Bibliometric analysis of ongoing projects

9th report
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1 EXECUTIVE SUMMARY

This report presents a bibliometric analysis of Innovative Medicine Initiative Joint Undertaking (IMI JU) project research published between 2010 and 2017, using citations as an index of research quality and co-authorship as an index of collaboration. This is the nineth report commissioned by IMI from Clarivate Analytics. The data show that IMI continues to perform well and rapidly expand its research effort.

The overall volume of IMI project research has increased rapidly since 2010, and the initiative continues to show an exceptionally high growth in publication output. This increase is expected as the number of funded projects has increased over time and as the projects funded early in the history of the program begin to publish. To date, IMI projects have produced 3,737 publications which have been matched to the Clarivate Web of Science™. This represents a 40% increase from the 2,686 publications matched to the Web of Science in Report 8, which covered IMI project research published between 2009 and 2016.

Around three quarters of IMI project research (73.3%) has been published in high impact journals, i.e. those journals in the highest quartile ranked by Journal Impact Factor. The average Journal Impact Factor of all IMI project publications was 5.83. IMI project research was wide-ranging – the research portfolio of IMI projects ranges from basic biological research to clinical practice. IMI project research has been published most frequently in the disciplines of Pharmacology & Pharmacy, Neurosciences and Biochemistry & Molecular Biology.

The quality of IMI project research (as indexed by citation impact) has been maintained while output has grown. The citation impact of IMI project research (1.98) was approximately twice the world average (1.00), which indicates the research was internationally influential. Between 2010 and 2017, the citation impact for IMI project papers was considerably higher (73.7%) than the European Union's (EU) average citation impact (1.14) in similar fields (journal categories). One quarter of papers from IMI projects were highly-cited - that is, the papers were in the world's top 10% of papers in that journal category and year of publication, when ranked by number of citations.

The output of individual IMI projects has also increased. BTCURE (Call 2) was the most prolific IMI project, with 573 publications as of this report. This is a 24.2% increase on the 461 publications attributed to BTCURE in Report 8. This growth is below the growth for all IMI projects in aggregate, but this it likely to be becaue the BTCURE project ended in the first quarter of 2017.

Projects funded by IMI were highly collaborative. Nearly two-thirds (59.7%) of all IMI project papers were coauthored by researchers affiliated with different sectors, more than three-quarters (83.3%) of involved collaboration between institutions and more than half (60.0%) of all IMI project papers were internationally collaborative. Collaborative IMI project research was internationally influential with a citation impact (2.80) well over twice the world average (1.0).

IMI's field-normalised citation impact (1.98) is on par with well-established funding bodies such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Medical Research Council (MRC) and the Wellcome Trust (WT) (1.55, 1.91 and 2.02 respectively). Its journal-normalised citation impact (1.29) and percentage of highly-cited papers (25%) are also similar to those of the comparator funders.

The collaborative research activity of the selected IMI projects has increased over time and involves a diverse range of institutions across multiple sectors and countries. It is also clear from the data that there is significant collaboration with institutions that were not formal participants in the IMI-supported projects, and that the involvement of such partners has grown with time.

Research in both Europe and North America tends to be clustered in major cities with an existing strong academic research base. It is also clear that the citation impact of the research IMI supports within these clusters is higher than the average national benchmarks. A relatively high percentage of IMI-supported research in the Spanish clusters in particular, is published in Open Access journals. Rates of international collaboration (as indicated by co-authorship involving more than one country) are very high for the European clusters.

A more detailed summary of the key findings of this report (with cross-references to the relevant sections of this report) is presented below.

Summary of key findings

Since its first call for proposals in 2008, IMI has funded over 85 projects from a total of 23 funding calls, a further 4 calls are currently open for proposals. Of the calls, 11 were from IMI's first phase, which ran from 2008 to 2013, and the rest from its second phase, which was launched in 2014 and is still in progress. It may take several months for a project to progress from inception to the point where it has generated sufficient data for a publication. It may take further months or years until it has produced its most valuable results. Some of the IMI projects that are analysed here are still relatively young, and early bibliometric indicators may not fully reflect their eventual impact.

- IMI projects have published a total of 3,737 unique Web of Science publications (Figure 4.1.1). IMI project research continues to show substantial growth, with the research publication count increasing every year since its inception to 1,420 publications in 2017 (Figure 4.3.1).
- More IMI project publications appeared in *PLOS ONE* than in other journals (142 publications), followed by *Annals of the Rheumatic Diseases* (124 publications). All of the 20 journals in which IMI-funded project publish most frequently rank in the top quartile by Journal Impact Factor (Table 4.4.1).
- The highest Impact Factor journal in which IMI research was published is the *New England Journal of Medicine*, which has a Journal Impact Factor of 59.558. IMI project research published nine times in *Nature* and 8 times in *Science*, which hava Journal Impact Factors of 38.138 and 34.661 respectively (Table 4.4.2).
- IMI project research was most frequently published in Pharmacology & Pharmacy journals (Figure 4.5.1). Of the 484 papers published in this field, 20.0% were highly-cited, 37.4% appeared in open access journals, and the average citation impact of these papers was 1.5 times the world average for the field to which they relate (Tables 4.5.2 and 4.5.3).
- IMI project research had a citation impact of at least equal to the European (EU-28) average in seven out of the 10 journal subject categories to which most IMI publications are assigned (Figure 4.6.1 and Table 4.6.1).
- A quarter (25%) of IMI papers were in the world's top 10% of most highly-cited papers in the relevant field and year of publication, suggesting very strong performance (Table 4.7.1).
- The citation impact of IMI project papers was nearly twice the world average (1.98) between 2010 and 2017. This indicates that the quality of IMI-associated research (as indicated by citation impact) has been maintained while output has continued to grow (Table 4.7.1).
- The number of publications from Call 1 increased from 2010 to 2013 to a peak of 172, before falling to less than 100 publications in 2017. Other early calls follow a similar pattern of initial growth followed by a decline (Figure 5.1.1).
- Research associated with three of the active projects in Call 1 (EUROPAIN, NEWMEDS, U-BIOPRED) received more than twice the world average number of citations for research published in the same field and year (Figure 5.2.1).
- IMI project research is collaborative across sectors, institutions and countries. More than half (59.7%) of IMI project papers were published by co-authors affiliated with more than one sector. More than three-quarters (83.3%) of IMI project papers involved collaboration between institutions. And more than half (60.0%) of all IMI project papers were internationally collaborative (Table 6.1.1). Cross sector collaboration has declined marginally since the last report, but all other types of collaboration measured have increased.
- BTCURE had the most cross-sector collaborative papers, 332 out of a total of 541 (61.4%), as well as the most internationally collaborative papers (313 out of 541) (Tables 6.2.1-6.2.3).

- IMI's research output grew faster (2918.2%) between 2010 and 2017 than any of the seven selected comparators (Table 7.2.1.2).
- IMI's citation impact of twice the world average was around the same as those of the MRC (1.91), CSIRO (1.55) and the WT (2.02) (Table 7.2.2.1).
- Of the five projects analysed, BTCURE and EU-AIMS had the largest proportional increases in the number of co-authoring institutions that were not formally part of the IMI-supported project (Figure 8.1.1).
- The largest geographic clusters of research supported by IMI in European are London (680 publications), Amsterdam (581), Stockholm (353), Paris (278) and Copenhagen (271). The largest clusters in North America are Boston (134), Toronto (132), Bethesda (74), New York (69) and Montreal (62) (Table 9.1 and Table 9.3).
- Typically, around 35-40% of EU-28 biomedical research involves international co-authorship whereas the lowest rate of international co-authorship for the European clusters analysed was 61.4% (Madrid). In addition, around two thirds of the European clusters have rates of international co-authorship of at least 75%. The North American clusters, as expected, have high rates of international collaboration because IMI is a European funding organisation (Table 9.1 and Table 9.3).

2 INTRODUCTION

2.1 OVERVIEW

The Innovative Medicines Initiative (IMI) Joint Undertaking has commissioned Clarivate Analytics to undertake a periodic evaluation of its research portfolio using bibliometric indicators.

The commissioned evaluation comprises a series of reports focusing on research publications produced by IMI funded researchers. This report is the nineth evaluation in the series.

2.2 INNOVATIVE MEDICINES INITIATIVE (IMI) JOINT UNDERTAKING

IMI's purpose is to improve health by speeding up the development of, and patient access to, innovative medicines, particularly in areas where there is an unmet medical or social need. It does this by facilitating collaboration between the key players involved in healthcare research, including universities, the pharmaceutical and other industries, small and medium-sized enterprises (SMEs), patient organisations, and medicines regulators.

IMI is a partnership between the EU and the European pharmaceutical industry, represented by the European Federation of Pharmaceutical Industries and Associations (EFPIA). IMI, as part of its second phase, has a budget of €3.3 billion for the period of 2014 to 2024. Half of this comes from the EU's research and innovation programme, Horizon 2020. The other half comes from large companies, mostly from the pharmaceutical sector; these do not receive any EU funding, but contribute to the projects 'in kind', for example by donating their researchers' time or providing access to research facilities or resources. The first phase of IMI had a budget of €2 billion equally shared between EU and EFPIA.

To date, IMI has announced 11 calls for proposals from its first phase and a further 16 calls for proposals under its second phase. The first funding call was announced in 2008 and the latest, was launched in July 2018. This report covers the research output (publications and papers) of a total of 60 projects from IMI phase one and 24 projects from IMI phase two.

2.3 CLARIVATE ANALYTICS

Clarivate Analytics, formerly the IP & Science business of Thomson Reuters, provides reporting and consultancy services within Research Analytics using customised analyses to bring together several indicators of research performance in such a way as to enable customers to rapidly make sense of and interpret a wide-range of data points to facilitate research strategy decision-making. We have extensive experience with databases on research inputs, activity and outputs and have developed innovative analytical approaches for benchmarking, interpreting and visualization of international, national and institutional research impact.

Clarivate Analytics' Research Analytics is a suite of products, services and tools that provide comprehensive research analysis, evaluation and management. For over half a century we have pioneered the world of citation indexing and analysis, helping to connect scientific and scholarly thought around the world. Today, academic and research institutions, governments, not-for-profits, funding agencies, and all others with a stake in research, need reliable, objective methods for managing and measuring performance.

Our consultants have up to 20 years of experience in research performance analysis and interpretation. In addition, the Clarivate regional Sales team provide effective on-site support to maximise the value of our work.

Visit Clarivate Analytics or our Scientific & Academic Research Professional Services team online for more information.

2.4 SCOPE OF THIS REPORT

The analyses and indicators presented in this report have been specified to provide an analysis of IMI research output for research management purposes:

- To provide bibliometric indicators to identify excellence in IMI-supported research and to benchmark this research, where possible, overall and at individual project level.
- To show that collaboration, at all levels (researcher, institutional and country), is being encouraged through the projects funded by IMI.

