the journal articles of the Council's grant recipients. Similar studies are few, Borrego (2016) conducting the first comprehensive study of compliance under an OA mandate. The extent of overall OA found by Borrego and this study was more substantial than that recorded by other investigations. The most likely explanation for higher OA is that the Spanish Government and NHMRC OA policies are national funder mandates. The main

difference between the studies was the extent of hybrid OA articles, Borrego (2016) identifying a negligible amount in marked contrast with the 25.58% found by this study.

The large quantity of non-OA articles from hybrid subscription journals provided considerable scope for the deposit of AAMs in IRs. Authors deposited the AAMs of a quarter of non-OA articles in repositories, that represented 11.06% of the sample. This study identified numerous challenges facing authors in the deposit of AAMs in IRs, including confusion over the nature of the accepted manuscript, long embargoes and complicated licensing. The opportunity exists for mentoring, education, and outreach programs to increase awareness of publishers' agreements and conditions such as embargoes. The deposit of AAMs in IRs holds the best potential for increasing the extent of OA, including compliance under OA mandates.

# Chapter 6: Conclusion

In 2012, Australia's premier medical research funder, the NHMRC implemented its policy mandating OA for all Council funded journal articles along. The primary rationale for the Council's policy was to maximise the dissemination of publicly funded research among other researchers and the broader community. The research problem of this study was:

> The NHMRC OA Policy mandates OA for all Council funded journal articles, but the extent of OA compliance is unknown. While literature demonstrates the increase in the range of journal OA models, it also records low levels of author participation in depositing author accepted manuscripts in repositories.

Four research questions relating to NHMRC funded journal articles published in 2013 and 2014 were pivotal in addressing this problem:

1. What proportion of NHMRC funded articles is open access in journals?
2. What proportion of NHMRC funded articles not open access in journals has author accepted manuscripts in at least one Australian institutional repository?
3. What proportion of NHMRC funded journal article metadata is in Australian institutional repositories?

The policies of journal titles were the subject of the final research question:

4. What are the open access models and author accepted manuscript policies of the journal titles in which NHMRC grant recipients publish?

## Research Implications

A key finding of this study was that over two-thirds of the articles in the sample were OA, most published in journals with a small number of accepted manuscripts located in Australian IRs and PMC. The extent of OA articles published in hybrid subscription and fully OA journals was higher than that reported by other studies. Delayed OA journals also significantly contributed to overall OA. Despite the relatively high level of OA, there was a large number of non-articles mostly published in hybrid subscription journals and a few subscription-only titles. The

deposit of author manuscripts of non-OA articles in repositories reduced the non-compliant component under the Council's policy to just under one-third of the sample. However, the large quantity of non-OA has implications for the NHMRC OA Policy, as well as research into funder mandates and the deposit of AAMs in Australian IRs.

## Implications for Policy

By its very nature, the topic of this study is about policy: the NHMRC OA Policy, Australia's first national funder OA mandate. The research problem addressed the policy issue concerning the lack of information on compliance under the Council's policy. The NHMRC OA Policy was comparatively successful during its first two years, with over two-thirds of the articles in the sample found to be OA. Most of the OA was in journals with a small number of accepted manuscripts located in Australian IRs and PMC. The results from this study provide the basis for future investigations into the NHMRC OA Policy.

The relative success of the NHMRC OA Policy is due in part to the Council having no restriction on where researchers choose to publish. The NHMRC OA Policy requires OA within 12 months from the date of publication. By doing so, the Council acknowledges the importance of many medical society journals that provide delayed OA, most with embargoes on OA of between six and 12 months. The extent of hybrid OA was higher than that reported by other studies, as was publishing in fully OA journals. The high level of OA in journals that charge APCs is partly due to the Council allowing grants to pay for the publication costs of articles from approved research activities. Notwithstanding, the NHMRC does not directly pay APCs, valuing AAMs in IRs as OA compliant with the Council's policy.

The NHMRC recognises the advantages of an established network of Australian IRs to store the metadata of all Council funded publications and house the AAMs of non-OA articles. The Council is also aware of the importance of a central search platform, with Trove fulfilling that role. The Council anticipated greater engagement by grant recipients in the NHMRC OA Policy by requiring the deposit of metadata into IRs, regardless of whether the articles were OA or not. Notwithstanding, IR staff deposit most of the publication metadata. The Council needs to tackle the issue of

author disengagement and the lost opportunity of acquiring AAMs after acceptance within the publishing cycle. Long embargoes and CC BY-NC-ND licensing imposed by some publishers threaten compliance with the NHMRC OA Policy and require action on the part of the Council to resolve the issues.

## Implications for Research

Funder OA studies provide a better understanding of the extent of OA under mandates. Borrego (2016) conducted the first comprehensive study of compliance under a government's OA policy, while Bakker et al. (2017) investigated the mandate of a medical society. The extent of OA found by the funder studies was more significant than other research into OA.

Funder studies reviewed in this study identified the crucial roles played by OAJDs and delayed OA journals in OA compliance. While the investigation into the NHMRC OA Policy found a comparatively high level of hybrid OA, other studies confirmed the low level of hybrid OA. Borrego (2016) identified the success and popularity of subject repositories, such as arXiv, in encouraging authors to deposit. All funder studies recognised the need for the strategic promotion of the deposit of AAMs in IRs to increase the extent of OA under funder OA policies (Bakker et al., 2017; Borrego, 2016).

Funder studies provide models for future research, especially the coding tools designed by Borrego (2016) and this study (Table 8). This study used the funding acknowledgement fields in WoS to locate journal articles funded by the NHMRC. Since data collection for this thesis, there has been greater unification of the variations in funder agency names in WoS that will facilitate future studies.

## Implications for Practice

This study found that Australian IRs held the metadata for three-quarters of NHMRC funded publications; much of the credit is due to IR and library staff. Progress in the tagging of NHMRC and ARC supported publications will increase the level of funder acknowledgement in the metadata of Australian IRs. In collecting data for this research, the metadata and OA content in IRs were readily discoverable via Google databases and Trove. Among the critical findings of this investigation was that the

deposit of author manuscripts of non-OA articles in Australian IRs and PMC reduced the non-compliant component under the Council's policy.

This study identified several possible reasons for the low deposit of AAMs. A fundamental problem is the author's confusion over the nature of the publisher's accepted version. The complexity of repository procedures and publishers' conditions also complicate the deposit of AAMs into IRs. The issue of authors selecting social networking platforms over IRs requires addressing in terms of funder policies, the NHMRC OA Policy giving preference to IRs over SCNs. Mentoring, education, and outreach programs need to increase awareness of the accepted manuscript and publishers' conditions, including licensing and embargoes. Promoting the deposit of AAMs through education and outreach programs is pivotal to increasing OA in IRs.

