Article processing charges and fully open access journals: National Health and Medical Research Council funded articles

Noreen Kirkman
Independent researcher
Noreen.kirkman@gmail.com | https://orcid.org/0000-0003-1006-0210

Noreen Kirkman graduated with a Master of Philosophy from Curtin University in 2020, the topic of her thesis covering compliance under the National Health and Medical Research Council's Open Access Policy.

Acknowledgements: Dr Andrew Duncan assisted with the currency standardisation of article processing charges.
Conflict of Interest: The author has no conflicts of interest.
Funding Source: The author received no financial support for the research or publication of this article.

Abstract

Introduction: The National Health and Medical Research Council, Australia's largest medical research funder, mandates open access for journal articles published from funded research. Publishing articles in fully open access journals is an acceptable route to achieve compliance. However, the total cost of article processing charges and the extent to which Council funds contribute to payment are unknown.

Objectives: The main objectives of this study were to calculate the cost of article processing charges and determine the extent of acknowledgement of payment for Council-funded articles published in fully open access journals during 2019.

Methods: The funding acknowledgement fields of Web of Science provided the list of Council-funded articles. The Directory of Open Access Journals identified fully open access journal titles and their article processing charges. Data analysis involved bibliometric research methods, principally descriptive statistics.

Results: The cost of article processing charges for 2,261 articles published in 2019 was over US$5,000,000. Charges ranged from zero to US$5,200, with the median being US$1,900. The acknowledgement of payment of article processing charges was extremely low (1.72%).

Discussion: The insufficient acknowledgement of the considerable expenditure on article processing charges is concerning. The "Australian Code for the Responsible Conduct of Research" underscores the principles of transparency in declaring interests. Required is greater disclosure of expenditure on article processing charges and accountability for public-funded research.

Conclusion: The disclosure of article processing charge payments should be mandated by the Council and included in the publication metadata deposited in repositories under the National Health and Medical Research Council's Open Access Policy. Acknowledgements and disclosures are essential in recognising professional contributions and ensuring the responsible conduct of research.

Introduction

The National Health and Medical Research Council (NHMRC) is an Australian Government agency responsible for coordinating health and medical research funding. Expenditure on over 612 grants under the 2021 NHMRC Grant Application Round amounted to A$913 million (NHMRC, 2021, November 10). The Council promotes ethical conduct and integrity in research through the "Australian Code for the Responsible Conduct of Research". The Council also recognises the importance of providing access to publicly funded research through the NHMRC Open Access (OA) Policy (NHMRC, 2018b; NHMRC, 2020, April). The policy requires peer-reviewed journal articles and conference papers resulting from the Council's funding to be OA within 12 months of publication. Compliance with the NHMRC Policy is achievable by publishing OA articles in journals in hybrid subscription, delayed access, and fully OA journals. For authors of non-OA articles, the deposit of accepted manuscripts in repositories (known as green OA) is an accepted route.

This study focuses on NHMRC-funded articles published in fully OA journals, also known as gold OA. The source for the identification of fully OA journals is the Directory of Open Access Journals (DOAJ) (https://doaj.org). All journal titles are freely and immediately OA accessible under open licences. Although many fully OA journals do not charge fees (Morrison, 2018; Morrison et al., 2021; Morrison et al., 2015; Solomon & Björk, 2012), Crawford (2020, 2021) found that two-thirds of articles in fully OA journals had article processing charges (APCs). The cost of APCs is a crucial consideration for authors in deciding whether to publish OA.

The average APC for publishing in a fully OA journal was US$1,023 in 2019 but increased to US$1,203 in 2020 (Crawford, 2020, 2021). APC-based OA is one of the characteristics of mega-journals, along with large volume, broad scope, and soundness-based peer review (Björk, 2015). Many mega-journals have competitive APCs to achieve economic market share: for example, the charge for Nature's *Scientific Reports* is marginally lower than for *PLOS ONE* (Alencar & Barbosa, 2021; Khoo, 2019). Some publishers have re-submission policies for manuscripts submitted to selective titles that default to broad scope journals. BMJ's policy identifies *BMJ Open* as the journal for the automatic reconsideration of re-submitted articles (Björk, 2015). BMC has a similar policy associated with its subject-specific titles (Spezi et al., 2017).

Some journals converted from the subscription model have low APCs, as in the case of Wolters Kluwer's *Medicine* (2017). However, Khoo (2019), Crawford (2016, 2020), Shi and Morrison (2020) identified the steady increase in the cost of APCs to publish in journal titles published by BioMed Central (BMC), Frontiers Media, Multidisciplinary Digital Publishing Institute (MDPI), and Hindawi. The entry of subscription journal publishers into fully OA journal publishing has also been of concern (Morrison, 2017; Solomon & Björk, 2016), including Holtzbrinck Publishing Group's acquisition of Springer and BMC (Shi & Morrison, 2020).

BMC was among the first commercial OA publishers and one of the earliest publishers to introduce a membership program providing APC discounts (BioMed Central, 2019, February 17). MDPI's Institutional Open Access Program also facilitates APC discounts for articles published in MDPI journals (Korolev, 2020; MDPI, 2018, December 23), with Frontiers Media offering discounts under institutional memberships (Frontiers, 2019, January 27). Some journal publishers offer waivers for authors of identified countries, while others provide discounts to member institutions. While lower APCs are incentives, Vervoort et al. (2021) warned that discount programs influence authors' decision-making.