Outline of report

- Section 3 describes the data sources and methodology used in this report along with definitions of the indicators and guidelines to interpretation.
- Section 4 presents analyses of IMI project publications overall, including trends in publications, frequently used journals, and top research fields. Where possible IMI research is benchmarked to EU-28 research.
- Section 5 presents citation analyses of IMI publications at the call level, examining trends in publications, citation impact and outputs of individual project. Where possible the IMI projects are benchmarked to world output and overall IMI output.
- Section 6 presents collaboration analyses for IMI publications overall and at the project level, examining collaboration between different sectors and countries.
- Section 7 presents analysis of IMI publications, benchmarked to similar organisations. The organisations are: Commonwealth Scientific and Industrial Research Organization, Critical Path Institute, Foundation for the National Institutes of Health (NIH), Grand Challenges in Global Health, Indian Council of Medical Research, MRC, and the Wellcome Trust.
- Section 8 presents analysis of the collaborative networks that IMI research supports. These networks include institutions across multiple sectors and who may be direct participants in IMI projects or part of a wider network of co-authorship.
- Section 9 presents geographic clusters where IMI research activity occurs, including bibliometric data, the constituent institutions and top five journal subject categories within the clusters.

3 DATA SOURCES, INDICATORS AND INTERPRETATION

3.1 BIBLIOMETRICS AND CITATION ANALYSIS

Research evaluation is increasingly making wider use of bibliometric data and analyses. Bibliometrics is the analysis of data derived from publications and their citations. Publication of research outcomes is an integral part of the research process and is a universal activity. Consequently, bibliometric data have a currency across subjects, time and location that is found in few other sources of research-relevant data. The use of bibliometric analysis, allied to informed review by experts, increases the objectivity of, and confidence in, evaluation.

Research publications accumulate citation counts when they are referred to by more recent publications. Citations to prior work are a normal part of publication and reflect the value placed on a work by later researchers. Some papers get cited frequently and many remain uncited. Highly cited work is recognised as having a greater impact and Clarivate Analytics has shown that high citation rates are correlated with other qualitative evaluations of research performance, such as peer review.[1] This relationship holds across most science and technology areas and, to a limited extent, in social sciences and even in some humanities subjects.

Indicators derived from publication and citation data should always be used with caution. Some fields publish at faster rates than others and citation rates also vary. Citation counts must be carefully normalised to account for such variations by field. Because citation counts naturally grow over time, it is essential to account for growth by year. Normalisation is usually done by reference to the relevant global average for the field and for the year of publication.

Bibliometric indicators have been found to be more informative for core natural sciences, especially for basic science, than they are for applied and professional areas and for social sciences. In professional areas the range of publication modes used by leading researchers is likely to be diverse as they target a diverse, non-academic audience. In social sciences there is also a diversity of publication modes and citation rates are typically much lower than in natural sciences.

Bibliometrics work best with large data samples. As the data are disaggregated, so the relationship weakens. Average indicator values (e.g. of citation impact) for small numbers of publications can be skewed by single outlier values. At a finer scale, when analysing the specific outcome for individual departments, the statistical relationship is rarely a sufficient guide by itself. For this reason, bibliometrics are best used in support of, but not as a substitute for, expert decision processes. Well-founded analyses can enable conclusions to be reached more rapidly and with greater certainty,and are therefore an aid to management and to increased confidence among stakeholders, but they cannot substitute for review by well-informed and experienced peers.

3.2 DATA SOURCE

For the bibliometric analysis, data will be sourced from the databases underlying the Clarivate Analytics **Web of Science**, which gives access to conference proceedings, patents, websites, and chemical structures, compounds and reactions in addition to journals. It has a unified structure that integrates all data and search terms together and therefore provides a level of comparability not found in other databases. It is widely acknowledged to be the world's leading source of citation and bibliometric data.

The **Web of Science Core Collection** is part of the Web of Science and focuses on research published in journals and conferences in science, medicine, arts, humanities and social sciences. The authoritative, multidisciplinary content covers over 18,000 of the highest impact journals worldwide, including over 3,800 Open Access journals and over 170,000 conference proceedings. Coverage is

[1] *Evidence* Ltd. (2002) Maintaining Research Excellence and Volume: A report by *Evidence* Ltd to the Higher Education Funding Councils for England, Scotland and Wales and to Universities United Kingdom (UK). (*Adams J, et al.)* 48pp.

both current and retrospective in the sciences, social sciences, arts and humanities, in some cases back to 1900. Within the research community, these data are often still referred to by the acronym 'ISI'.[2] Clarivate Analytics has extensive experience with databases on research inputs, activity and outputs and has developed innovative analytical approaches for benchmarking and interpreting international, national and institutional research impact.

3.3 METHODOLOGY

Papers/publications: Clarivate Analytics abstracts publications including editorials, meeting abstracts and book reviews as well as research journal articles. The terms 'paper' and 'publication' are often used interchangeably to refer to printed and electronic outputs of many types. In this document the term 'paper' has been used exclusively to refer to substantive journal articles, reviews and some proceedings papers and excludes editorials, meeting abstracts or other types of publication. Papers are the subset of publications for which citation data are most informative and which are used in calculations of citation impact.

Citations: The citation count is the number of times that a citation has been recorded for a given publication since it was published. Not all citations are necessarily recorded since not all publications are indexed. The material indexed by Clarivate Analytics, however, is estimated to attract about 95% of global citations.

Citation impact: Citations per paper' is an index of academic or research impact (as compared with economic or social impact). It is calculated by dividing the sum of citations by the total number of papers in any given dataset (so, for a single paper, raw impact is the same as its citation count). Impact can be calculated for papers within a specific research field such as Clinical Neurology, or for a specific institution or group of institutions, or a specific country. Citation count declines in the most recent years of any time-period as papers have had less time to accumulate citations (papers published in 2007 will typically have more citations than papers published in 2010).

Field-normalised citation impact (nci_F): Citation rates vary between research fields and with time, consequently, analyses must take both field and year into account. In addition, the type of publication will influence the citation count. For this reason, only citation counts of papers (as defined above) are used in calculations of citation impact. The standard normalisation factor is the world average citations per paper for the year and journal category in which the paper was published. This normalisation is also referred to as 'rebasing' the citation count.

Mean normalised citation impact (mnci): The mean nci indicator for any specific dataset is calculated as the mean of the nci_F of all papers within that dataset.

Web of Science journal categories or Clarivate Analytics InCites: Essential Science Indicators^SM fields: Standard bibliometric methodology uses journal category or ESI fields as a proxy for research fields. ESI fields aggregate data at a higher level than the journal categories – there are only 22 ESI research fields compared to 254 journal categories. Journals are assigned to one or more categories, and every article within that journal is subsequently assigned to that category. Papers from prestigious, 'multidisciplinary' and general medical journals such as *Nature, Science*, *The Lancet*, *The BMJ*, *The New England Journal of Medicine* and the *Proceedings of the National Academy of Sciences* (PNAS) are assigned to specific categories based on the journal categories of the references cited in the article.

[2] The origins of citation analysis as a tool that could be applied to research performance can be traced to the mid-1950s, when Eugene Garfield proposed the concept of citation indexing and introduced the Science Citation Index, the Social Sciences Citation Index and the Arts & Humanities Citation Index, produced by the Institute of Scientific Information – ISI (now Clarivate Analytics).

The selection procedures for the journals included in the citation databases are documented here http://mjl.clarivate.com/.[3]

Journal-normalised citation impact (nci_J): Another bibliometric indicator which can be very useful in small datasets is the journal-normalised citation impact, nci_J. This indicator is calculated from the citation impact relative to the specific journal in which the paper is published. For example, a paper published in the journal *Acta Biomaterialia* in 2005 that has been cited 189 times, would have an expected citation rate of 49.57 (the average number of citations per paper for this journal and publication year) and hence a nci_J of 6.3. This paper, therefore, has been cited more than expected for the journal.

3.4 DATA COLLATION

This analysis used a dataset comprising publications arising from IMI-supported projects. This contained publications associated with each IMI project identified using grant acknowledgments, title and abstract text search, as well as other parameters developed in conjunction with IMI staff. There are currently 86 active IMI projects. IMI staff validated the publications identified by this process and the list of projects to be analysed was provided by IMI staff.

[3] Essential Science Indicators are defined by a unique grouping of journals with no journal being assigned to more than one field. These fields are focussed on the science, technology, engineering and medicine subjects and arts & humanities subjects are excluded. Customised analyses, however, can be designed to include these as an additional category.

4 CITATION ANALYSIS – IMI SUPPORTED PUBLICAITONS OVERALL

This Section analyses the volume and citation impact of publications arising from IMI-supported projects, and where possible, benchmarks this against similar European research.

The datasets analysed include IMI-supported publications identified in Clarivate Analytics Web of Science up to December 2017. The census point for inclusion of publications into the eighth report was 31st December 2016. Therefore, this report reflects changes in IMI activity between these points. Citation counts for all publications included previously have been updated to the end of 2017. Unless otherwise specificed metrics are for all IMI-supported documents from all calls in IMI 1 and IMI 2, in aggregate.

When considering the analyses in this Section, earlier caveats regarding paper numbers should be borne in mind (Section 3).

4.1 PUBLICATIONS FROM IMI-SUPPORTED PROJECTS

Publications from IMI-supported projects were identified using bibliographic data supplied by IMI, and through specific keyword searches using funding acknowledgment data in Web of Science. The process of identifying publications from IMI-supported projects that have Clarivate Analytics citation data is outlined in Figure 4.1.1.

The IMI project dataset started with 2,686 publications which were previously identified as IMI publications. Separately, 1,420 new publications were identified as IMI-associated through keyword searches of funding acknowledgement text in Web of Science. The combination of these two datasets led to a total of 4,106 unique publication records associated with IMI-supported projects. Of these 4,106 publications that were matched to the databases underlying the Clarivate Analytics Web of Science, 369 were eliminated as they were either published in 2018 or could not be distinguished as IMI from a manual review of the dataset. Therefore, 3,737 Web of Science publications remained. Of the identified records 5 could not be assigned to a specific project.

The citation counts for this report were sourced from the citation databases which underlie Clarivate Analytics Web of Science and were extracted in March 2018. Normalised bibliometric indicators were calculated using standard methodology and the Clarivate Analytics National Science Indicators (NSI) database for 2017.

FIGURE 4.1.1 IDENTIFYING PUBLICATIONS FROM IMI-SUPPORTED PROJECTS WITH CLARIVATE ANALYTICS CITATION DATA

IMI-identified publications

- There were 2,686 publications previously idenfitied as IMI publications.