## Limitations

A limitation to researching the first two years of the Council's OA Policy was the removal of the 2012 and 2014 NHMRC OA Policies (NHMRC, 2012a; NHMRC, 2014b; NHMRC, 2014c) from the Council's website and replacing them with the current policy and documentation. Fortunately, archived copies of previous NHMRC OA policies in the Internet Archive (https://archive.org) provided the necessary evidence of the existence of the earlier records. This research discovered a widespread issue with the removal or relocation of formerly accessible documents from the websites of peak organisations, government agencies, publishers, journal websites, and database suppliers. While updates to information on websites are essential, longer-term studies of OA and IRs require the preservation of historical policies and reports to assess progress.

Another major limitation of this study was the timing of data collection. The NHMRC OA Policy requires OA 12 months from the date of publication. Owing to the delays caused by the size of the original dataset and the time constraints of a Master of Philosophy thesis, the scheduling for data collection was 24 months after publication. The extended period may have inflated the data on AAMs in Australian IRs, although the low rate of deposit suggests otherwise.

Time also prevented a survey of the AAM policies and procedures of Australian IRs. The lack of uniform IR procedures made it difficult to generalise across institutions about authors' experience in depositing AAMs. At the time of data collection, some Australian IR systems were technically unable to tag funder information and mandated deposit of material (Huggard et al., 2017). Since 2017, there has been an increase in the tagging of NHMRC records with the probable consequence of higher funder information than reported in this study.

## Recommendations

Required are further studies into compliance with the NHMRC OA Policy. This study provided a model and methodology on which to base these studies. Longitudinal investigations would reveal changes in the extent of OA compliance, especially in journals and IRs. Future research topics will need to accommodate peer-reviewed conference papers covered by the current policy. The evolution of the Council's OA Policy over time could also be a focus, perhaps building on the documentation in Table 1.

An exciting but challenging area of research is compliance under the Australian Research Council OA Policy (ARC, 2017). The ARC OA Policy also mandates metadata and OA in IRs, but with a more extensive range of outputs including books, book chapters, non-traditional research outputs, as well as journal articles. Comparisons of compliance under the ARC and the NHMRC OA policies would highlight the similarities and differences. Research investigating the parallels among international funder OA policies would prove useful in providing information on global trends.

The funding acknowledgement fields of many journal articles in this study indicated that funding came from multiple funders. The different funder requirements and policies are likely to influence the extent, type of OA versions, and the time frames for compliance with OA mandates. Sources of funding and grant history are topics suggested for quantitative and qualitative studies, as well as the investigations of authors' decision-making about OA and APCs. While NHMRC allows grants to pay for publication charges stemming from approved research activities, the Council does not directly fund APCs. The extent that NHMRC grants contributed to the payment

of APCs is unknown, although there is literature that maintains that this is standard practice.

Questionnaires, surveys, and research interviews would be useful in gaining information on researchers' attitudes towards OA, knowledge of journal OA models, and IRs. Further studies need to focus on the critical role of IRs in meeting OA compliance. The deposit of AAMs in IRs holds the best potential for increasing the extent of OA. Future research needs to continue the focus on the reasons for the low deposit of AAMs in IRs, including author's confusion over the nature of the accepted version and publisher's policies.

The OA feature in WoS is a significant development with the ability to scope new projects and refocus existing research. The terminology used in OA studies requires review to enable cross-analysis and comparison. Further research into OA also needs to include scholarly books, book chapters and conference papers (Eve, 2014).

## Concluding Comments

As the first comprehensive investigation to measure compliance with Australia's earliest national-level open access policy, this study fills a gap in the knowledge about compliance under the NHMRC OA Policy. This study found that over two-thirds of the articles in this study were OA. Most of the OA was in journals with a small number of accepted manuscripts located in Australian IRs and PMC. This study found that Australian IRs held the metadata for three-quarters of NHMRC funded publications.

The NHMRC recognises the advantages of an established network of Australian IRs with Trove as the central platform. Improving IR deposit rates is an important step to increase OA compliance with the NHMRC OA Policy as well as increasing access to Council funded publications. The study highlighted the need for better guidelines, procedures, and supportive programs for authors to meet the requirements of OA mandates. A coherent national approach addressing the main issues of OA would increase awareness as well as compliance with the NHMRC OA Policy.

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# Appendices

## Appendix A: NHMRC revised policy on the dissemination of research findings [as of 1 July 2012, archived 28 January 2014]



Australian Government
National Health and Medical Research Council

NHMRC

### Dissemination of Research Findings

#### NHMRC revised policy on the dissemination of research findings

A revised NHMRC policy for the dissemination of research findings came into effect on 1 July 2012.

The Australian Government makes a major investment in research to support its essential role in improving the wellbeing of our society. To maximise the benefits from research, publications resulting from research activities must be disseminated as broadly as possible to allow access by other researchers and the wider community. NHMRC acknowledges that researchers take into account a wide range of factors in deciding on the best outlets for publications arising from their research.

Such considerations include the status and reputation of a journal, book, publisher or conference, the peer review process of evaluating their research outputs, access by other stakeholders to their work, the likely impact of their work on users of research and the further dissemination and production of knowledge.

Taking heed of these considerations, NHMRC wants to ensure the widest possible dissemination of the research supported by NHMRC funding, in the most effective manner and at the earliest opportunity.

NHMRC therefore requires that any publications arising from an NHMRC supported research project must be deposited into an open access institutional repository within a twelve month period from the date of publication.

NHMRC understands that some researchers may not be able to meet the new requirements initially because of current legal or contractual obligations.

#### Outcomes of NHMRC round table meeting to discuss the revised policy on the dissemination of research findings

On Monday 14 May 2012, NHMRC held an Open Access roundtable meeting to discuss the revised policy on the dissemination of research findings. The meeting brought together representatives from the publishing industry, research offices, librarians, repository managers, AAMRI and the Group of 8 to discuss the implementation of the revised policy.

The points below provide information regarding some of the major issues discussed at this meeting.

It should be noted that NHMRC is sensitive to copyright and licensing arrangements currently in place between authors, institutions and publishers. NHMRC is also aware that institutions and individuals will need to develop mechanisms to ensure compliance with NHMRC's policy that take into account agreements already in place between authors and publishers.

One issue of concern raised at the roundtable was the statement "within a twelve month period of the date of publication" in the revised policy. In this context it should be noted that a recent UK report from the Working Group on Expanding Access to Published Research Findings, chaired by Dame Janet Finch, recently published a report titled "Accessibility, Sustainability, Excellence: How to Expand Access to Research Publications". The working Group noted that where funds for "gold" open access are not made available, it is unreasonable for funders to mandate open-access embargoes of less than 12 months.