Some funders in medicine and health allow grants or additional funding to pay for APCs (Solomon & Björk, 2012; Wang et al., 2015). However, research funding in some clinical fields, such as primary care and public health, is often inadequate to cover the cost (Ellingson et al., 2021; Nicholas et al., 2017; Solomon & Björk, 2012; Wang et al., 2015). Grants sometimes favour experienced researchers over early-career or junior researchers (Nicholas et al., 2017). Ellingson et al. (2021) identified differences between researchers in clinical medicine. General researchers published more in fully OA journals with no or lower APCs, while high-impact authors paid higher APCs and published to a greater extent in hybrid subscription journals (Ellingson et al., 2021).

Funder OA policies contributed to growth in OA but not all provide clear advice on APCs. The Wellcome Trust was one of the first funders to mandate OA (Pinfield, 2015; Pinfield et al., 2017) and accommodates reasonable APCs for grant-holders to publish in fully OA journals (Wellcome Trust, 2021). In cases involving multiple funders, the Trust recommends splitting costs relative to funders' contributions. Under the United Kingdom Research and Research OA Policy (UK Research and Innovation, 2021), OA block grants available through research councils provide assistance to pay for APCs to publish in fully OA journals (UK Research and Innovation, 2021, August 31). However, some funding agencies do not fund APCs (Earney, 2017).

According to the NHMRC Direct Research Costs Guidelines, grants cover research, not publication costs, although funds may become available over the project's lifetime (NHMRC, 2017, 2019). The Council OA Policy mandates the

acknowledgement of NHMRC funding in publication metadata but does not specify the disclosure of APC payments (NHMRC, 2020, April). Previous research found that 20.85% of Council-funded articles published during 2013-2014 were in fully OA journals (Kirkman, 2018; Kirkman & Haddow, 2020).

Many NHMRC grant recipients are also members of universities, research institutes and hospitals, and may have access to institutional funds or membership discounts for APCs. However, the Council of Australian University Librarians (CAUL) and the Council of New Zealand University Librarians (CONZUL) identified the lack of information at the institutional level about APC payments (Cramond et al., 2019). CAUL's (2018) submission to the Australian Government's Inquiry into Funding Australia's Research Response questioned the contribution of Australian funders with OA policies, such as the NHMRC, to the payment of APCs.

The literature revealed the gap in information about the total costs of APCs despite funders mandating OA. Australia's largest funder, the NHMRC, has an OA Policy but the Council's contribution to APC payment is unknown. This study investigated the cost of APCs to publish Council-funded articles in fully OA journals and the extent to which the Council contributed to APC payments for OA mandated by the Council's policy.

Objectives and Research Questions

The initial objectives were to determine the extent to which fully OA journals in this study had APCs and calculate the cost. Further objectives aimed to identify the APCs of core journal titles and uncover the degree of disclosure of APC payments. The following research questions guided the research. Of articles entirely and partially funded by the NHMRC and published in fully OA journals during 2019:

- What were the number and proportion of articles and journal titles with APCs?
- What were the total, range, and median costs of the APCs?
- What were the core journal titles, subject focus, and publishers?
- What was the extent of APC acknowledgement?

Methods

Centralised collections proved useful in international studies, but the lack of central management of APC data in Australia made similar investigations difficult (Pieper & Broschinski, 2018; Shamash, 2016, October 26; Wakeling et al., 2021; Woodward et al., 2014). Relevant to this investigation were studies into the APCs of fully OA journals using data provided by the DOAJ (Crawford, 2016, 2018, 2020, 2021; Ellingson et al., 2021; Khoo, 2019; Wang et al., 2015). Other studies into APCs gathered data from journal websites (Ellingson et al., 2021) or through Unpaywall (https://unpaywall.org) (Cramond et al., 2019).

For this study, Web of Science (WoS) was the source of NHMRC-funded articles: the search strategy combining the funding acknowledgement information for variations

of "National Health and Medical Research Council" and the publication year 2019. The search output downloaded to Microsoft Excel in early 2020 formed the master spreadsheet, with all articles verified as receiving funding from the NHMRC. The DOAJ identified the required journal titles: a separate spreadsheet of articles in fully OA journals created for data collection and analysis. The dataset included the funding acknowledgement and Web of Science Category (WC) fields, the latter mapped to the Australian and New Zealand Standard Research Classification (ANZSRC) fields of research (FoR) as used by the NHMRC bibliometric report (NHMRC, 2018a).

The download of APC information on a specific date (1 May 2020) was necessary to ensure consistency. As most APCs were in United States dollars (US$), the standardisation to this currency enabled analysis. Amounts were those derived from direct conversion with rounding not used. Publishers' websites from late December 2018 and early 2019 were the sources for data on membership programs offering APC discounts.

Bibliometric analysis used descriptive statistics to analyse APC and other data relating to the articles and journal titles. The tallying of data enabled the calculation of the total cost of APCs, the mean (average), and the median (middle) APC. While the average APC is suitable for a normal distribution, the median APC is less likely to skew results for long-tail distributions with very high and low APCs. Data analysis included the examination of the funding acknowledgement fields for disclosures of APC payment. The categorisation of articles into fully NHMRC-funded and those with multiple funders enabled further analysis of the distribution of APC payments.