Web of Science

- 1,420 new publications were identified as IMI-associated through Web of Science funding text
- The combination of the previously identified publications and those identified for this report, led to 4,106 unique records in IMI dataset overall

Publications (total)

- 4,106 were matched in Clarivate Analytics database
- 369 records are not used because they were published in 2018 or could not be identifeid as IMI on manual review of the dataset

IMI project dataset

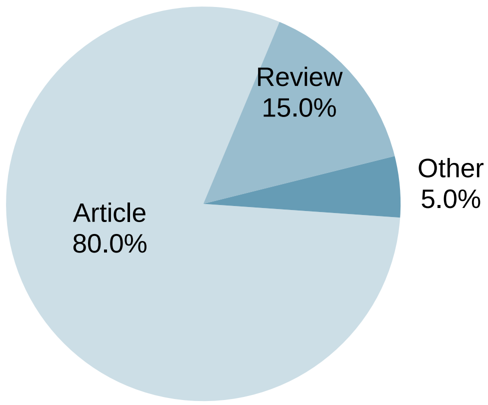
- 3,737 unique Web of Science publications linked to Clarivate Analytics citation databases; all publications were published before end-2017 and so have 2017 citation data
- 3,550 papers (2,997 articles and 553 reviews; 95%); 187 other document types (50 editorials, 120 meeting abstracts, 10 letters, 4 corrections and 3 news items; 5.0%)

4.2 SHARE OF PAPERS RELATIVE TO OTHER PUBLICATION TYPES

FIGURE 4.2.1 CATEGORISATION OF IMI PROJECT RESEARCH BY DOCUMENT TYPE

Figure 4.2.1 shows the percentage of Web of Science publications from IMI-associated projects classified as papers (articles and reviews) relative to other document types. Papers are the subset of publications for which citation data are most informative and which are used in calculations of normalised citation impact.

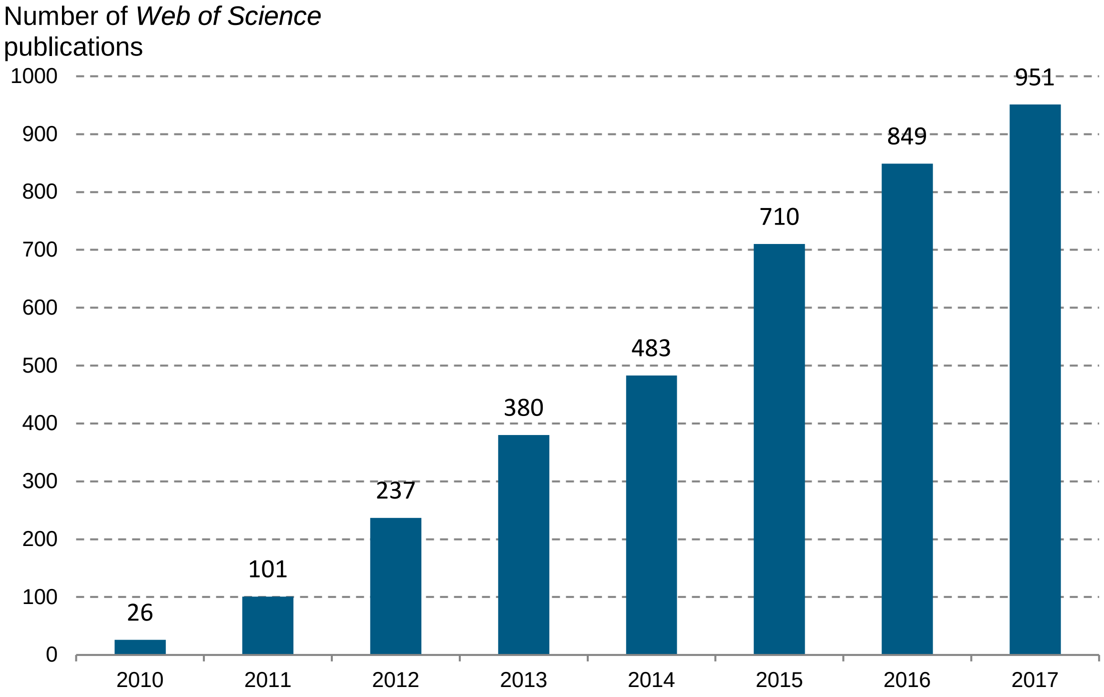
IMI project research resulted in 3,737 unique Web of Science publications. Of these publications 95% were substantive articles or reviews with 187 documents not falling into these document types. These documents (classified as 'Other') comprised 50 editorials, 120 meeting abstracts, 10 letters, 4 corrections and 3 news items.



4.3 TRENDS IN PUBLICATION OUTPUT

Figure 4.3.1 shows the annual number of Web of Science publications arising from IMI projects between 2010 and 2017.

FIGURE 4.3.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS FOR IMI PROJECTS BY YEAR, 2010-2017

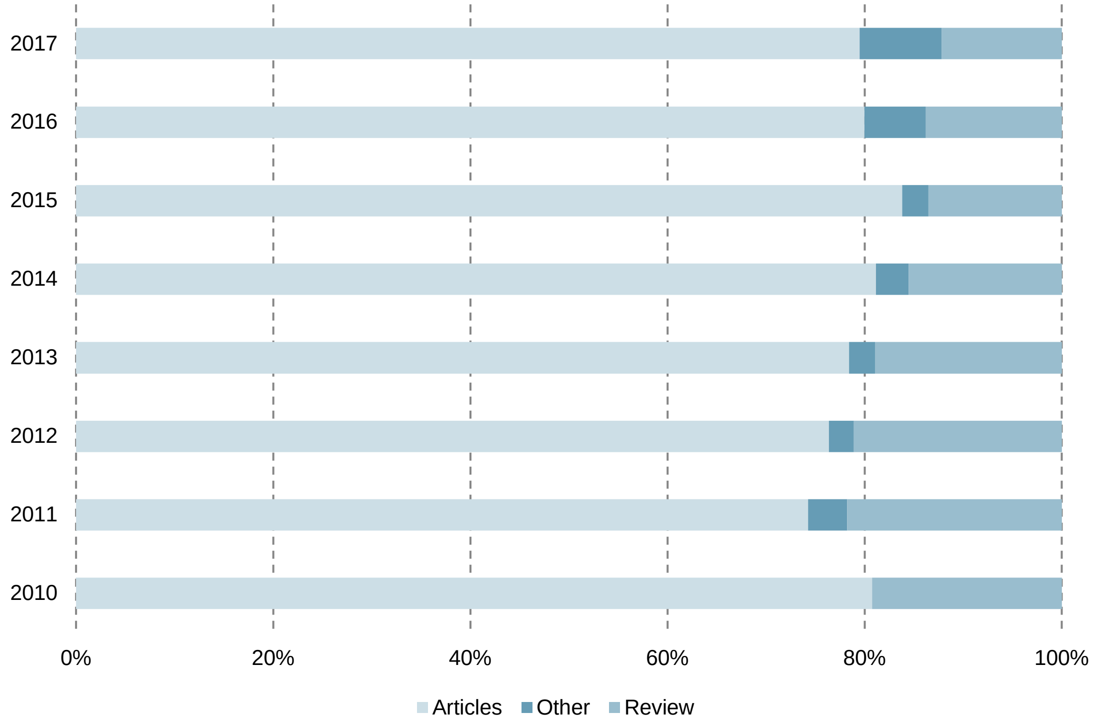


IMI project research continued to show substantial growth with publication count increasing every year between 2010 and 2017:

- The percentage change in the output of IMI project-supported publications between 2016 and 2017 was 12.0%, compared with a growth of 19.6% between 2015 and 2016.
- While the percentage growth has decreased over time the number of publications continues to grow roughly linearly by an average of 132 per year.

Figure 4.3.2 shows the proportion of papers (articles and reviews) relative to other document types for IMI project research between 2010 and 2017.

FIGURE 4.3.2 CATEGORISATION OF WEB OF SCIENCE PUBLICATIONS FOR IMI PROJECTS BY YEAR AND DOCUMENT TYPE, 2010-2017



- IMI project research continued to generate a high proportion of papers relative to other document types. Articles accounted for around 80% of all publications, dropping 0.5% to 79.5% in 2017. Review papers accounted for approximately 20% of publications between 2010 and 2013 but fell after this point to 12.2% in 2017.

4.4 IN WHICH JOURNALS DO IMI PROJECT PUBLICATIONS APPEAR MOST FREQUENTLY?

The 20 journals in which IMI project publications appeared most frequently (ranked by number of publications) between 2010 and 2017, are listed in Table 4.4.1. Together, the 20 most frequently used journals account for 905 Web of Science publications - almost one-quarter (24.2%) of all IMI project publications.

IMI project publications appeared most frequently in *PLOS ONE* (142 publications), followed by *Annals of the Rheumatic Diseases* (124 publications). 18 of the 22 IMI publications in the *American Journal of Respiratory and Critical Care Medicine* (JIF = 13.12) were meeting abstracts and 4 were articles.

IMI continued to have a strong focus on Rheumatology, this category is represented three times in the top ten most frequent publishers of IMI research. However, the top 20 most frequent journals contain several in the multidisciplinary category, indicating a wider interest in IMI research.

Of the 20 journals in Table 4.4.1, all 20 were in the top quartile when ranked by Journal Impact Factor.

IMI project publications were published in a total of 925 journals, of which 604 were ranked in the top quartile (by Journal Impact Factor) of journals in their specific journal category. A total of 2,990 publications (80% of IMI project publications) were published in these well-regarded journals. The average Journal Impact Factor of all IMI project publications is 6.10.

The highest Impact Factor journal in which IMI project research was published is the *New England Journal of Medicine*, with a Journal Impact Factor of 59.558. IMI projects have published a total of nine publications (two since report 8) in *Nature*, which had a Journal Impact Factor of 38.138 and eight (two since report 8) in *Science* with a Journal Impact Factor of 34.661.

The 20 open access journals appearing most frequently (ranked by number of publications) in the IMI project publications dataset, 2010-2017, are listed in Table 4.4.3. This list is notably different to previous reports due to the re-indexing of a number of journals as newly open access. Clarivate Analytics is constantly adapting its database to be consistent with modern publishing practices, in this case giving improved insight on open access. Literature is now tagged at the publication level rather than the journal level, allowing journals to be associated with both open and closed access.

Of the top 20 open access journals in which IMI project research published most frequently, *Annals of the rheumatic diseases* had the highest impact factor (12.384). *PLOS ONE* is the open access journal with the highest number of IMI publications (142).