#### Further detail regarding the revised NHMRC policy on the dissemination of research findings

### Why has the NHMRC revised its policy on the dissemination of research findings?

The overarching aim of NHMRC's Policy is to ensure that the findings of publicly funded health and medical research are made available to the wider public as soon as possible. Both the research community and the public gain from knowledge derived from NHMRC funded research, and both wish to derive maximum benefit from these outputs.

This revision brings NHMRC further into line with other international health and medical research funding agencies such as the US National Institutes of Health, the Wellcome Trust and the UK Medical Research Council.

### When does the revised dissemination policy commence?

The policy commenced on 1 July 2012, but the first articles are not due to be made available in an Institutional Repository until 1st of July 2013.

### What do I do if I have an article accepted for publication before the 1st of July 2012, but published after this date?

Articles accepted for publication before the 1st of July 2012 but published after this date will be exempt from the revised policy on the dissemination of research findings.

NHMRC considers an article 'accepted' for publication from the date the article's author and publisher execute a publication 'licensing agreement', or from the date the publisher notifies the author that their article was accepted for publication on condition of the author signing a publication license agreement, whichever comes first.

### Who is responsible for ensuring compliance with the revised policy?

Compliance with the policy is a matter for the Administering Institution to discuss with the NHMRC – the NHMRC will not routinely check compliance with individual Chief Investigators (CIs).

The Chief Investigator A (CIA) on any given grant will be responsible for providing the publication metadata (ie – journal name, title, author list, volume, issue, page numbers etc) and, as and when it becomes available, the appropriate copy of the publication to the institutional repository (although this may be managed via the institutional research administration office). This is independent of the CIA's authorship role (first, last or middle) on a given paper.

### Which publications should be included in the institutional repository?

NHMRC does not intend to place restrictions on the types of publications that can be included in an institutional repository. The Administering Institution should assist researchers to identify and capture appropriate information.

In line with NHMRC's Funding Agreement any material published in respect of an NHMRC-funded research activity must include acknowledgement of NHMRC's funding, including the grant identification number (clause 20.2). Similarly, it is expected that any material published in respect of an NHMRC-funded research activity will be included in the institutional repository.

Researchers should ensure that all publications are listed in the scientific Final Report for each grant. If a publication cannot be included in the institutional repository, a justification for its non-inclusion must be provided in the Final Report.

### What information needs to be submitted to the institutional repository and when?

Publication metadata (ie – journal name, title, author list, volume, issue, page numbers etc) must be submitted to the institutional repository as soon as possible after the paper is accepted for publication, no matter when (or if) the paper itself will become openly accessible.

The manuscript/journal article should be submitted to the institutional repository as soon as possible after the publication date. The repository manager will ensure that the manuscript/journal article is made available at a date that complies with the journal's copyright transfer agreement.

If the copyright transfer/licence agreement does not allow the article (or manuscript) to be made available within twelve months of the date of publication, it needs to be made available as soon as possible after that date. If the journal *never* allows the article to be made available, this information must be provided at the time of Final Report submission. Institutions may wish to use a publicly

available 'holding note' to explain that copyright/licensing restrictions prevent inclusion of a particular article on the repository until a specific date.

### Which version of the manuscript/journal article do I need to make available via the institutional repository?

There are numerous versions of the article that can be made available via the institutional repository. Both the author's version of the article (Word document) after peer-review, with revisions having been made and the publisher's version (e.g. journal version with final pagination and formatting) are acceptable under this revised policy.

Journals may have different policies regarding what version of a manuscript or article can be made available, and timing of this availability. This information should be included in any copyright/licensing agreement.

To find further information regarding which version of a paper can be uploaded to your institutional repository, consult your librarian or the SHERPA/RoMEO database of international publisher policies, which provides a great deal of detail:

http://www.sherpa.ac.uk/romeo/

OAKList covers the policies of Australian journals: http://www.oaklist.qut.edu.au

### If I publish my article in an Open Access journal or in PubMed Central, do I also need to submit the article/manuscript to my institutional repository?

No. If the print version (journal version) of the article is openly accessible via the publisher's website or via a service such as PubMed Central, it is sufficient to just make the article metadata available in the institutional repository and provide a link to the site where the print version is available.

### What do I do if my institution does not have an institutional repository?

NHMRC recently held a round table discussion regarding the implementation of the revised dissemination policy. During this discussion, some concerns were expressed regarding the cost of administering the revised policy. Universities are better placed than some other institutions in terms of infrastructure support due to previous funding provided for institutional repositories via the Australian Scheme for Higher Education Repositories (ASHER).

There is a possibility of shared access to institutional repositories between universities, medical research institutes and hospitals. This shared repository access will need to be negotiated between the partner institutions.

If no institutional repository is immediately available to a Chief Investigator, this will need to be recorded in the grant Final Report.

NHMRC may discuss the implementation of this Policy with Administering Institutions that do not provide researchers with access to a repository.

## Further background

Further background on the development of this revised policy can be found at the link below.

- Revised Policy on Dissemination of Research Findings *22 February, 2012*

## Contact

| | |
|---|---|
| **Postal address** | NHMRC<br>GPO Box 1421<br>Canberra ACT 2601 |
| **Email address** | nhmrc@nhmrc.gov.au |
| **Telephone** | (02) 6217 9000 |

## Archive

**Previous Policy on Dissemination of Research Findings**

The Australian Government makes a major investment in research to support its essential role in improving the wellbeing of our society. To maximise the benefits from research, findings need to be disseminated as broadly as possible to allow access by other researchers and the wider community.

NHMRC acknowledges that researchers take into account a wide range of factors in deciding on the best outlets for publications arising from their research. Such considerations include the status and reputation of a journal or publisher, the peer review process of evaluating their research outputs, access by other stakeholders to their work, the likely impact of their work on users of research and the further dissemination and production of knowledge. Taking heed of these considerations, NHMRC wants to ensure the widest possible dissemination of the research supported by NHMRC funding, in the most effective manner and at the earliest opportunity.

NHMRC therefore encourages researchers to consider the benefits of depositing their data and any publications arising from a research project in an appropriate subject and/or institutional repository wherever such a repository is available to the researcher(s). If a researcher is not intending to deposit the data from a project in a repository within a six month period, s/he should include the reasons in the project's Final Report. Any research outputs that have been or will be deposited in appropriate repositories should be identified in the Final Report.

# Appendix B: NHMRC's policy on the dissemination of research findings [1 February 2014, archived 1 December 2014]





## NHMRC Open Access Policy



### NHMRC's Policy on the Dissemination of Research Findings

The revised NHMRC policy on the dissemination of research findings (NHMRC Open Access Policy) has been in effect since 1 July 2012.