Results

Articles and journal titles with article processing charges

The number of NHMRC-funded articles published in full OA journals in 2019 was 2,261 (representing 29.9% of 7,562 articles supported by the Council in that year) and published in 331 journal titles. Table 1 presents the actual numbers of journal titles and articles with or without APCs. The results demonstrated that over 98% of articles were APC funded OA. Over 95% of the journals had APCs, with article volumes varying from journal to journal.

Table 1: Articles and Journal Titles with Article Processing Charges

Category	Articles (n)	Articles (%)	Journal Titles (n)	Journal Titles (%)
With APC	2,222	98.28	315	95.17
No APC	39	1.72	16	4.83
Totals	2,261	100.00	331	100.00

Total, range, and median costs of article processing charges

The total cost of the APCs was US$5,047,064.40. Of the article dataset, 39 had no charges, while 2,222 (over 98%) of articles had APCs ranging from US$271.80 to US$5,200. The average APC was US$2,232.23. The median was US$1,900. For a graphical representation of the range of APCs, see Figure 1.

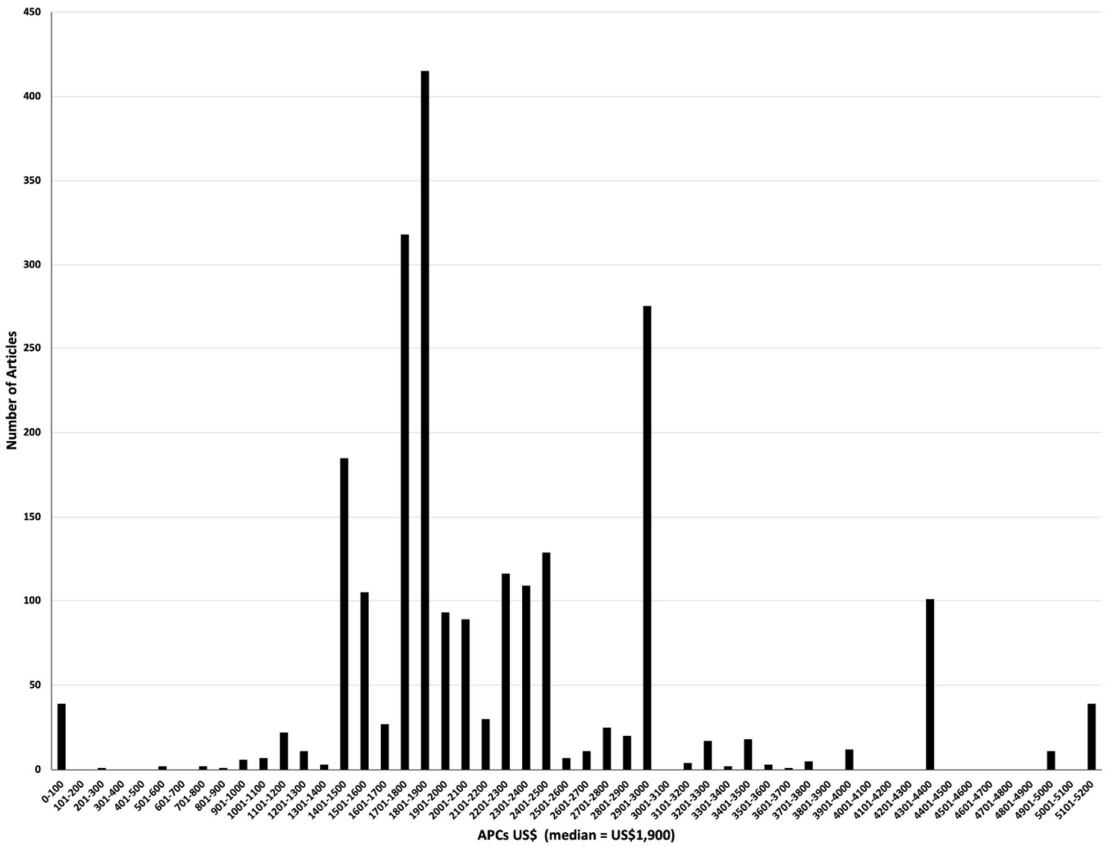

Figure 1: Range of Article Processing Charges for Articles in Fully Open Access Journals

Journals, fields of research, and publishers

Table 2 provides data for those titles with 20 or more articles: the number of journal titles precluded the tabulation of all journals. Journal titles with below-median APCs included *BMJ Open* (US$1,875), *Scientific Reports* (US$1,456.25) and *PLOS One* (US$1,595). Charges for publishing in most BMC journals were also below the median APC. Straddling the middle ground between the median and average APCs were four journals published by MDPI, the range being US$1,855 and US$2,268. The APC (US$2,950) for publishing in *Frontiers in Immunology* was above the average, with *Nature Communications* (US$4,362.50) and *Cell Reports* (US$5,200) having the highest charges, the former being the third most favoured journal in which authors published.

ANZSRC fields revealed the subject areas in which NHMRC grant recipients published. Journals with APCs below the median were mainly in the multidisciplinary

sciences and public health and health services. While there were above-median APCs for some journals within clinical sciences, this field included over 20 specialist sub-fields. Higher APCs were evident among journals within the fields of immunology and neurosciences. *Cell Reports* charged the highest APC within biochemistry and cell biology and this study.