TABLE 4.4.1 JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 20 RANKED BY NUMBER OF WEB OF SCIENCE PUBLICATIONS, 2010-2017

Journal	Number of *Web of Science* Publications	Number of Papers	Journal Impact Factor (2017)	*Web of Science* Journal Categories	Quartile
PLOS ONE	142	142	3.057	*MULTIDISCIPLINARY SCIENCES*	*Q1*
ANNALS OF THE RHEUMATIC DISEASES	124	94	12.384	*RHEUMATOLOGY*	*Q1*
SCIENTIFIC REPORTS	77	77	5.228	*MULTIDISCIPLINARY SCIENCES*	*Q1*
DIABETOLOGIA	55	36	6.206	*ENDOCRINOLOGY & METABOLISM*	*Q1*
ARTHRITIS RESEARCH & THERAPY	44	44	3.979	*RHEUMATOLOGY*	*Q1*

Journal	Number of *Web of Science* Publications	Number of Papers	Journal Impact Factor (2017)	*Web of Science* Journal Categories	Quartile
PAIN	43	43	5.557	*CLINICAL NEUROLOGY; NEUROSCIENCES; ANESTHESIOLOGY*	*Q1*
ARTHRITIS & RHEUMATOLOGY	43	39	6.009	*RHEUMATOLOGY*	*Q1*
PSYCHOPHARMACOLOGY	41	41	3.54	*NEUROSCIENCES; PSYCHIATRY; PHARMACOLOGY & PHARMACY*	*Q1*
JOURNAL OF ALZHEIMERS DISEASE	37	37	3.92	*NEUROSCIENCES*	*Q1*
EUROPEAN JOURNAL OF PHARMACEUTICAL SCIENCES	37	35	3.773	*PHARMACOLOGY & PHARMACY*	*Q1*
PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA	32	32	9.423	*MULTIDISCIPLINARY SCIENCES*	*Q1*
NATURE COMMUNICATIONS	31	31	11.329	*MULTIDISCIPLINARY SCIENCES*	*Q1*
MOLECULAR PHARMACEUTICS	30	30	4.342	*PHARMACOLOGY & PHARMACY; MEDICINE, RESEARCH & EXPERIMENTAL*	*Q1*
DRUG SAFETY	29	28	3.206	*PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH; PHARMACOLOGY & PHARMACY; TOXICOLOGY*	*Q1*
DIABETES	29	24	8.784	*ENDOCRINOLOGY & METABOLISM*	*Q1*
JOURNAL OF IMMUNOLOGY	24	24	4.985	*IMMUNOLOGY*	*Q1*
AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE	22	4	13.118	*CRITICAL CARE MEDICINE*	*Q1*
BIOINFORMATICS	22	22	5.766	*MATHEMATICAL & COMPUTATIONAL BIOLOGY; BIOTECHNOLOGY & APPLIED MICROBIOLOGY; STATISTICS & PROBABILITY; COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS; BIOCHEMICAL RESEARCH METHODS*	*Q1*
JOURNAL OF BIOLOGICAL CHEMISTRY	22	22	4.258	*BIOCHEMISTRY & MOLECULAR BIOLOGY*	*Q1*
NUCLEIC ACIDS RESEARCH	21	21	9.202	*BIOCHEMISTRY & MOLECULAR BIOLOGY*	*Q1*

TABLE 4.4.2 JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 20 RANKED BY JOURNAL IMPACT FACTOR, 2010-2017

Journal	Number of *Web of Science* Publications	Number of Papers	Journal Impact Factor (2017)	*Web of Science* Journal Categories	Quartile
NEW ENGLAND JOURNAL OF MEDICINE	1	1	59.558	*CLINICAL NEUROLOGY*	*Q1*
NATURE REVIEWS DRUG DISCOVERY	5	1	47.12	*BIOTECHNOLOGY & APPLIED MICROBIOLOGY; PHARMACOLOGY & PHARMACY*	*Q1*
LANCET	2	2	44.002	*MEDICINE, GENERAL & INTERNAL; PSYCHIATRY*	*Q1*
NATURE BIOTECHNOLOGY	1	0	43.113	*BIOTECHNOLOGY & APPLIED MICROBIOLOGY*	*Q1*
NATURE REVIEWS IMMUNOLOGY	2	2	39.416	*IMMUNOLOGY*	*Q1*
NATURE REVIEWS MOLECULAR CELL BIOLOGY	1	1	38.602	*CELL BIOLOGY*	*Q1*
NATURE	9	9	38.138	*MULTIDISCIPLINARY SCIENCES*	*Q1*
JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION	7	5	37.684	*CARDIAC & CARDIOVASCULAR SYSTEMS; CLINICAL NEUROLOGY; RHEUMATOLOGY; MEDICINE, GENERAL & INTERNAL*	*Q1*
CHEMICAL REVIEWS	2	2	37.369	*CHEMISTRY, MULTIDISCIPLINARY*	*Q1*
NATURE REVIEWS GENETICS	2	2	35.898	*GENETICS & HEREDITY*	*Q1*
SCIENCE	8	7	34.661	*MULTIDISCIPLINARY SCIENCES*	*Q1*
NATURE REVIEWS CANCER	1	1	34.244	*ONCOLOGY*	*Q1*
CHEMICAL SOCIETY REVIEWS	1	1	34.090	*CHEMISTRY, MULTIDISCIPLINARY*	*Q1*
NATURE GENETICS	9	6	31.616	*GENETICS & HEREDITY*	*Q1*
PHYSIOLOGICAL REVIEWS	1	1	30.924	*PHYSIOLOGY*	*Q1*
NATURE MEDICINE	5	5	30.357	*BIOCHEMISTRY & MOLECULAR BIOLOGY; CELL BIOLOGY; MEDICINE, RESEARCH & EXPERIMENTAL*	*Q1*
NATURE REVIEWS NEUROSCIENCE	2	2	29.298	*NEUROSCIENCES*	*Q1*
CELL	1	1	28.710	*CELL BIOLOGY; CELL BIOLOGY*	*Q1*
NATURE CHEMISTRY	1	1	27.893	*CHEMISTRY, MULTIDISCIPLINARY*	*Q1*
LANCET ONCOLOGY	1	1	26.509	*ONCOLOGY*	*Q1*

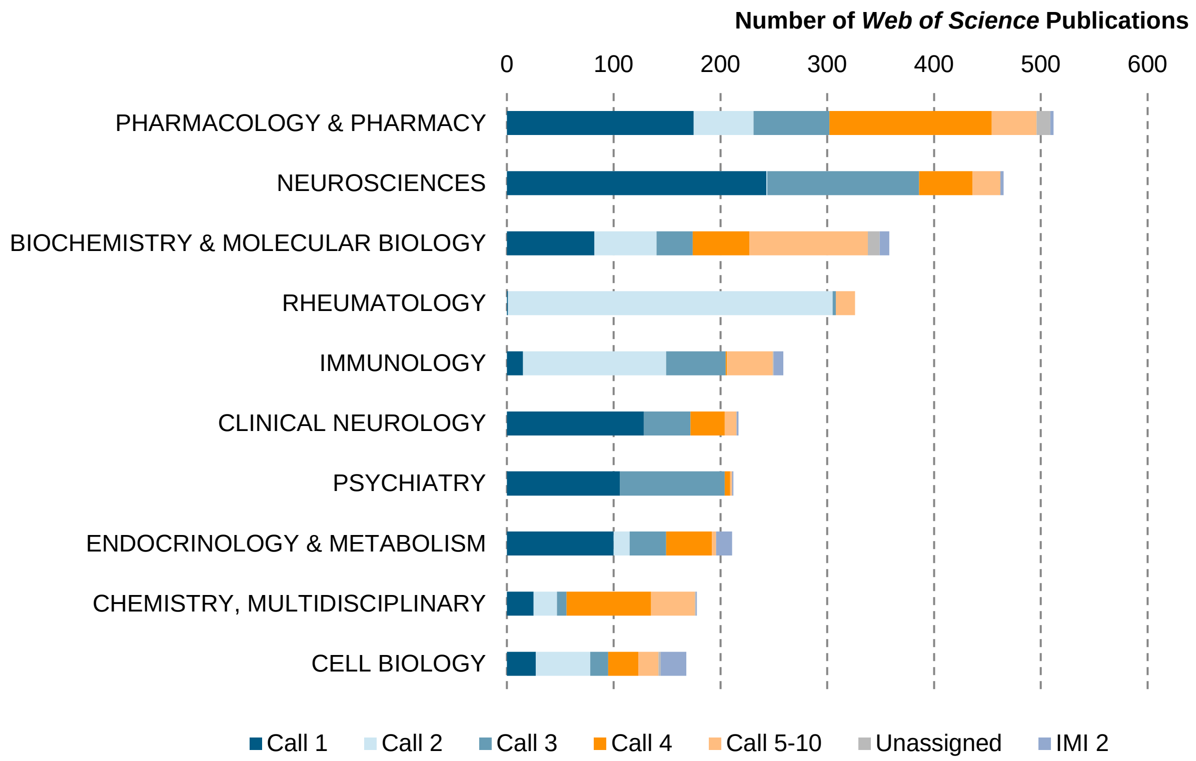
TABLE 4.4.3 OPEN ACCESS JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 20 RANKED BY NUMBER OF WEB OF SCIENCE PUBLICATIONS, 2010-2017

Open Access Journal	Number of *Web of Science* Publications	Number of Papers	Journal Impact Factor (2017)	*Web of Science* Journal Categories
PLOS ONE	142	142	3.057	MULTIDISCIPLINARY SCIENCES
SCIENTIFIC REPORTS	77	77	5.228	MULTIDISCIPLINARY SCIENCES
ARTHRITIS RESEARCH & THERAPY	44	44	3.979	RHEUMATOLOGY
ARTHRITIS & RHEUMATOLOGY	36	36	6.009	RHEUMATOLOGY
NATURE COMMUNICATIONS	31	31	11.329	MULTIDISCIPLINARY SCIENCES
PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA	31	31	9.423	MULTIDISCIPLINARY SCIENCES
DIABETOLOGIA	27`	27	6.206	ENDOCRINOLOGY & METABOLISM
ANNALS OF THE RHEUMATIC DISEASES	26	25	12.384	RHEUMATOLOGY
DIABETES	22	22	8.784	ENDOCRINOLOGY & METABOLISM
NUCLEIC ACIDS RESEARCH	21	21	9.202	BIOCHEMISTRY & MOLECULAR BIOLOGY
BIOINFORMATICS	20	20	5.766	MATHEMATICAL & COMPUTATIONAL BIOLOGY; BIOTECHNOLOGY & APPLIED MICROBIOLOGY; STATISTICS & PROBABILITY; COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS; BIOCHEMICAL RESEARCH METHODS
JOURNAL OF BIOLOGICAL CHEMISTRY	20	20	4.258	BIOCHEMISTRY & MOLECULAR BIOLOGY
JOURNAL OF IMMUNOLOGY	20	20	4.985	IMMUNOLOGY
ARTHRITIS AND RHEUMATISM	19	19	8.955	RHEUMATOLOGY
JOURNAL OF ALZHEIMERS DISEASE	19	19	3.920	NEUROSCIENCES
ANTIMICROBIAL AGENTS AND CHEMOTHERAPY	18	17	4.415	MICROBIOLOGY; PHARMACOLOGY & PHARMACY
EUROPEAN JOURNAL OF IMMUNOLOGY	16	15	4.179	IMMUNOLOGY
JOURNAL OF ANTIMICROBIAL CHEMOTHERAPY	16	16	4.919	PHARMACOLOGY & PHARMACY
INTERNATIONAL JOURNAL OF MOLECULAR SCIENCES	15	15	3.257	CHEMISTRY, MULTIDISCIPLINARY
TRANSLATIONAL PSYCHIATRY	15	15	5.538	PSYCHIATRY

4.5 WHICH RESEARCH FIELDS ACCOUNT FOR THE HIGHEST VOLUME OF IMI PROJECT PUBLICATIONS?

Figure 4.5.1 shows the top ten Web of Science journal categories[4] rank by numbers of publications associated with IMI project research[5]. IMI 1 calls 5-11 have a lower number of publications relative to calls 1-4 and for clarity of presentation these publications are shown as one group in Figure 4.5.1. Likewise, IMI 2 has far fewer publication compared to IMI 1 and so all IMI 2 calls are aggriaged in one group in Figure 4.5.1.