The Policy is as follows:

The Australian Government makes a major investment in research to support its essential role in improving the wellbeing of our society. To maximise the benefits from research, publications resulting from research activities must be disseminated as broadly as possible to allow access by other researchers and the wider community. NHMRC acknowledges that researchers take into account a wide range of factors in deciding on the best outlets for publications arising from their research.

Such considerations include the status and reputation of a journal, book, publisher or conference, the peer review process of evaluating their research outputs, access by other stakeholders to their work, the likely impact of their work on users of research and the further dissemination and production of knowledge.

Taking heed of these considerations, NHMRC wants to ensure the widest possible dissemination of the research supported by NHMRC funding, in the most effective manner and at the earliest opportunity.

**NHMRC therefore requires that any publication arising from NHMRC supported research must be deposited into an open access institutional repository within a twelve month period from the date of publication.**

NHMRC understands that some researchers may not be able to meet the new requirements initially because of current legal or contractual obligations.

**Additional guidance on the policy is provided below, followed by a step-by-step guide.**

### Who is responsible for implementing the policy?

The *NHMRC Funding Agreement* outlines the responsibilities of Administering Institutions with regard to publications and data resulting from NHMRC-supported research activities.

Researchers are required to conduct their research and disseminate their research findings in accordance with the Funding Agreement, and by reference, the NHMRC Open Access Policy. The Chief Investigator A (CIA) on the NHMRC grant is responsible for providing the publication metadata and relevant NHMRC Grant ID (and the appropriate copy of the publication when it becomes available) to the institutional repository (this may be managed via the institutional research administration office). This is independent of CIA's authorship role (first, last or middle) on a given paper.

### What published outputs are covered by the policy?

The revised policy applies to all peer-reviewed journal publications arising from all NHMRC grants, with the exception of scholarships.

The policy applies to all peer reviewed journal publications published after the 1st of July 2012, regardless of the start date of the relevant grant.

NHMRC's Research Grants Management System (RGMS) has been modified so that when CIAs update their publication records, they can now indicate whether the publication is available in a repository, and link it to the relevant grant. CIs are able to do this for all publications, not just those published since July 2012.

### What published outputs are NOT covered by the policy?

The revised policy does not apply to other published outcomes of the funded research such as books, book chapters, theses, and technical reports.

### What if I am unable to make the article available within 12 months, due to legal obligations?

NHMRC understands that in some instances researchers may not be able to meet the new requirements because of legal or contractual obligations. CIAs should make this clear to NHMRC when reporting on their grants.

NHMRC does not require that your publication be made available via a journal's proprietary or paid 'Open Access' program.

### What manuscript versions are acceptable under the policy?

Both the author's version of the article (as accepted by the journal after peer-review, with revisions having been made) and the publisher's version (e.g. journal version with final pagination and formatting) are acceptable under this policy.

Journals may have different policies regarding which version of a manuscript or article can be made available, and the timing of this availability. The CIA should work with their Institutional Repository (IR) manager, library staff or research office to determine the options available to them that allow compliance with the policy.

**A comprehensive list of open access repositories at Australian institutions is available via the Australian Open Access Support Group (AOASG) website.**

### How does NHMRC's policy compare with the Australian Research Council's new policy?

NHMRC and ARC's policies are substantially comparable.

The ARC policy came into effect in January 2013, and applies to grants received in 2013 (commencing 2014), with the first publications not expected in IRs until after January 2014. The NHMRC policy was implemented in July 2012 with publications being deposited in IRs from July 2013. The ARC policy is available on the ARC website.

The AOASG has published a comparison of the two agencies policies on the AOASG website.

### Does the University grants management system meet the criteria for an institutional repository?

The key requirement of an institutional repository is that it be publicly and freely available, and include the metadata and/or the pre-print, post-print or the journal version of the article. Your system administrator may be able to advise on whether your grants management system meets this requirement.

### If an article is not able to be deposited into an IR, will it affect the applicant's peer review score?

No. The ability/inability of applicants to deposit their publication in an IR will not affect their scores during the peer review process. If you are unable to deposit the article, you should provide a reason (e.g. legal/contractual limitations) in RGMS.

### If an article is not able to be deposited into an IR, will it affect the applicant's eligibility?

No. If you are unable to deposit the article, you should provide a reason in RGMS.

### If the field on 'Related NHMRC Grants' affiliated to a publication is not provided, will the applicant's eligibility be affected?

No.

### Does the tick box for publications to be deposited into an IR refer to a collection of publications or for each individual publication?

The tick box applies to each individual publication (i.e. one tick for each publication).

### What does the following question in RGMS refer to? "Is the article in an institutional repository?"

**Note:** The metadata for all journal articles must be submitted to your institutional repository immediately upon publication, regardless of the type of journal it is published in.

Select "Yes" if (ONE OR MORE OF THE FOLLOWING APPLIES TO YOUR ARTICLE):

- The relevant pre-print/post-print version has been submitted to an IR;
- The publication is in an open access journal (e.g. PLoS);
- The embargo on the publication has lapsed, and the article is now freely available through the journal website; or
- The publication has been submitted to an open access subject repository (e.g. PubMed Central).

## Guide for Authors

### Where the research described in the publication is funded (entirely or in part) by NHMRC:

1. The author(s) decides which journal they wish to submit their paper to. Note that:

   NHMRC's Policy does not require authors to take a particular route to publication (Green or Gold). It is the author's choice as to which particular journal they think best suits their article. Compliance does not require publications to be available via a Journal's proprietary or paid 'Open Access' program.

2. The CIA should contact their IR manager, library or research office to obtain instructions on how to deposit the publication and the publication metadata in the IR, as institutional practices may vary from one institution to the next. If the administering institution does not have an institutional repository, then:

   One of the other CIs can lodge in their institution's IR; or

Administering institutions that don't have an IR may be able to negotiate with an affiliated university for access on behalf of their researchers.

3. The timing of submission should be as advised by the IR manager or library. The repository manager will ensure that the appropriate version of the publication will be made available via the IR at the first available date.

   Note that the publication date is the official date of publication, not the date that the article first appears online (e.g. e-pub ahead of print).

   The IR should make the publication and the relevant metadata available to the public within 12 months of this official date of publication where legally possible.

4. Once the submitted paper is accepted for publication in a peer reviewed journal, the CIA of the grant is required to comply with the following:

   If the publication is freely available to the public via the journal website, only the metadata and the link to the publication need to be provided to the IR, and both can be made immediately available in the IR.