Table 2: Journals, Article Processing Charges, Publishers, and Fields of Research

Journal Titles	Articles (n)	APC US$	Publisher	ANZSRC Fields of Research (*Non-standard)
BMJ Open	194	1,875.00	BMJ	General Medical and Health Sciences*
Scientific Reports	147	1,456.25	Nature	Multidisciplinary Sciences*
Nature Communications	101	4,362.50	Nature	Multidisciplinary Sciences*
PLOS ONE	95	1,595.00	PLOS	Multidisciplinary Sciences*
Frontiers in Immunology	76	2,950.00	Frontiers	Immunology
International Journal of Environmental Research and Public Health	57	2,371.13	MDPI	Public Health and Health Services
Nutrients	49	2,061.86	MDPI	Nutrition and Dietetics
International Journal of Molecular Sciences	48	1,855.67	MDPI	Biochemistry and Cell Biology
BMC Public Health	46	1,712.50	BMC	Public Health and Health Services
Cell Reports	39	5,200.00	Elsevier/Cell	Biochemistry and Cell Biology
BMC Health Services Research	26	1,712.50	BMC	Public Health and Health Services
Frontiers in Neuroscience	25	2,950.00	Frontiers	Neurosciences
eLife	24	2,500.00	eLife Sciences	General Biological Sciences*
Frontiers in Psychiatry	23	1,900.00	Frontiers	Clinical Sciences
Journal of Medical Internet Research	22	2,500.00	JMIR	Public Health and Health Services
PLOS Neglected Tropical Diseases	21	2,250.00	PLOS	Clinical Sciences
Journal of Clinical Medicine	20	2,268.04	MDPI	General Medical and Health Sciences*
Journal of the American Heart Association: Cardiovascular and Cerebrovascular Disease	20	2,000.00	Wiley for American Heart Association	Cardiovascular Medicine and Haematology

Presented in Table 3 are the results of the analysis of publishers with journals with four or more articles with data for publishers of journal titles with fewer articles or no APCs aggregated to facilitate tabulation. Publishers of journals with no APCs, including the Royal Society of Chemistry and the National Institute of Environmental Health Sciences, published 39 articles in 16 journals.

Eight publishers (Frontiers, BMC, Nature Publishing Group, MDPI, Elsevier, the BMJ Publishing Group, PLOS, and Wiley) published over 85% of articles in journals with APCs and amounting to over US$4,000,000. The average cost of APCs for the eight publishers was US$2,275: an amount higher than the average and median APC for articles in fully OA journals.

BMC, MDPI and Frontiers published 46.13% of the articles, their discount agreements probably contributing to the high level of publishing in their journals. Archived publishers' websites, dating from late 2018 and early 2019, provided data on the number of Australian institutions in membership programs. MDPI's (2018, December 23) program involved 16 institutions: ten universities and six organisations, including the Australasian College of Tropical Medicine. All associations/organisations had discounts between 15 and 25%, while most universities agreed to 10%. BMC (2019, February 17) had memberships with 13 Australian universities and the Royal North Shore Hospital Department of Radiation Oncology. In January 2019, one Australian university had a membership agreement with Frontiers (2019, January 27).

Table 3: Article Processing Charges by Publishers

Articles (n)	Journals (n)	APC (US$)	Publisher
442	90	803,161.14	BMC
309	29	819,430.00	Frontiers Media
292	38	577,216.51	MDPI
286	15	767,019.57	Nature Publishing Group
203	3	394,500.00	BMJ Publishing Group
164	7	317,825.00	Public Library of Science
116	22	437,911.91	Elsevier
115	25	266,752.87	Wiley
32	3	83,550.00	American Society for Microbiology
32	7	75,831.25	Oxford University Press
32	3	72,800.00	JMIR Publications
24	1	60,000.00	eLife Sciences Publications Ltd
18	1	54,000.00	JAMA Network
17	11	31,950.00	SAGE Publishing
17	3	31,450.00	Association for Research in Vision and Ophthalmology
13	7	28,622.00	Dove Medical Press
13	7	25,390.00	Hindawi Limited
12	1	48,000.00	American Association for the Advancement of Science
12	8	24,593.48	Taylor & Francis Group
10	1	11,950.00	PeerJ Inc.
9	1	16,875.00	Microbiology Society
6	4	12,895.00	Wolters Kluwer
6	2	9,477.12	Ivyspring International Publisher

Articles (n)	Journals (n)	APC (US$)	Publisher
4	1	12,000.00	Life Science Alliance
4	1	11,700.00	Society for Neuroscience
34	24	52,163.55	Publishers of journals with APCs (3 or less articles)
39	16	0.00	Publishers with no APCs
2261	331	5,047,064.40	

Acknowledgement of article processing charges

Acknowledgement statements are also sources of funding. However, only 25 articles (just over 1%) in this study disclosed APC payments. Of these articles, five acknowledged the NHMRC; one recognised the joint payment by the Council, the University of Newcastle, and the ARC; and another involved the NHMRC and the Walter and Eliza Hall Institute (WEHI). The ARC supported three APCs; WEHI financed another two, as did the Victor Chang Cardiac Research Institute. Australian and international universities and overseas research institutes funded the remainder of APC payments.