FIGURE 4.5.1 TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WERE PUBLISHED, 2010-2017



- IMI projects generated more publications in Pharmacology & Pharmacy than in other journal categories, followed by Neurosciences and Biochemistry & Molecular Biology.
- Since the last report, Immunology has overtaken Clinical Neurology in terms of number of publications, and Multidisciplinary Chemisty and Cell Biology have overtaken Genetic & Heredity, which is no long in the top ten Web of Science journal categories.
- The majority of publications (93.3%) in Rheumatology were from the call 2 project BTCURE.
- The publications assigned to Neurosciences and Psychiatry were predominantly from calls 1 and 3.

[4] Journals can be associated with more than one Web of Science category.
[5] It should be noted that there are 130 publications which are associated with multiple IMI calls.

Table 4.5.1 shows the same data as Figure 4.5.1. It provides the number of publications assigned to each of the top ten Web of Science journal categories in which IMI project research is published. Table 4.5.2 and Table 4.5.3 provide the citation impact, percentage of highly-cited and percentage of publications in open access journals for the IMI project research in the top ten journal categories.

TABLE 4.5.1 NUMBER OF PUBLICATIONS BY IMI 1 CALL AND IMI 2 FOR THE TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED, 2010-2017

	Number of publications by IMI 1 Call												
Journal Category	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**IMI 2**	**Not assigned**
Pharmacology & Pharmacy	175	56	71	152	5	11	4	2	13	0	7	3	13
Neurosciences	243	1	142	50	0	0	0	19	3	0	4	3	0
Biochemistry & Molecular Biology	82	58	34	53	19	28	0	12	1	0	51	9	11
Rheumatology	1	304	3	0	0	0	0	13	0	0	5	0	0
Immunology	15	134	56	1	0	1	4	12	3	12	11	9	1
Clinical Neurology	128	0	44	32	0	0	0	5	0	0	6	2	0
Psychiatry	106	0	98	5	0	0	0	1	0	0	1	1	0
Endocrinology & Metabolism	100	15	34	43	0	0	0	1	2	0	1	15	0
Chemistry, Multidisciplinary	25	22	9	79	22	6	0	4	1	0	8	1	1
Cell Biology	27	51	17	28	1	2	0	5	0	0	11	24	2

TABLE 4.5.2 FIELD NORMALISED, JOURNAL NORMALISED AND RAW CITATION IMPACT OF PAPERS IN TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED, 2010-2017

		Citation Impact		
Journal category	**Number of Papers**	**Normalised at field level (nci_F)**	**Normalised at journal level (nci_J)**	**Raw citation impact**
Pharmacology & Pharmacy	484	1.54	1.18	10.31
Neurosciences	445	1.81	1.29	20.74
Biochemistry & Molecular Biology	343	1.93	1.44	14.77
Rheumatology	287	2.07	1.06	16.38
Immunology	247	1.56	1.17	13.36
Clinical Neurology	200	3.09	1.44	27.30
Psychiatry	198	2.29	1.12	19.59
Endocrinology & Metabolism	181	1.44	0.99	12.72
Chemistry, Multidisciplinary	176	1.56	1.36	16.10
Cell Biology	170	1.79	1.45	14.21

TABLE 4.5.3 TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED, WITH PERCENTAGE OF PUBLICATIONS IN OPEN ACCESS JOURNALS, AND PERCENTAGE OF HIGHLY-CITED PAPERS, 2010-2017

Journal Category	Number of Web of Science publications	% of Open Access publications	Number of papers	% of Highly Cited Papers
Pharmacology & Pharmacy	503	37.4%	484	20.0%
Neurosciences	460	49.1%	445	29.2%
Biochemistry & Molecular Biology	344	63.1%	343	21.6%
Rheumatology	325	53.9%	287	29.3%
Immunology	253	58.9%	247	23.5%
Clinical Neurology	214	41.1%	200	39.5%
Psychiatry	208	51.0%	198	26.8%
Endocrinology & Metabolism	206	64.1%	181	17.1%
Chemistry, Multidisciplinary	177	41.2%	176	23.9%
Cell Biology	171	73.1%	170	30.0%

- There is a step change in the percentage of papers seen in open access journals compared to the previous reports. This step is likely not representative of a real difference in publishing behaviour, but a result of increased resolution as Clarivate Analytics has improved its ability to identify open access publications through its collaboration with ImpactStory.[6]
- IMI project research was most frequently published in Pharmacology & Pharmacy journals. Of the 503 papers published in this field, 20.0% were highly-cited.
- There were 214 publications (200 papers) in Clinical Neurology; this category has the highest percentage of highly cited papers (39.5%).
- The percentage of publications in open access journals was highest in Cell biology (73.1%).

[6] Easing Access to Open Access: Clarivate Analytics partners with Impactstory: https://clarivate.com/blog/easing-access-to-open-access-clarivate-analytics-partners-with-impactstory/

4.6 IMI RESEARCH FIELDS WITH HIGHEST VOLUME OF PUBLICATIONS BENCHMARKED AGAINST EU-28 PUBLICATIONS OF THE SAME FIELD

Figure 4.6.1 shows the citation impact of the top ten Web of Science journal categories in which IMI project research was published. These data are benchmarked against the same journal categories for EU-28 research papers. Table 4.6.1, expands on this figure and shows the percentage of publications for each journal category for IMI and EU-28.

FIGURE 4.6.1 TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED, BENCHMARKED AGAINST EU-28 PAPERS IN THE SAME JOURNAL CATEGORIES, 2010-2017

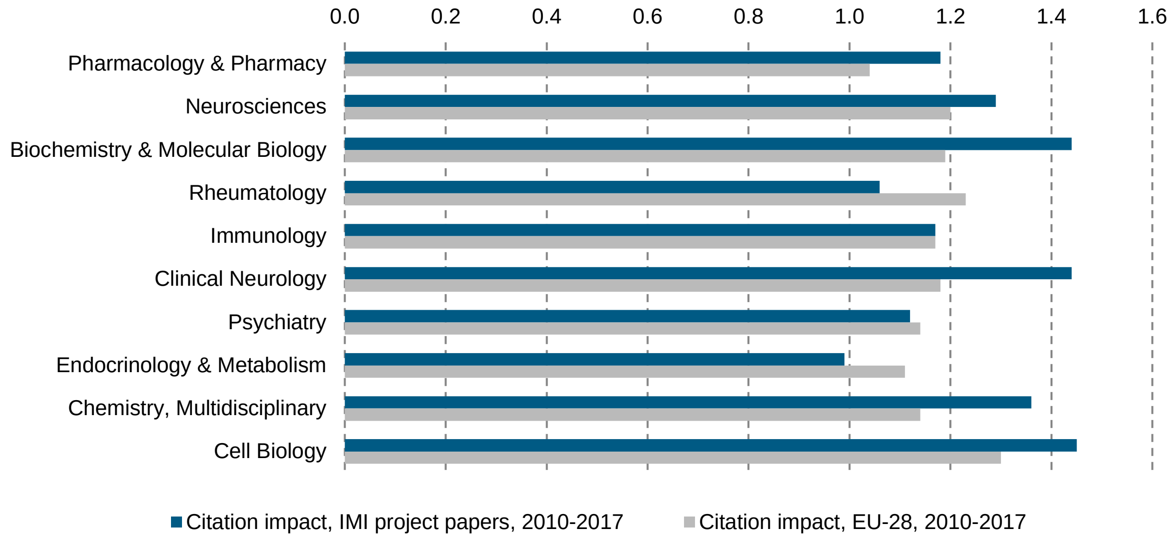


TABLE 4.6.1 CITATION IMPACT AND PERCENTAGE OF PAPERS IN TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED, BENCHMARKED AGAINST EU-28 PAPERS IN THE SAME JOURNAL CATEGORIES, 2010-2017

Journal category	% of IMI papers	% of EU-28 papers	Citation impact normalised at field level	
			IMI papers	EU-28
Pharmacology & Pharmacy	13.6%	2.3%	1.18	1.04
Neurosciences	12.5%	3.0%	1.29	1.20
Biochemistry & Molecular Biology	9.7%	4.0%	1.44	1.19
Rheumatology	8.1%	0.5%	1.06	1.23
Immunology	7.0%	1.7%	1.17	1.17
Clinical Neurology	5.6%	2.1%	1.44	1.18
Psychiatry	5.6%	1.5%	1.12	1.14
Endocrinology & Metabolism	5.1%	1.5%	0.99	1.11
Chemistry, Multidisciplinary	5.0%	3.0%	1.36	1.14
Cell Biology	4.8%	2.0%	1.45	1.30

- IMI project research had a higher citation impact in most of the fields it is most frequently published in than the EU-28 papers published in the same research fields (as determined by journal subject categories) except for Rheumatology, Psychiatry and Endocriology and Metabolism.
- The journal category in which IMI-supported papers had the highest citation impact was Cell Biology (1.45).
- The journal category with the highest citation impact for EU-28 papers was Cell Biology (1.30).

4.7 IS IMI PROJECT RESEARCH WELL-CITED?

The number of citations a paper receives (also known as its citation impact) is at least partly determined by the field to which it relates. Typically, papers published in disciplines such as biomedical research receive more citations than papers published in subjects such as engineering, even if the papers are published in the same year. All citation impact data presented in this report are therefore normalised, or rebased, to the relevant world average to allow comparison between years and fields.

Table 4.7.1 and 4.7.2 present summary results for all IMI publications and papers.

TABLE 4.7.1 SUMMARY CITATION ANALYSIS FOR IMI SUPPORTED RESEARCH PAPERS, 2010-2017

		Citation Impact			
	Number of Papers	Normalised at field level (nci_F)	Normalised at journal level (nci_J)	Average Percentile	% Highly cited papers
IMI projects	3,550	1.98	1.29	38.68	25.0%

TABLE 4.7.2 SUMMARY OF IMI SUPPORTED RESEARCH PUBLICATIONS, 2010-2017

	Number of Publications	% Publications in Open access journals	Number of papers	Citations	Raw citation impact
IMI Projects	3,737	52.2%	3,550	52,362	14.75

SUMMARY OF KEY FINDINGS

- The citation impact of IMI project papers was 1.98 for the 7-year period, 2010-2017 (almost twice the world average of 1.0). This indicates the quality of IMI-associated research (as indicated by citation impact) had been maintained while output had continued to grow.
- The citation impact of IMI project papers was 60% higher than the EU's average citation impact (1.17)[7,8] relative to the world baseline between 2010 and 2017, in the same group of journal categories.
- Almost a quarter (24.3%) of IMI papers were highly-cited, that is, they were in the world's top 10% of most highly-cited papers in the relevant journal category and year of publication.