   If the journal allows the author to make the accepted version of the publication available in an IR within 12 months, the metadata and accepted version can be submitted to the IR, with the publication metadata being made immediately available and the publication itself being made available as soon as the embargo permits.

   If the researcher has made the work available in a subject repository (e.g. PubMed Central), the author can make the metadata available through the IR with a link to the open access version in the subject repository.

   If the journal does NOT allow any version of the publication to be made available in an IR, the publication metadata should be submitted to the IR, and the CIA should provide a reason in RGMS for non-compliance with the NHMRC dissemination policy.

5. The CIA should ensure that their RGMS CV/profile publication data has been updated to reflect the following publication details:

   the basic publication metadata - author/s, title, journal name, date etc; submitted via the normal process of adding publications to a CV.

   the grant ID of the relevant NHMRC grant(s) that contributed to the research described in the publication should be appended to the publication data.

   if the publication is available to the public via the IR, the checkbox indicating this should be completed.

6. The National Library of Australia currently harvests data from most IRs into its central TROVE database that is freely accessible.

## Further background information

Further background on the development of this revised policy can be found at: Revised Policy on Dissemination of Research Findings - 22 February, 2012 (PDF, 1.1MB)

Previous Policy on Dissemination of Research Findings (PDF, 1.3MB)

Page last updated on 1 December 2014

# Appendix C: NHMRC's policy on the dissemination of research findings [20 November 2014]



## NHMRC Open Access Policy

Grants & Funding

Administering grants
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NHMRC Funding Calendar
Outcomes of funding rounds
Partnering with NHMRC
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Australian Standard Research Classifications and NHMRC Research Keywords and Phrases
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Commissioner of Complaints
NHMRC Open Access Policy
NHMRC Open Access Policy: Key updates 20 November 2014
NHMRC Research Funding Access Policy
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Research Ethics Committee and Regulatory Approvals Clearance
Research funding statistics and data
Research Grants Management System (RGMS)

Home > Grants & Funding > Policy > NHMRC Open Access Policy

### NHMRC's Policy on the Dissemination of Research Findings

The NHMRC Open Access Policy has been in effect since 1 July 2012.

The following outlines the updated version (20 November 2014).

**The Policy is as follows:**

The Australian Government makes a major investment in research to support its essential role in improving the wellbeing of our society. To maximise the benefits from research, publications resulting from research activities must be disseminated as broadly as possible to allow access by other researchers and the wider community. NHMRC acknowledges that researchers take into account a wider range of factors in deciding on the best outlets for publications arising from their research.

Such considerations include the status and reputation of a journal, book, publisher or conference, the peer review process of evaluating their research outputs, access by other stakeholders to their work, the likely impact of their work on users of research and the further dissemination and production of knowledge.

Taking heed of these considerations, NHMRC wants to ensure the widest possible dissemination of the research supported by NHMRC funding, in the most effective manner and at the earliest opportunity.

**NHMRC therefore requires that any publication arising from NHMRC supported research must be deposited into an open access institutional repository and/or made available in another open access format within a twelve month period from the date of publication.**

NHMRC understands that some researchers may not be able to meet the new requirements initially because of current legal or contractual obligations.

NHMRC Open Access Policy: Key updates 20 November 2014

Additional guidance on the policy is provided below, followed by a step-by-step guide.

### Additional Guidance

#### Who is responsible for implementing the policy?

The *NHMRC Funding Agreement* outlines the responsibilities of Administering Institutions with regard to publications and data resulting from NHMRC-supported research activities.

Researchers are required to conduct their research and disseminate their research findings in accordance with the Funding Agreement, and by reference, the NHMRC Open Access Policy. This may be managed via the institutional research administration office.

The Chief Investigator A (CIA) on the NHMRC grant is therefore responsible for ensuring that the NHMRC Open Access Policy is complied with. This is independent of CIA 's authorship role (first, last, middle, or non-author) on a given published peer-reviewed article (hereafter referred to as 'publication'). This includes:

- provision of the publication metadata (and if relevant, a URL/doi to an open access format) and relevant NHMRC Grant ID to the institutional repository; and
- provision of an appropriate copy of the publication to the institutional repository (IR), if an open access version is not already available elsewhere (e.g. PubMed Central, publisher website).

#### What published outputs are covered by the policy?

The revised policy applies to all peer-reviewed journal publications arising from all NHMRC grants, with the exception of

scholarships.

The policy applies to all peer reviewed journal publications published after the 1st of July 2012, regardless of the start date of the relevant grant.

NHMRC's Research Grants Management System (RGMS) has been modified so that when CIAs update their publication records, they can now link it to the relevant grant ID, and indicate whether the metadata of the publication has been deposited into an institutional repository. CIAs can also indicate whether the publication is freely available via an open access repository. CIs are encouraged to do this for all publications, not just those published since July 2012.

## What published outputs are NOT covered by the policy?

The revised policy does not apply to other published outcomes of the funded research such as books, book chapters, theses, and technical reports.

## If my publication is already freely available through the publisher or another repository (e.g. PubMed Central), will I need to deposit a copy in my institutional repository?

No. However, you must deposit the publication metadata and affiliated NHMRC Grant ID in your institutional repository.

## What if I am unable to make the article available within 12 months, due to legal obligations?

NHMRC understands that in some instances researchers may not be able to meet the new requirements because of legal or contractual obligations. CIAs should make this clear to NHMRC when reporting on their grants. NHMRC does not require that your publication be made available via a journal's proprietary or paid 'Open Access' program.

## What manuscript versions are acceptable under the policy?

Both the author's version of the article (as accepted by the journal after peer-review, with revisions having been made) and the publisher's version (e.g. journal version with final pagination and formatting) are acceptable under this policy.

Journals may have different policies regarding which version of a manuscript or article can be made available, and the timing of this availability. The CIA should work with their institutional repository manager, library staff or research office to determine the options available to them that allow compliance with the policy. A comprehensive list of open access repositories at Australian institutions is available via the Australian Open Access Support Group (AOASG) website.

## How does NHMRC's policy compare with the Australian Research Council's new policy?

NHMRC and ARC's policies are substantially comparable. The ARC policy came into effect in January 2013, and applies to grants received in 2013 (commencing 2014), with the first publications not expected to be made available through institutional repositories or in another open access format until after January 2014. The NHMRC policy was implemented in July 2012 with publications being made available through the relevant institutional repositories or another open access format from July 2013. The ARC policy is available on the ARC website.

The AOASG has published a comparison of the two agencies policies on the AOASG website.

## Does the University grants management system meet the criteria for an institutional repository?

The key requirement of an institutional repository is that it be publicly and freely available, and include the metadata and/or the pre-print, post-print or the journal version of the article. Your system administrator may be able to advise on whether your grants management system meets this requirement.