Owing to the low level of acknowledgements of APC payments, further categorisation summarised the cost of APCs by groups of funders (see Table 4). International funders with NHMRC grants funded almost one-third of the publications. More than two-thirds of the articles had financial support from funder collaborations between the Council and other Australian and New Zealand funders and a small number of scholarship-holders. While the relative contributions are unknown, the APC expenditure for journal articles funded by Australian funders was in the vicinity of over US$3,000,000.

The NHMRC was the only research funder for 430 articles (19%), three having no APC. Of the 427 articles with APCs, the total cost amounted to almost US$900,000, with an APC range of US$271.74 to US$5,200. The average APC was US$2,088. The median APC for the sub-set of NHMRC-only funded articles was US$1,875, comparable to the median APC of US$1,900 in the study.

Table 4: Council-funded Articles by Funder Collaborations

Funder Collaboration	APCs (US$)	Articles (n)	Articles (%)	APC Cited (n)	APC (US$)
No other funder	891,581.43	430	19.02	5	12,034.29
ARC	233,882.08	99	4.38	3	7,176.25
Scholarships	231,291.86	114	5.04	0	0.00
Australian & NZ (including commercial)	1,887,977.78	879	38.88	10	22,398.11
International (including commercial)	1,802,331.25	739	32.68	7	18,060.00
Totals	5,047,064.40	2,261	100.00	25	59,668.65

NHMRC-only funded articles provided an opportunity for further analysis using ANZSRC fields matched to APCs: the results are presented in Table 5. The area of public health and health services encompassed the broadest range of APCs from just over US$800 to US$5,000: the latter charge was for articles in *Lancet Global Health* and *Lancet Public Health*. A similar pattern existed for articles in biochemistry and cell biology journals, which included the highest APC in this study (US$5,200) for *Cell Reports*. The field of multidisciplinary sciences encompassed many journal titles with below-median APCs (such as *Scientific Reports* and *PLOS ONE*) and *Nature Communications* with one of the highest APCs in the investigation.

Table 5: Council-Only Funded Articles (n=430): Fields of Research and Article Processing Charges

Articles (n)	ANZSRC Fields of Research (*Non-standard)	Lowest APC (US$)	Highest APC (US$)
79	General Medical and Health Sciences*	1,875.00	3,500.00
61	Public Health and Health Services	815.22	5,000.00
60	Clinical Sciences	0.00	3,300.00
50	Multidisciplinary Sciences*	1,195.00	4,362.50
40	Biochemistry and Cell Biology	1,237.11	5,200.00
30	Immunology	0.00	3,000.00
18	Nutrition and Dietetics	1,787.50	2,062.50
15	Microbiology	1,855.67	3,300.00
12	Neurosciences	1,750.00	3,000.00
11	General Biological Sciences*	1,546.39	2,500.00
8	Pharmacology and Pharmaceutical Sciences	1,649.48	2,950.00
6	Cardiovascular Medicine and Haematology	1,712.50	2,000.00
6	Genetics	1,875.00	3,200.00
6	Oncology and Carcinogenesis	1,712.50	2,430.00
6	Optometry and Ophthalmology	1,850.00	1,850.00
6	Other Medical and Health Sciences	1,712.50	1,712.50
6	Paediatrics and Reproductive Medicine	1,030.93	2,490.00
4	Medical Physiology	2,950.00	2,950.00
2	Biomedical Engineering	1,855.67	1,855.67
2	Human Movement and Sports Science	271.74	1,739.13
1	Dentistry	1,712.50	1,712.50
1	Medical Biochemistry and Metabolomics	1,900.00	1,900.00

Discussion

The percentage of Council-funded articles published in fully OA journals in 2019 was 29.9%, a noteworthy increase compared to 20.85% recorded in a previous study on compliance with the NHMRC OA Policy (Kirkman, 2018; Kirkman & Haddow, 2020). Most journals had APCs, a high percentage (98%) of articles involved APC payment. The finding contrasts with extensive literature arguing that most fully OA journals

have no or negligible cost (Morrison, 2018; Morrison et al., 2021; Morrison et al., 2015; Solomon & Björk, 2012). In addition, the total expenditure on APCs was massive: over US$5,000,000 for a single year. Although APC discounts likely reduced this total, data collected from publishers' websites showed that universities and research centres did not universally embrace concessional membership programs.

Mega-journals were responsible for driving much of the growth in full OA. Many mega-journals had below-median APCs, high acceptance rates, and broad subject scope (Björk, 2018; Siler et al., 2020; Spezi et al., 2017; Wakeling et al., 2016). Nature's *Scientific Reports* directly competed with *PLOS ONE*: journals with multidisciplinary coverage and below-median APCs. The slightly lower APC of *Scientific Reports* probably contributed to the higher level of Council-funded articles during 2019 compared to *PLOS ONE* that was more popular among NHMRC grant recipients during 2013 and 2014 (Kirkman, 2018; Kirkman & Haddow, 2020).