[7] EU-28 grouping of countries: Clarivate Analytics National Science Indicators 2017 database; similar research has been defined as including the same journal categories as in the IMI project dataset.

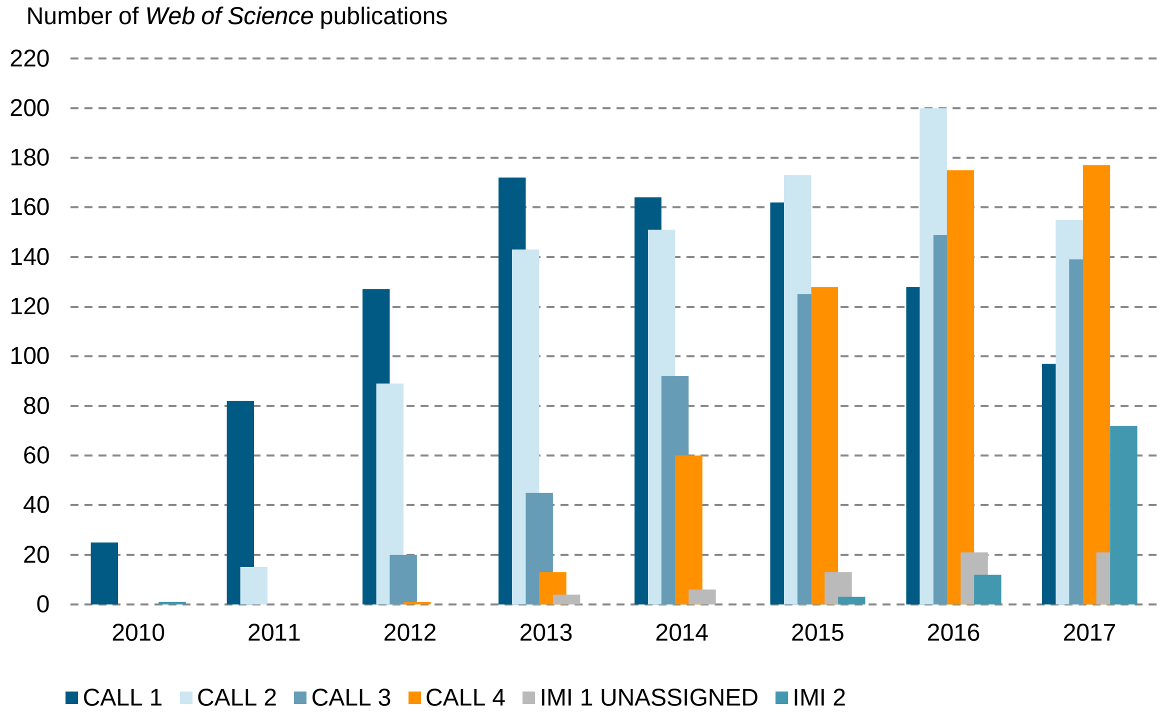
[8] For this analysis, only papers are considered since only these publication types have normalised citation impact data (see Section 3).

5 CITATION ANALYSIS – AT IMI PROJECT LEVEL

5.1 TRENDS IN PUBLICATION OUTPUT BY IMI FUNDING CALL

Figure 5.1.1 shows the number of Web of Science publications between 2010 and 2017 for IMI group by call. Call 1-4 are shown separately. Calls 5-11 are more recent and consequently have fewer publications, they are therefore shown in aggregate in Figure 5.1.2. Likewise, IMI 2 has far fewer publication compared than IMI 1 and so all IMI 2 calls are aggregated into a single group in Figure 4.5.1. Table 5.1.1 presents summary bibliometric data for IMI 1 calls 1-11 and IMI 2, including number of publications, numbers of papers, and citation impact.

FIGURE 5.1.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL 2010-2017



- The number of publications from call 1 increased from 2010 to a peak of 172 in 2013.
- In 2015 and 2016, call 2 had the highest number of publications (173 and 200, respectively) but fell below call 4 in 2017 (155 publications), which exhibits a steep growth profile between 2013 and 2016.
- Calls 1 - 4 grow approximately linearly for 3 - 4 years from first publications, followed by a short plateau and call 1 has started to show a shallow decline over the period 2016 – 2017.

FIGURE 5.1.2 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL 2010-2017

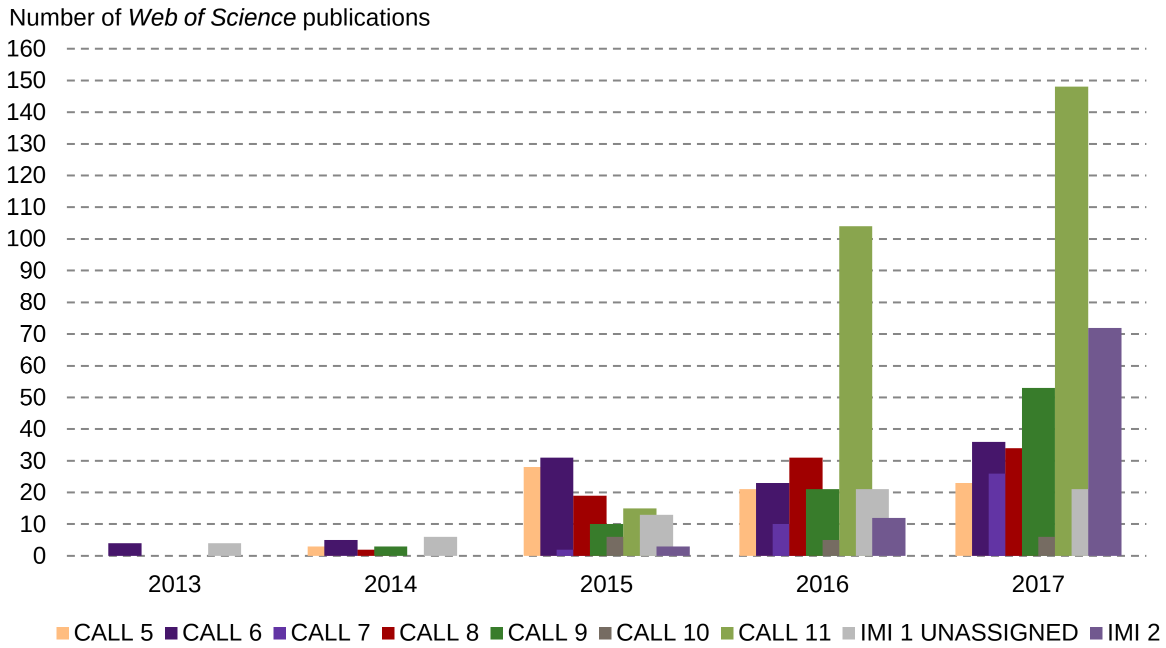


TABLE 5.1.1 SUMMARY BIBLIOMETRIC ANALYSES OF IMI PROJECTS AGGREGATED BY FUNDING CALL, 2010-2017

IMI Call	Number of Publications[9]	% Publications in Open access journals	Number of Papers	Raw citation impact	Citation Impact Normalised at field level (nci_F)	Citation Impact Normalised at journal level (nci_J)
1	957	49.9%	912	20.71	1.83	1.20
2	926	62.2%	883	16.60	1.99	1.23
3	569	58.6%	529	14.01	2.05	1.20
4	553	46.4%	544	10.38	2.08	1.41
5	75	46.7%	75	5.63	1.33	1.07
6	99	51.5%	98	7.11	1.39	1.03
7	38	60.5%	33	2.82	2.97	1.70
8	86	57.0%	76	5.43	1.29	1.03
9	87	39.1%	80	5.21	2.72	2.47
10	17	70.6%	17	3.24	1.13	1.25
11	267	61.0%	251	5.97	2.51	1.37
IMI 2	88	70.0%	76	2.04	1.66	0.74
Unassigned	63	60.0%	61	7.09	1.37	1.07

- IMI call 1 generated the highest number of Web of Science publications (957), and papers (912). Of the 957 publications in call 1, around half (49.9%) were published in open access journals. The publications generated by IMI 1 call 1 also had the highest raw citation impact (20.71).

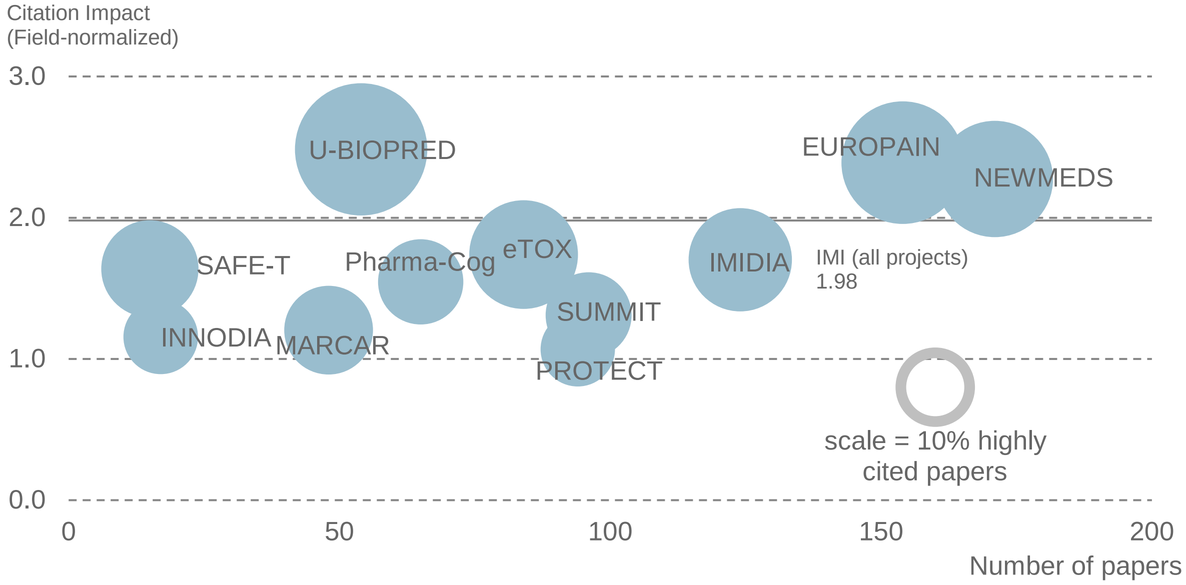
[9] Publications can be associated with more than one call.

- Papers assigned to call 7 had the highest average field normalised citation impact (2.97), though it should be noted this is an average for only 33 papers.

5.2 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 1

Figure 5.2.1 presents an analysis of IMI-supported research published by IMI 1, call 1 projects. Only projects with at least 10 papers and one highly-cited paper over the time period (2010-2017) are shown. The number of papers, average citation impact and share of highly-cited papers are compared. The area of the 'bubble' is proportional to the share of highly-cited papers. The solid horizontal line indicates the average citation impact for all IMI project papers.