## Is compliance with the NHMRC Open Access Policy a condition of the NHMRC grant?

Yes, all recipients of NHMRC grants must comply with the NHMRC Open Access Policy, as outlined in Section A of NHMRC Funding Rules.

## If an article is not able to be made available through an IR or in another open access format, will it affect the applicant's peer review score?

No. The inability of applicants to make their publication available through an IR or in another open access format will not affect their scores during the peer review process. If you are unable to fulfil this requirement, you should provide a reason (e.g. legal/contractual limitations) in RGMS.

## If an article is not able to be made available through an institutional repository or in another open access format, will it affect the applicant's eligibility?

No. If you are unable to fulfil this requirement, you should provide a reason (e.g. legal/contractual limitations) in RGMS.

## If the field on 'Related NHMRC Grants' affiliated to a publication is not provided, will the applicant's eligibility be affected?

No. However, NHMRC encourages all researchers to link relevant publications with NHMRC Grant IDs to assist in reporting and peer-review in the future.

### Can Article Processing Charges be paid from Direct Research Costs?

Yes, under the Principles-based NHMRC Direct Research Costs Guidelines, "NHMRC funds can only be used for reasonable publication costs where the publication has occurred as the result of the approved Research Activity". The guideline can be accessed in the NHMRC Direct Research Costs Guidelines (PDF, 45KB)

### Who is responsible for ensuring that a copy of the publication is made open access (and in which repository), if the CIA is not an author on the paper?

The CIA must ensure that NHMRC's Open Access Policy is complied with. However, the publication need only be deposited in **one** open access repository and/or made available in another open access format, and need not necessarily be in the institutional repository of the CIA's institution. This is to ensure that access to the publication is made available through at least one avenue.

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## Guide for Authors

### Where the research described in the publication is funded (entirely or in part) by NHMRC:

1. The author(s) decides which journal they wish to submit their paper to. Note that:

    NHMRC's Policy **does not** require authors to take a particular route to publication (Green or Gold). It is the author's choice as to which particular journal they think best suits their article. Compliance does not require publications to be available via a Journal's proprietary or paid 'Open Access' program.

2. The CIA should contact their institutional repository manager, library or research office to obtain instructions on how to deposit the publication and/or the publication metadata in the institutional repository, as institutional practices may vary from one institution to the next. If the administering institution does not have an institutional repository, then:

    One of the other CIs can lodge in their institution's repository; or

    Administering institutions that don't have an IR may be able to negotiate with an affiliated university for access on behalf of their researchers.

3. The timing of submission should be as advised by the institutional repository manager or library. The institutional repository manager will ensure that the appropriate version of the publication will be made available via the institutional repository at the first available date.

    Note that the publication date is the official date of publication, not the date that the article first appears online (e.g. e-pub ahead of print).

    The institutional repository should make the publication metadata immediately available to the public upon publication.

    The institutional repository should make the publication and the relevant metadata available to the public within 12 months of this official date of publication where legally possible.

4. Once the submitted paper is accepted for publication in a peer reviewed journal, the CIA of the grant is required to comply with the following:

    If the publication is freely available to the public via the journal website, only the metadata and the link to the publication need to be provided to the institutional repository, and both must be made immediately available in the institutional repository.

    If the journal allows the author to make the accepted version of the publication available in an institutional repository within 12 months, the metadata and accepted version can be submitted to the IR, with the publication metadata being made immediately available and the publication itself being made available as soon as the embargo permits.

    If the researcher has made the work available in a subject repository (e.g. PubMed Central), the author can make the metadata available through the institutional repository with a link to the open access version in the subject repository.

    If the journal does NOT allow any version of the publication to be made available in an institutional repository, the publication metadata should be submitted to the institutional repository, and the CIA should provide a reason in RGMS for non-compliance with the NHMRC dissemination policy.

5. The CIA should ensure that their RGMS CV/profile publication data has been updated to reflect the following publication details:

    the basic publication metadata - author/s, title, journal name, date etc; submitted via the normal process of adding publications to a CV.

    the grant ID of the relevant NHMRC grant(s) that contributed to the research described in the publication should be appended to the publication data.

    if the publication is available to the public via the institutional repository or another open access format, the checkbox indicating this should be completed.

6. The National Library of Australia currently harvests metadata from most IRs into its central TROVE database that is

freely accessible.

## Further background information

Further background on the development of this revised policy can be found at:

- Revised Policy on Dissemination of Research Findings – February 2014 (PDF, 5.33MB)
- Revised Policy on Dissemination of Research Findings - 22 February, 2012 (PDF, 1.0MB)
- Previous Policy on Dissemination of Research Findings (PDF, 1.35MB)

Page last updated on 9 December 2014

Appendix D: NHMRC open access policy: Key updates 20 November 2014

## NHMRC Open Access Policy: Key updates 20 November 2014

| ITEM | 1ST FEBRUARY 2014 | UPDATED 20TH NOVEMBER 2014 |
|---|---|---|
| Policy statement | NHMRC requires that any publication arising from NHMRC supported research must be deposited into an open access institutional repository within a twelve month period from the date of publication. | NHMRC requires that any publication arising from NHMRC supported research must be deposited into an open access institutional repository and/or made available in another open access formatwithin a twelve month period from the date of publication. |
| CIA's responsibility | • Submission of metadata to institutional repository<br>• Submission of NHMRC Grant ID to institutional repository<br>• Submission of a copy of the | • Submission of metadata to institutional repository<br>• Submission of NHMRC Grant ID to institutional repository<br>• Submission of a copy of the publication to |

| ITEM | 1ST FEBRUARY 2014 | UPDATED 20TH NOVEMBER 2014 |
|---|---|---|
| | publication to the institutional repository. | the institutional repository if an open access version is not already available elsewhere (e.g. PubMed Central, publisher website). |
| RGMS | CIA may indicate if their publication has been deposited into an institutional repository. | • CIA may indicate if their publication metadata has been deposited into an institutional repository.<br>• CIA may also indicate whether the publication is freely available via an open access repository. |
| If my publication is already freely available through the publisher or another repository (e.g. PubMed | N/A | No. However, you must deposit the publication metadata and affiliated NHMRC Grant ID in your institutional repository. |

| ITEM | 1ST FEBRUARY 2014 | UPDATED 20TH NOVEMBER 2014 |
|---|---|---|
| Central), will I need to deposit a copy in my institutional repository? | | |
| Is compliance with the NHMRC Open Access Policy a condition of the NHMRC grant? | N/A | Yes, all recipients of NHMRC grants must comply with the NHMRC Open Access Policy, as outlined in Section A of NHMRC Funding Rules. |
| Can Article Processing Charges be paid from Direct Research Costs? | N/A | Yes, under the Principles-based NHMRC Direct Research Costs Guidelines, "NHMRC funds can only be used for reasonable publication costs where the publication has occurred as the result of the approved Research Activity" |

| ITEM | 1ST FEBRUARY 2014 | UPDATED 20TH NOVEMBER 2014 |
|---|---|---|
| Who is responsible for ensuring that a copy of the publication is made open access (and in which repository), if the CIA is not an author on the paper? | N/A | The CIA must ensure that NHMRC's Open Access Policy is complied with. However, the publication needs only be deposited in one open access repository and/or made available in another open access format, and need not necessarily be in the institutional repository of the CIA's institution. |
| Metadata management by institutional repository | N/A | The institutional repository should make the publication metadata immediately available to the public upon publication. |

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## Appendix E: Glossary

**Article processing charge or articles publication charge (APC):** A fee paid to the publisher, usually by the author, author's institution, or funder), to make a publication available in open access.