Fully OA journals in medicine and health also contributed to the increase in full OA, with more Council-funded articles during 2019 in *BMJ Open* than *PLOS ONE* (Kirkman, 2018; Kirkman & Haddow, 2020). The popularity of *BMJ Open* among NHMRC grant recipients was primarily due to its relatively low APC and medical focus, but also due to BMJ's practice of automatic consideration of re-submitted articles in that journal (Björk, 2015). BMC, with its suite of journal titles with below-median APCs, also has a re-submission policy redirecting authors to other journals by the publisher (Spezi et al., 2017). However, the public health specialty of *BMC Public Health* and *BMC Health Services Research* was probably the chief factor for the relatively high publishing rates in these journal titles.

Despite many journals in this study having median or below-median APCs, journals with some subject specialisation tended to have above-median APCs. BMC, Frontiers Media and MDPI were the publishers of almost half of the journals in which Council-funded authors published (see Table 3) and included journal titles covering specialist subjects, such as BMC's *Breast Cancer Research*, *Frontiers in Immunology*, and MDPI's *Nutrients*. Khoo (2019), Crawford (2016, 2020), Shi and Morrison (2020) identified these publishers as responsible for the steady increase in the cost of APCs.

However, the highest APCs (between US$4,362.50 and US$5,200) were for reputable journals within public health and health sciences, biochemistry and cell biology, and the multidisciplinary sciences. The extensive global reach and impact of journals such as *Nature Communications*, the *Lancet Global Health*, the *Lancet Public Health*, and *Cell Reports* undoubtedly influenced many authors' decision-making to publish in these titles. Still, the capacity to pay higher APCs was also a major contributing factor. This finding confirmed Khoo's (2019) argument that high APCs are not obstacles for some authors.

The analysis by grant collaborations (see Table 4) found that one-third involved international funding agencies and organisations, some with policies supporting the payments of moderate APCs to publish in fully OA journals such as the Wellcome Trust (Wellcome Trust, 2021). Two-thirds of the articles obtained research funding from the NHMRC in partnership with Australian funders and a small number of New Zealand funding agencies and scholarship-holders, with an APC of over US$3,000,000. Yet very few articles (just over 1%) included disclosures of the source of APC payments, and fewer still acknowledged the Council as contributing to the cost.

The "Australian Code for the Responsible Conduct of Research" outlines the principles of responsible research conduct, including transparency in declaring interests to avoid conflict of interest and accountability in using public resources (NHMRC et al., 2018). According to *Disclosure of Interests and Management of Conflicts of Interest*, direct and indirect payments and publishing research require disclosure (NHMRC et al., 2019). The acknowledgement of APC payments should be a requirement in the publication metadata deposited in repositories as required under the Council's OA Policy.

The NHMRC mandates OA, but APC cost is a barrier to many authors' decisions to publish OA. In mandating OA, the NHMRC needs to have a clear statement on the payment of APCs to ensure greater compliance with its policy and ensure access to publicly funded research by the wider community and researchers. Reporting APC payments should be an essential part of publication acknowledgements and responsible conduct of research.

Limitations

The author acknowledges the limitations of Web of Science and recognises that other databases, such as Scopus, have funding acknowledgement fields with additional or different data. While the rationale for standardising APCs was to enable analysis, currency conversion based on daily exchange rates has inherent limitations. Time constraints precluded the systematic searching of acknowledgements in the publication metadata of repositories for information on APC payments. Time also prevented an in-depth investigation of publishers' APC discount programs and waiver policies.

Recommendations for Further Research

More comparative research into APCs is crucial for a greater understanding of the issues of OA, including authors' capacity to pay and the contribution of funders with OA mandates to support APC payment. Further investigations need to encompass APC disclosure within the context of codes of ethical research, and the use of grants to review. Additional studies are also necessary to assess the effect of transformative agreements on funders' assistance for APCs in fully OA journals (Borrego et al., 2020).

Conclusion

The benefits of publishing in fully OA journals include free, immediate, and unrestricted access to research by the wider community and researchers. However, the cost of APCs is a critical consideration in authors' decision-making to publish OA. In mandating OA, the Council needs to have a clear policy on the payment of APCs to ensure access to publicly funded research and greater compliance under the NHMRC OA Policy.

The "Australian Code for the Responsible Conduct of Research" outlines the principles of responsible research which include transparency and accountability for public resources. The disclosure of APC payments should be a requirement in the publication metadata deposited in repositories as required under the Council's OA Policy. Acknowledgements and disclosures are essential in recognising professional contributions, transparency, and accountability in the responsible conduct of research, especially in medicine and health.

References

Alencar, B. N., & Barbosa, M. C. (2021). Open access publications with article processing charge (APC) payment: A Brazilian scenario analysis. *Anais da Academia Brasileira de Ciências, 93*(4), e20201984. https://doi.org/10.1590/0001-3765202120201984

BioMed Central. (2019, February 17). *Membership*. https://web.archive.org/web/20190217143024/https://www.biomedcentral.com/about/institutional-support/membership

Björk, B.-C. (2015). Have the "mega-journals" reached the limits to growth? *PeerJ 3*(e981). https://doi.org/10.7717/peerj.981

Björk, B.-C. (2018). Publishing speed and acceptance rates of open access megajournals. *Online Information Review, 45*(2), 270-277. https://doi.org/10.1108/OIR-04-2018-0151

Borrego, Á., Anglada, L., & Abadal, E. (2020). Transformative agreements: Do they pave the way to open access? *Learned Publishing, 32*(2), 216-232. https://doi.org/10.1002/leap.1347