FIGURE 5.2.1 PAPER NUMBERS, AVERAGE CITATION IMPACT AND SHARE OF HIGHLY-CITED RESEARCH FOR SELECTED IMI PROJECTS – CALL 1, 2010-2017



The data in Figure 5.2.1 shows that:

- The average citation impact of all projects with at least 10 publications was above the world average (1.0) and the percentage of highly-cited research was above the world average (10%). This shows excellent research performance of IMI-associated research.
- Research associated with three of the projects that had at least 10 publications (NEWMEDS, EUROPAIN, U-BIOPRED) in call 1 was cited more than twice the world average.
- Of the 11 projects in call 1, three (NEWMEDS, EUROPAIN, U-BIOPRED) had papers with an average citation impact greater than the average citation impact of all IMI project papers (1.98).

Table 5.2.1 shows citation impact normalised against world average values and expands on the data shown in Figure 5.2.1. Table 5.2.2 shows the raw citation impact and the percentage of publications in open access papers by project for call 1 publications.

TABLE 5.2.1 SUMMARY CITATION INDICATORS FOR IMI PROJECTS IN CALL 1, 2010-2017

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level (nci_F)**	**Normalised at journal level (nci_J)**	**Average Percentile**	**% Highly cited papers**
eTOX	84	1.74	1.48	33.66	25.00%
EUROPAIN	154	2.39	1.46	27.89	31.82%
IMIDIA	124	1.70	1.18	32.88	22.58%
INNODIA	17	1.16	0.91	70.87	11.76%
MARCAR	48	1.20	0.93	40.49	16.67%
NEWMEDS	171	2.27	1.18	33.15	28.65%
Pharma-Cog	65	1.55	1.00	42.08	15.38%
PROTECT	94	1.07	1.04	39.96	11.70%
SAFE-T	15	1.64	1.53	29.35	20.00%
SUMMIT	96	1.31	0.88	47.20	15.63%
U-BIOPRED	54	2.48	1.34	25.27	37.04%
Overall (IMI projects)	**3550**	**1.98**	**1.26**	**35.77**	**25.55%**

TABLE 5.2.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 1, 2010-2017

Project	**Number of Publications**	**Number of Papers**	**% Publications in Open access journals**	**Citations**	**Raw citation impact**
eTOX	86	84	59.3%	1799	21.37
EUROPAIN	154	154	35.1%	4119	26.75
IMIDIA	127	124	78.0%	2666	21.50
INNODIA	19	17	36.8%	28	1.65
MARCAR	49	48	79.6%	693	14.38
NEWMEDS	173	171	50.3%	5285	30.88
Pharma-Cog	69	65	26.1%	1294	19.91
PROTECT	95	94	38.9%	1018	10.83
SAFE-T	17	15	29.4%	194	12.93
SUMMIT	99	96	65.7%	1346	14.02
U-BIOPRED	79	54	26.6%	1334	24.54

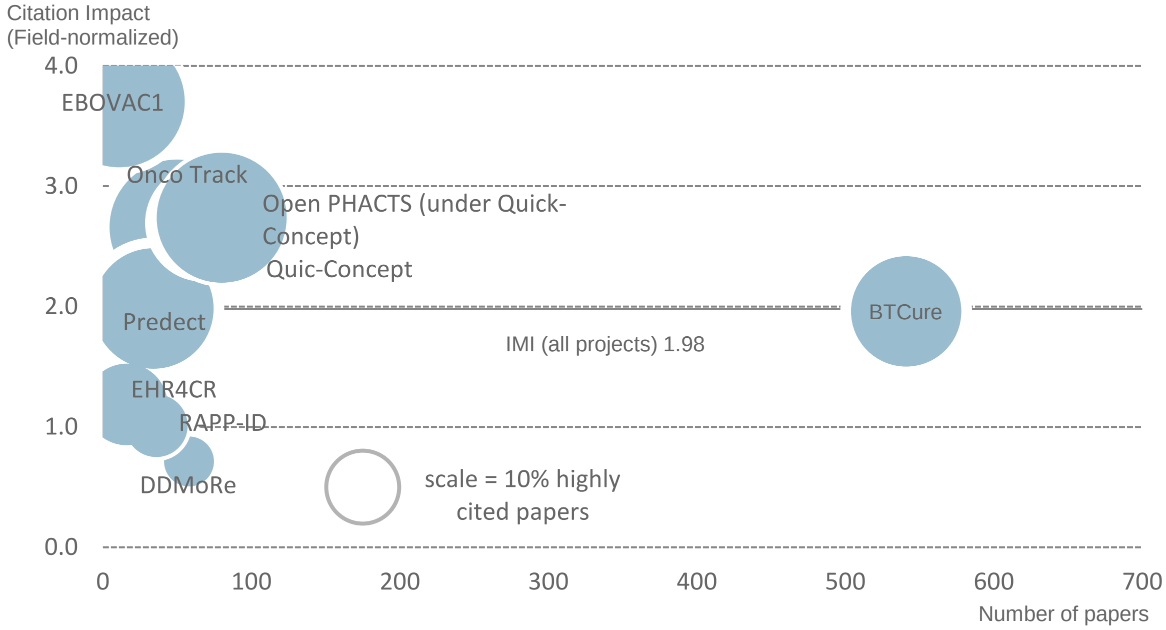
- Of the projects in call 1, IMDIA had the highest number of publications in open access journals (99), and MARCAR had the highest percentage of publications in open access journals (79.6%).
- There is a step change in the percentage of papers seen in open access journals compared to the previous reports. This is likely not representative of a real difference in publishing behaviour, but a result of increased resolution as Clarivate Analytics has improved its coverage of open access publications.[10]

[10] Easing Access to Open Access: Clarivate Analytics partners with Impactstory: https://clarivate.com/blog/easing-access-to-open-access-clarivate-analytics-partners-with-impactstory/

5.3 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 2

Figure 5.3.1 presents an analysis of IMI-supported research published by IMI 1, call 2 projects. Only projects with at least 10 papers and one highly-cited paper over the time period (2010-2017) are shown. The number of papers, average citation impact and share of highly-cited papers are compared. The area of the 'bubble' is proportional to the share of highly-cited papers. The solid horizontal line indicates the average citation impact for all IMI project papers.

FIGURE 5.3.1 PAPER NUMBERS, AVERAGE CITATION IMPACT AND SHARE OF HIGHLY-CITED RESEARCH



FOR SELECTED IMI PROJECTS – CALL 2, 2010-2017

The data in Figure 5.3.1 shows that:

- The average citation impact of most call 2 projects was above world average. RAPP-ID had a citation impact very close to world average (1.01).
- BTCURE was by far the most prolific IMI call 2 project with 541 papers at the end of 2017. The citation impact of this research was twice the world average (1.96).
- Research associated with EBOVAC1 was very well-cited with a citation impact of well over three times (3.70) the world average. It should be noted that this project only only published 11 papers by the end of 2017.
- QUIC-CONCEPT, Open PHACTS and Onco Track were also very well-cited with a citation impact of more than twice the world average; 2.74, 2.69 and 2.66 respectively.
- Four of the nine projects in this call had an average citation impact greater than the citation impact of all IMI project papers, and Predect was exactly at the IMI average.

Table 5.3.1 shows citation impact normalised against world average values for call 2 and is an expansion of the data used in Figure 5.3.1. Table 5.3.2 shows raw citation impact and the percentage of open access papers by project for call 2 publications.

TABLE 5.3.1 SUMMARY CITATION INDICATORS FOR IMI PROJECTS IN CALL 2, 2010-2017

Project	Number of Papers	Citation Impact Normalised at field level (nci_F)	Normalised at journal level (nci_J)	Average Percentile	% Highly cited papers
BTCure	541	1.96	1.13	34.40	27.54%
DDMoRe	58	0.71	0.71	62.27	6.90%
EBOVAC1	11	3.70	1.43	32.76	36.36%
EHR4CR	16	1.19	1.31	48.07	12.50%
Onco Track	50	2.66	1.33	27.12	40.00%
Open PHACTS	68	2.69	1.77	44.65	22.06%
Predect	34	1.98	1.47	38.18	32.35%
Quic-Concept	80	2.74	1.70	38.37	33.75%
RAPP-ID	36	1.01	1.00	42.97	8.33%
Overall (IMI projects)	**3550**	**1.98**	**1.26**	**35.77**	**25.55%**

TABLE 5.3.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 2, 2010-2017

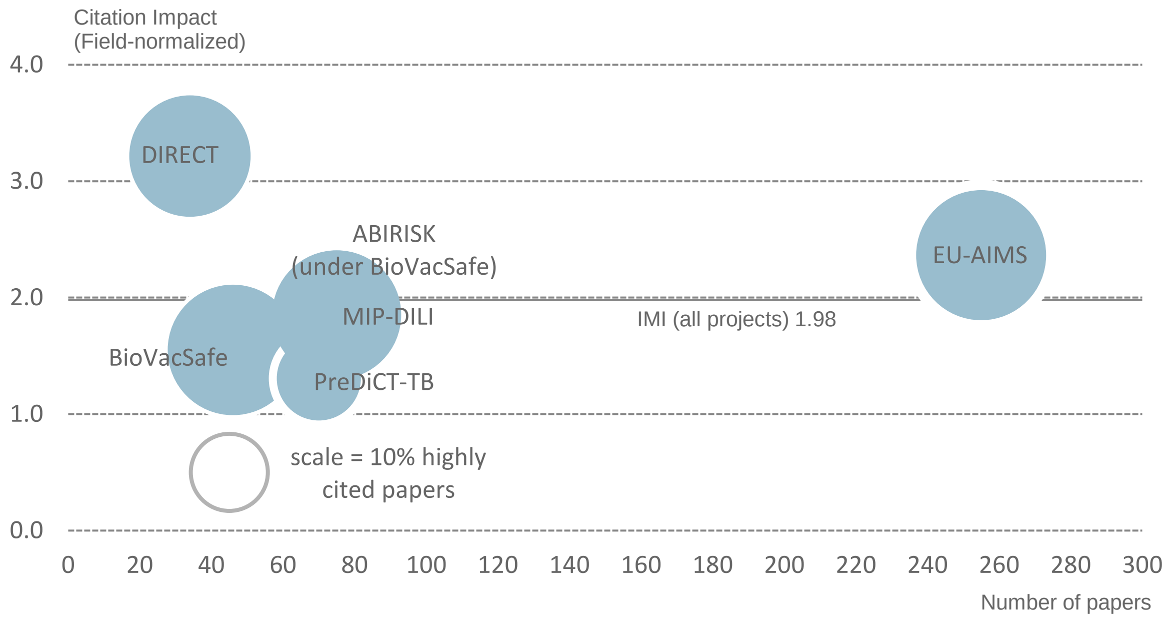
Project	Number of Publications	Number of papers	% Publications in Open access journals	Citations	Raw citation impact
BTCure	573	541	59.2%	9098	16.72
DDMoRe	61	58	63.9%	327	5.60
EBOVAC1	13	11	100.0%	68	6.09
EHR4CR	16	16	75.0%	124	7.75
Onco Track	53	50	58.5%	1664	33.26
Open PHACTS	71	68	84.5%	1496	19.43
Predect	36	34	77.8%	445	13.09
Quic-Concept	80	80	61.3%	1826	22.82
RAPP-ID	36	36	50.0%	396	11.00

- Among the projects with at least 10 publications, BTCURE was the project with the highest number of open access publications (339), but all of EBOVAC1's 13 publications were open access.