**Australasian Open Access Strategy Group (AOASG):** The Australasian Open Access Strategy Group was launched in October 2012 with the aims to provide advice and information to all practitioners in the area of open access (Kingsley, 2013, November 21).

**Author accepted manuscript**: Also known as the **postprint**, the author accepted manuscript is the author's version of the publication as accepted after peer review and revisions and is usually the final version of the publication before publication.

**Bibliometrics:** Originally defined as the "application of mathematical and statistical methods to books and other media of communication" (Pritchard, 1969, p. 348), a more encompassing definition is a "sub-field of information science that deals with the quantitative analysis of scientific and technological literature" (De Bellis, 2009, p. xi).

**BOAI: Budapest Open Access Initiative**. The first formal statement defining scholarly open access developed by the Open Society Institute in Budapest, Hungary, and published on 14 February 2002 (BOAI, 2002), minor reviews of which occurred in 2012 (BOAI, 2012) and 2017 (BOAI, 2017).

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**CC BY-SA (Attribution-ShareAlike):** Licence permitting others to build upon a work even for commercial purposes, as long as they credit the author(s) and licence their new creations under identical terms (Creative Commons, 2017).

**Creative Commons:** A non-profit organisation that supports the legal and technical infrastructure, including a suite of licensing products, to enable the sharing of digital outputs.

**Delayed open access:** An OA model with embargo periods used by membership subscription journals published by society publishers that provides immediate access to members with non-members gaining access after a delayed period.

**Directory of Open Access Repositories (OpenDOAR):** OpenDOAR is a quality-controlled, authoritative directory of academic open access repositories providing statistics and content information (see http://www.opendoar.org).

**Directory of Open Access Journals (DOAJ):** DOAJ is a directory that indexes fully open access peer-reviewed journals (see https://doaj.org).

**Digital Object Identifier (DOI):** The DOI is the unique digital identification that identifies digital objects of any type including journal articles or open source software.

**Double-dipping:** Double-dipping occurs when there is an article processing charge (APC) for OA publishing, as well as a subscription fee, making the institution or author pay twice for access.

**Embargo period**: In scholarly publishing, the embargo period is the length of time imposed by publishers before the publication is open access either on the publishers' website or in an institutional or subject repository or website.

**Gold Open Access:** Gold OA refers to the approach or route to scholarly OA by publishing OA in scholarly publications such as OA articles in journals, OA book chapters or books, and OA papers in conference proceedings.

**Gratis Open Access:** Gratis OA publications are online and free of charge but do not extend reuse rights beyond that permitted by copyright legislation.

**Green Open Access:** Green OA refers to the approach or route to scholarly OA by depositing OA versions in repositories and websites.

**Hybrid Subscription Journal:** Hybrid subscription journal offer optional or hybrid OA for individual articles upon payment of an Article Processing Charge (APC), while the remainder of the journal is only accessible by individuals and institutions with subscriptions.

**Institutional Repository (IR):** An institutional repository hosted by an institution, with OA content that is publicly accessible.

**Open Access Mandate (of Policy):** An OA Mandate or policy is a requirement by an institution, funding agency, or government body that published research be available in an open access format and may include additional requirements regarding reuse.

**Metadata:** The Australian National Data Service's definition of metadata which is "information about an object or resource that describes characteristics such as content, quality, format, location and contact information" (Australian National Data Service, 2016, p. 2).

**Open Access Journals (OAJDs):** Open access journals are journals listed in the **Directory of Open Access Journals** and in which all content is OA.

**Partial Open Access:** Partial open access journals are mostly professional or society journals in which selected content is freely available either upon publication or after specified embargo periods, sometimes requiring user registration for non-members or non-subscribers.

**Postprint:** See **Author Accepted Manuscript**.

**Preprint:** The preprint is the version of an author(s) manuscript submitted to a journal or other publication that has not been through the publisher's peer-review process.

**Public access:** Public access describes a variety of materials that are free to read online, these resources may not necessarily include the right to reuse. See also **Gratis Open Access**.

**PubMed:** PubMed is a free resource that is developed and maintained by the National Center for Biotechnology Information (NCBI), at the U.S. National Library of Medicine (NLM) and based on the MEDLINE database of references and abstracts on life sciences and biomedical topics (see https://www.ncbi.nlm.nih.gov).

**PubMed Central (PMC):** PubMed Central is a free archive of biomedical and life sciences journal literature at the U.S. National Institutes of Health's National Library of Medicine (NIH/NLM) and is the repository specified as by the NLM's legislative mandate to collect and preserve the biomedical literature (see https://www.ncbi.nlm.nih.gov/pmc/).

**RoMEO (Rights Metadata for Open Archiving):** A database of publishers' policies widely used to determine the archiving policies of publishers and administered by SHERPA Services at the University of Nottingham (see http://www.sherpa.ac.uk/romeo/).

**Scholarly collaboration network (SCNs):** Scholarly collaboration networks (SCNs) are platforms that allow researchers to develop and maintain professional relationships.

**Self-archiving: Self-archiving involves** making a copy of a manuscript available through a personal website, institutional repository, or another repository.

**SHERPA (Securing a Hybrid Environment for Research Preservation and Access):** SHERPA was part of the JISC FAIR (Focus on Access to Institutional Resources) Programme, and while a completed project, its work has been continued by the SHERPA/RoMEO online resource (see http://www.sherpa.ac.uk/repositories/sherpasearch.html).

**Subject repository:** A subject repository is an online database that collects and preserves the intellectual digital output within a discipline or subject. The best known are PubMed Central (PMC), specific to medicine, and arXiv covering the discipline of physics.

**Subscription journal:** A journal publishing model supported by subscriptions paid by individuals, institutions, or members.