Council of Australian University Librarians. (2018). *Inquiry into Funding Australia's Research response*. CAUL. https://web.archive.org/web/20210328162228/https://www.caul.edu.au/sites/default/files/documents/gov-inqu/research-funding2018response.pdf

Cramond, S., Barnes, C., Lafferty, S., Barbour, V., Booth, D., Brown, K., Costello, D., Croker, K., O'Connor, R., Rolf, H., Ruthven, T., & Scholfield, S. (2019). *Fair, affordable and open access to knowledge: The CAUL Collection and Reporting of APC Information Project.* Shifting sands and rising tides: Leading libraries through innovation: 40th IATUL Conference, 23–27 June 2019, Perth, Western Australia. https://docs.lib.purdue.edu/iatul/2019/fair/2/

Crawford, W. (2016). *The gold OA landscape 2011–2014*. Cites & Insights Books.

Crawford, W. (2018). *Gold open access journals 2012-2017 (GOAJ3)*. https://figshare.com/articles/dataset/Gold_Open_Access_Journals_2012-2017_GOAJ3_/6429362/1

Crawford, W. (2020). *Gold open access 2014-2019: articles in journals (GOA5)*. Cites & Insights Books. https://waltcrawford.name/goa5.pdf

Crawford, W. (2021). *Gold open access 2015-2020: articles in journals (GOA6)*. Cites & Insights Books. https://waltcrawford.name/goa6.pdf

Earney, L. (2017). Offsetting and its discontents: Challenges and opportunities of open access offsetting agreements. *Insights, 30*(1). http://doi.org/10.1629/uksg.345

Ellingson, M. K., Shi, X., Skydel, J. J., Nyhan, K., Lehman, R., Ross, J. S., & Wallach, J. D. (2021). Publishing at any cost: A cross-sectional study of the amount that medical researchers spend on open access publishing each year. *BMJ Open, 11*(2), e047107. http://dx.doi.org/10.1136/bmjopen-2020-047107

Frontiers. (2019, January 27). *Institutional Membership*. https://web.archive.org/web/20190127130721/https://www.frontiersin.org/about/institutional-membership

Khoo, S. Y.-S. (2019). Article processing charge hyperinflation and price insensitivity: An open access sequel to the serials crisis. *LIBER Quarterly, 29*(1), 1-18. http://doi.org/10.18352/lq.10280

Kirkman, N. (2018). *A study of open access publishing by NHMRC grant recipients* [Master of Philosophy, Curtin University]. Perth. https://espace.curtin.edu.au/handle/20.500.11937/77026

Kirkman, N., & Haddow, G. (2020). Compliance with the first funder open access policy in Australia. *Information Research, 24*(4), paper 857. http://informationr.net/ir/25-2/paper857.html

Korolev, S. (2020). UWM publications in MDPI journals. *UWM Libraries Other Staff Publications, 14*. https://dc.uwm.edu/lib_staffart/14

MDPI. (2018, December 23). *Institutional Open Access Program (IOAP)*. https://web.archive.org/web/20181223212250/https://www.mdpi.com/about/ioap

Morrison, H. (2017). From the field: Elsevier as an open access publisher. *The Charleston Advisor, 18*(3), 53-59. https://doi.org/10.5260/chara.18.3.53

Morrison, H. (2018). *Global OA APCs 2010-2017: Major trends*. ELPUB 2018, Toronto, Canada. https://hal.archives-ouvertes.fr/hal-01816699/document

Morrison, H., Borges, L., Zhao, X., Kakou, T. L., & Shanbhoug, A. N. (2021). *Open access article processing charges 2011-2021*. http://hdl.handle.net/10393/42327

Morrison, H., Salhab, J., Calvé-Genest, A., & Horava, T. (2015). Open access article processing charges: DOAJ survey May 2014. *Publications, 3*(1), 1-16. https://doi.org/10.3390/publications3010001

National Health and Medical Research Council. (2017). *NHMRC direct research costs guidelines*. NHMRC. https://web.archive.org/web/20190413231911/https://www.nhmrc.gov.au/sites/default/files/documents/attachments/direct-researchrcostsrguidelinesraugustr2017.pdf

National Health and Medical Research Council. (2018a). *Measuring up 2018*. NHMRC. https://www.nhmrc.gov.au/about-us/publications/measuring-2018

National Health and Medical Research Council. (2018b). *Open access policy: November 2018*. NHMRC. https://web.archive.org/web/20210118010056/https://www.nhmrc.gov.au/about-us/resources/open-access-policy

National Health and Medical Research Council. (2019). *NHMRC direct research costs guidelines*. NHMRC. https://www.nhmrc.gov.au/funding/manage-your-funding/funding-agreement

National Health and Medical Research Council. (2020, April). *Open access policy November 2018: Minor changes to align with funding agreement requirements around research metadata*

https://web.archive.org/web/20210118010056/https://www.nhmrc.gov.au/about-us/resources/open-access-policy

National Health and Medical Research Council. (2021, November 10). *Outcomes of funding rounds*. https://web.archive.org/web/20211110195539/https://www.nhmrc.gov.au/funding/data-research/outcomes

National Health and Medical Research Council, Australian Research Council, & Universities Australia. (2018). *Australian code for the responsible conduct of research*. NHMRC. https://web.archive.org/web/20211023145343/https://www.nhmrc.gov.au/about-us/publications/australian-code-responsible-conduct-research-2018

National Health and Medical Research Council, Australian Research Council, & Universities Australia. (2019). *Disclosure of interests and management of conflicts of interest: A guide supporting the Australian code for the responsible conduct of research*. NHMRC. https://web.archive.org/web/20211023145343/https://www.nhmrc.gov.au/about-us/publications/australian-code-responsible-conduct-research-2018

Nicholas, D., Rodríguez-Bravo, B., Watkinson, A., Boukacem-Zeghmouri, C., Herman, E., Xu, J., Abrizah, A., & Świgoń, M. (2017). Early career researchers and their publishing and authorship practices. *Learned Publishing, 30*(3), 205-217. https://doi.org/10.1002/leap.1087

Pieper, D., & Broschinski, C. (2018). OpenAPC: a contribution to a transparent and reproducible monitoring of fee-based open access publishing across institutions and nations. *Insights, 31*. http://doi.org/10.1629/uksg.439

Pinfield, S. (2015). Making open access work: The "state-of-the-art" in providing open access to scholarly literature. *Online Information Review, 39*(5), 604-636. https://doi.org/10.1108/OIR-05-2015-0167

Pinfield, S., Salter, J., & Bath, P. A. (2017). A "Gold-centric" implementation of open access: Hybrid journals, the "total cost of publication," and policy development in the UK and beyond. *Journal of the Association for Information Science and Technology, 68*(9), 2248-2263. https://doi.org/10.1002/asi.23742

Shamash, K. (2016, October 26). The impact of article processing charges on libraries and what is being done to help. *Impact of Social Sciences Blog*. https://blogs.lse.ac.uk/impactofsocialsciences/2016/10/26/the-impact-of-article-processing-charges-on-libraries-and-what-is-being-done-to-help/

Shi, A., & Morrison, H. (2020). *BioMedCentral (BMC) 2019–2020*. DigitalCommons@University of Nebraska-Lincoln. https://digitalcommons.unl.edu/scholcom/155/

Siler, K., Larivière, V., & Sugimoto, C. R. (2020). The diverse niches of megajournals: Specialism within generalism. *Journal of the Association for Information Science and Technology, 71*(7), 800-816. https://doi.org/10.1002/asi.24299

Solomon, D. J., & Björk, B.-C. (2012). Publication fees in open access publishing: Sources of funding and factors influencing choice of journal. *Journal of the American Society for Information Science and Technology, 63*(1), 98-107. https://doi.org/10.1002/asi.21660

Solomon, D. J., & Björk, B.-C. (2016). Article processing charges for open access publication - the situation for research intensive universities in the USA and Canada. *PeerJ, 4*, e2264. https://doi.org/10.7717/peerj.2264

Spezi, V., Wakeling, S., Pinfield, S., Creaser, C., Fry, J., & Willett, P. (2017). Open-access mega-journals: The future of scholarly communication or academic dumping ground? A review. *Journal of Documentation, 73*(2), 263-283. https://doi.org/10.1108/JD-06-2016-0082

UK Research and Innovation. (2021). *UKRI open access policy*. UKRI. https://www.ukri.org/wp-content/uploads/2021/08/UKRI-180821-UKRIOpenAccessPolicy-2.pdf

UK Research and Innovation. (2021, August 31). *Publishing your research findings*. UKRI. https://web.archive.org/web/20211109014635/https://www.ukri.org/manage-your-award/publishing-your-research-findings/making-your-research-publications-open-access/

Vervoort, D., Luc, J. G., Sá, M. P. B., & Etchill, E. W. (2021). Open access and article processing charges in cardiology and cardiac surgery journals: a cross-sectional analysis. *Brazilian Journal of Cardiovascular Surgery, 36*, 453-460. https://doi.org/10.21470/1678-9741-2021-0289

Wakeling, S., Kingsley, D., Jamali, H., Kennan, M. A., & Sarrafzadeh, M. (2021). Free for all, or free-for-all? A content analysis of Australian university open access policies. *bioRxiv*. https://doi.org/10.1101/2021.08.20.457045

Wakeling, S., Willett, P., Creaser, C., Fry, J., Pinfield, S., & Spezi, V. (2016). Open-access mega-journals: A bibliometric profile. *PLOS ONE, 11*(11), e0165359. https://doi.org/10.1371/journal.pone.0165359

Wakeling, S., Willett, P., Creaser, C., Fry, J., Pinfield, S., & Spezi, V. (2017). Transitioning from a conventional to a 'mega'journal: A bibliometric case study of the journal medicine. *Publications, 5*(2), 7. https://doi.org/10.3390/publications5020007

Wang, L. L., Liu, X. Z., & Fang, H. (2015). Investigation of the degree to which articles supported by research grants are published in open access health and life sciences journals. *Scientometrics, 104*(2), 511-528. https://doi.org/10.1007/s11192-015-1624-4

Wellcome Trust. (2021). *Open access policy*. https://web.archive.org/web/20211111063143/https://wellcome.org/grant-funding/guidance/open-access-guidance/open-access-policy

Woodward, H., Henderson, H., & Lawson, S. (2014). Report for Jisc collections on Total Cost of Ownership Project. http://dx.doi.org/10.6084/m9.figshare.1061430