# Appendix F: List of Australian Open Access Repositories (AOASG https://aoasg.org.au)

| Institution | Repository link | Software |
|---|---|---|
| Australian Catholic University | ACU Research Bank | Digital Commons. |
| Australian Institute of Family Studies | AIFS Publications | |
| Australian Institute of Health and Welfare | AIHW publications | |
| Australian Institute of Marine Science | AIMS Research Repository | DSpace |
| Australian National University | ANU Research Repository | DSpace |
| Australian Nuclear Science and Technology Organisation | ANSTO Publications Online | DSpace |
| Analysis & Policy Observatory | Analysis & Policy Observatory | |
| Baker IDI Heart and Diabetes Institute | Baker IDI Research Online | DSpace |
| Ballarat Health Services | Ballarat Health Services Digital Repository | DSpace |
| Bond University | epublications@bond | Digital Commons |
| Central Queensland University | ACQUIRE | Vital |
| Charles Darwin University | CDU eSpace | Fez |
| Charles Sturt University | CSU Research Output | DigiTool |
| CSIRO | Research Publications Repository | DigiTool |
| Curtin University | espace | DSpace |
| Dairy Australia | Research Reports repository | |
| Deakin University | Deakin Research Online | Fez |
| Edith Cowan University | Research Online | Digital Commons |
| Federation University Australia | FedUni ResearchOnline | Vital |
| Flinders University | Flinders Academic Commons (FAC) | DSpace |
| Great Barrier Reef Marine Park Authority | GBRMPA eLibrary | DSpace |
| Griffith University | Griffith Research Online | DSpace |
| James Cook University | ResearchOnline@JCU | ePrints |
| LaTrobe University | LaTrobe University Institutional Research Repository | Vital |
| Macquarie University | Macquarie University ResearchOnline | Vital |
| Monash University | Monash University Research Repository | Vital |
| Moore College | Myrrh – The Moore Institutional Repository | DSpace |
| Murdoch University | Murdoch Research Repository | ePrints |
| Northern Territory Department of Families and Health Services | NT Health Digital Library | DSpace |
| Queensland Department of Agriculture, Fisheries and Forestry | eResearch Archive (eRA) | ePrints |
| Queensland University of Technology | QUT ePrints | ePrints |
| RMIT University | Research Repository | Fez |
| Southern Cross University | ePublications@SCU | Digital Commons |
| Swinburne University of Technology | Swinburne Research Bank | Equella |

| Institution | Repository link | Software |
|---|---|---|
| University of Adelaide | Adelaide Research & Scholarship | DSpace |
| University of Canberra | UC Research Repository | Equella |
| University of Melbourne | Minerva Access | DSpace |
| University of Newcastle | NOVA | Vital |
| University of New England | e-publications@UNE | Vital |
| University of New South Wales | UNSWorks | Primo |
| University of Notre Dame | ResearchOnline@ND | Digital Commons |
| University of Queensland | UQ eSpace | Fez |
| University of South Australia | Research Outputs Repository | Primo |
| University of Southern Queensland | USQ ePrints | ePrints |
| University of the Sunshine Coast | USC Research Bank | Vital |
| University of Sydney | Sydney eScholarship Repository | DSpace |
| University of Tasmania | UTAS ePrints | ePrints |
| University of Tasmania | UTas eCite | in-house software |
| University of Technology, Sydney | OPUS | DSpace |
| University of Western Australia | UWA Research Repository | Pure |
| University of Western Sydney | UWS Research Repository | Vital |
| University of Wollongong | Research Online | Digital Commons |
| Victoria University | Victoria University Institutional Repository (VUIR) | ePrints |

# Appendix G: NHMRC Approved Administering Institutions (NHMRC https://www.nhmrc.gov.au)

| Entity name |
|---|
| Anzac Research Institute |
| Australian Catholic University Limited |
| Australian Centre for Heart Health |
| Australian Hearing |
| Australian Institute of Aboriginal and Torres Strait Islander Studies |
| Australian National University |
| Baker IDI Heart and Diabetes Institute Holdings Limited |
| Bond University Limited |
| Burnet Institute |
| Cancer Council NSW |
| Cancer Council Queensland |
| Cancer Council Victoria |
| Centenary Institute of Cancer Medicine and Cell Biology |
| Central Adelaide Local Health Network Incorporated, trading as The Queen Elizabeth Hospital |
| Central Queensland University |
| Centre for Eye Research Australia Limited |
| Charles Darwin University |
| Charles Sturt University |
| Children's Medical Research Institute |
| Commonwealth, Scientific and Industrial Research Organisation (CSIRO) |
| Curtin University of Technology |
| Deakin University |
| Ear Science Institute Australia Incorporated |
| Edith Cowan University |
| Federation University Australia |
| Florey Institute of Neuroscience and Mental Health |
| Griffith University |
| Health Support Queensland |
| Institute for Breathing and Sleep |
| James Cook University |
| La Trobe University |
| Macquarie University |
| Mater Medical Research Institute Limited |
| Melbourne Health |
| Menzies School of Health Research |
| Metro North Hospital and Health Service, The Prince Charles Hospital |
| Metro South Hospital and Health Service, Princess Alexandra Hospital |
| Monash University |
| Murdoch Childrens Research Institute |
| Murdoch University |
| National Ageing Research Institute |
| National Institute for Aboriginal and Torres Strait Islander Health Research Limited |
| Peninsula Health |
| Queensland University of Technology |
| RMIT University |
| Royal Brisbane and Women's Hospital Foundation |
| South Australian Health and Medical Research Institute Limited |
| Southern Cross University |
| St. Vincent's Institute of Medical Research |
| Swinburne University of Technology |
| Sydney Local Health District |
| The Asbestos Diseases Research Institute |
| The Bionics Institute of Australia |
| The Council of the Queensland Institute of Medical Research |
| The Flinders University of South Australia |
| The Garvan Institute of Medical Research |

| Entity name |
| --- |
| The George Institute for Global Health |
| The Heart Research Institute Ltd |
| The Sax Institute |
| The University of Adelaide |
| The University of New England |
| The University of Newcastle |
| The University of Notre Dame Australia |
| The University of Queensland |
| The University of Wollongong |
| The Walter and Eliza Hall Institute of Medical Research |
| Trans Tasman Radiation Oncology Group Limited |
| University of Canberra |
| University of Melbourne |
| University of New South Wales |
| University of South Australia |
| University of Southern Queensland |
| University of Sydney |
| University of Tasmania |
| University of Technology Sydney |
| University of the Sunshine Coast |
| University of Western Australia |
| University of Western Sydney |
| Victor Chang Cardiac Research Institute Limited |
| Victoria University |
| Western Sydney Local Health District |
| Woolcock Institute of Medical Research Limited |