5.4 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 3

Figure 5.4.1 presents an analysis of research published by IMI 1, call 3 projects. Only projects with at least ten papers and one highly-cited paper over the time period (2010-2017) are shown. The number of papers, average citation impact and share of highly-cited papers are compared. The area of the 'bubble' is proportional to the share of highly-cited papers. The solid horizontal line indicates the average citation impact for all IMI project papers.

FIGURE 5.4.1 PAPER NUMBERS, AVERAGE CITATION IMPACT AND SHARE OF HIGHLY-CITED RESEARCH FOR SELECTED IMI PROJECTS – CALL 3, 2010-2017



The data in Figure 5.4.1 shows that:

- The average citation impact of all projects in this call was above world average.
- EU-AIMS was by far the most prolific call 3 project with 255 papers by the end of 2017. The citation impact of this research was more than twice the world average (2.36).
- Research associated with DIRECT was also very well-cited with a citation impact that was over three times the world average (3.22).
- Two of the six projects in call 3 had an average citation impact greater than the citation impact of all IMI related projects.

Table 5.4.1 shows citation impact normalised against world average values for IMI call 3 projects and is an expansion of the data shown in Figure 5.4.1. Table 5.4.2 shows raw citation impact and the percentage of open access papers by project for call 3 publications.

TABLE 5.4.1 SUMMARY CITATION INDICATORS FOR IMI PROJECTS IN CALL 3, 2010-2017

Project	Number of Papers	Citation Impact: Normalised at field level (nci_F)	Citation Impact: Normalised at journal level (nci_J)	Average Percentile	% Highly cited papers
ABIRISK	48	1.49	1.17	45.48	18.75%
BioVacSafe	46	1.55	1.18	37.71	30.43%
DIRECT	34	3.22	1.21	46.85	26.47%
EU-AIMS	255	2.36	1.22	34.17	33.33%
MIP-DILI	75	1.85	1.45	38.85	28.00%
PreDiCT-TB	70	1.31	0.91	47.45	14.29%
Overall (IMI projects)	**3550**	**1.98**	**1.26**	**35.77**	**25.55%**

TABLE 5.4.2 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 3, 2010-2017

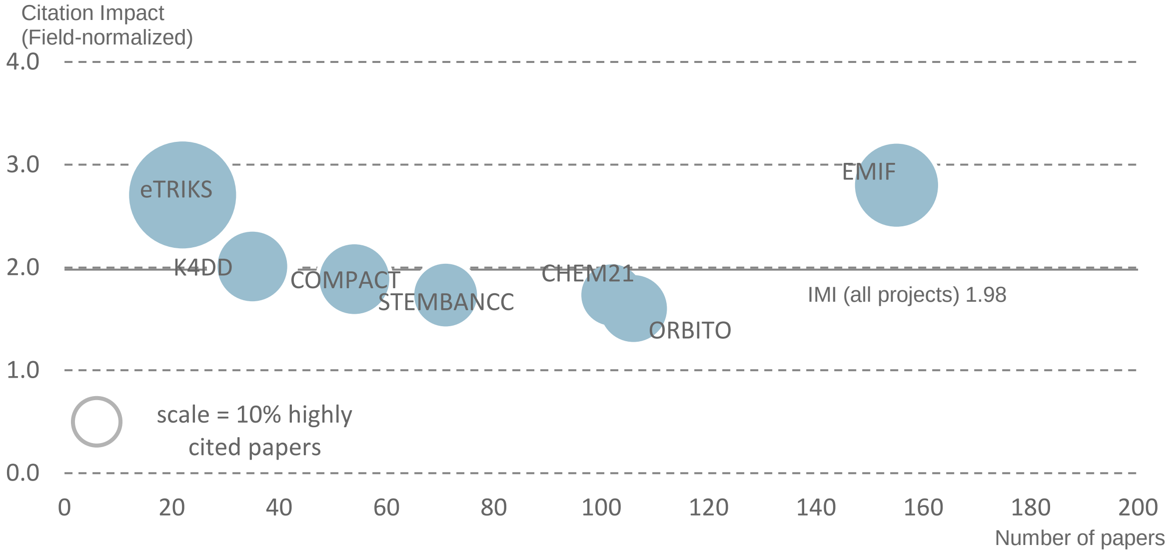
Project	Number of Publications	Number of papers	% Publications in Open access journals	Citations	Raw citation impact
ABIRISK	57	48	42.1%	617	12.85
BioVacSafe	48	46	68.8%	728	15.80
DIRECT	49	34	51.0%	556	16.35
EU-AIMS	262	255	59.2%	4851	18.88
MIP-DILI	82	75	48.8%	626	8.27
PreDiCT-TB	70	70	78.6%	598	8.54

- Among the projects with at least 10 publications, EU-AIMS was the project with the highest number of publications in open access journals (44) but PreDiCT-TB had the highest percentage of publications in open access journals (26.4%).

5.5 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 4

Table 5.5.1 presents an analysis of research published by IMI 1, call 4 projects. Only projects with at least ten papers and one highly-cited paper over the time period (2010-2017) are shown. The number of papers, average citation impact and share of highly-cited papers are compared. The area of the 'bubble' is proportional to the share of highly-cited papers. The solid horizontal line indicates the average citation impact for all IMI project papers.

FIGURE 5.5.1 PAPER NUMBERS, AVERAGE CITATION IMPACT AND SHARE OF HIGHLY-CITED RESEARCH FOR SELECTED IMI PROJECTS – CALL 4, 2010-2017



The data in Figure 5.5.1 shows that:

- The average citation impact of all projects in this call is above world average.
- EMIF produced the highest number of papers in call 4, with 155 to the end of 2017.
- Research associated with EMIF and eTRICKS was very well-cited with citation impacts of 2.80 and 2.71, respectively.
- Three of the seven projects in this call had an average citation impact greater than the citation impact of all IMI related projects.

Table 5.5.1 presents indicators where citation impact has been normalised against world average values and is an expansion of the data used in Figure 5.5.1. Table 5.5.2 shows raw citation impact and the percentage of open access papers by project for call 4 publications.

TABLE 5.5.1 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 4, 2010-2016

Project	Number of Papers	Citation Impact Normalised at field level (nci_F)	Normalised at journal level (nci_J)	Average Percentile	% Highly cited papers
CHEM21	102	1.73	1.38	40.27	16.67%
COMPACT	54	1.89	1.45	40.41	24.07%
EMIF	155	2.80	1.45	38.13	33.55%
eTRIKS	22	2.71	2.27	26.32	54.55%
K4DD	35	2.01	1.33	34.67	28.57%
ORBITO	106	1.60	1.28	46.73	19.81%
STEMBANCC	71	1.73	1.33	45.14	19.72%
Overall (IMI projects)	**3550**	**1.98**	**1.26**	**35.77**	**25.55%**

TABLE 5.5.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 4, 2010-2017

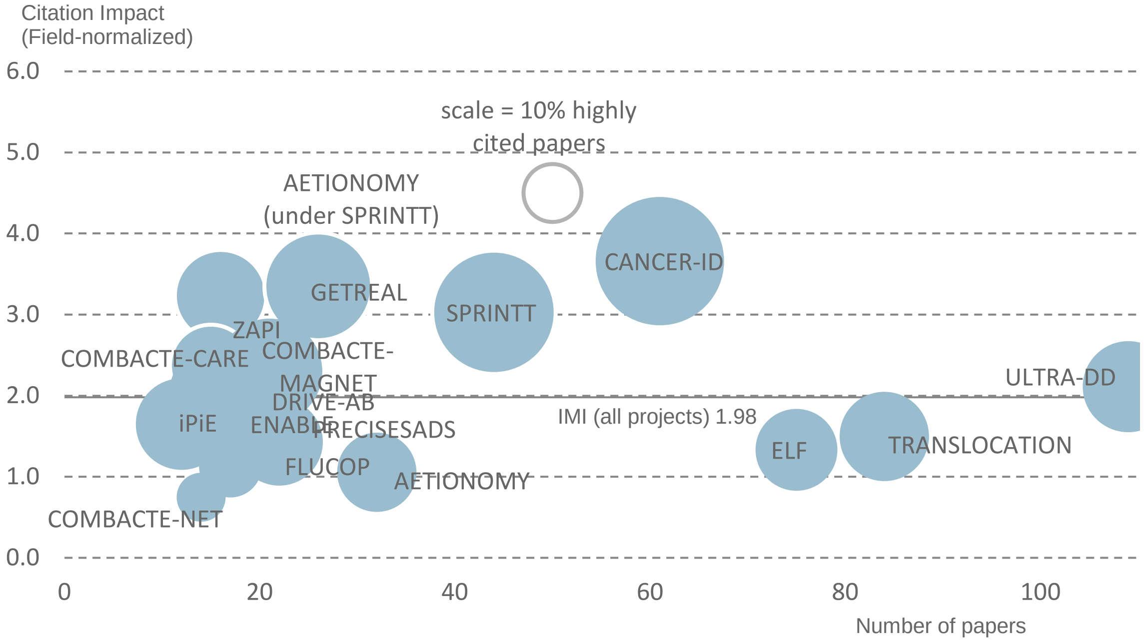
Project	Number of Publications	Number of Papers	% Publications in Open access journals	Citations	Raw citation impact
CHEM21	105	102	25.7%	1310	12.83
COMPACT	54	54	31.5%	586	10.85
EMIF	160	155	67.5%	1954	12.60
eTRIKS	22	22	77.3%	225	10.23
K4DD	35	35	57.1%	245	7.00
ORBITO	107	106	19.6%	836	7.86
STEMBANCC	71	71	66.2%	596	8.39

- EMIF has the highest number of citations (1954) and has a citation impact just lower than CHEM21 which has the highest.
- EMIF is the project with the highest number of publications (108) in open access journals and eTRICKS has the highest percentage in open access journals (77.3%)

5.6 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 5-11

Figure 5.6.1 presents an analysis of IMI-supported research published by IMI 1, call 5-11 projects. Only projects with at least ten papers and one highly-cited paper over the time period analysed (2010-2017) are shown. The number of papers, average citation impact and share of highly-cited papers are compared. The area of the 'bubble' is proportional to the share of highly-cited papers. The solid horizontal line indicates the average citation impact for all IMI project papers.

FIGURE 5.6.1 PAPER NUMBERS, AVERAGE CITATION IMPACT AND SHARE OF HIGHLY-CITED RESEARCH FOR SELECTED IMI PROJECTS – CALL 5-11, 2010-2017



The data in Figure 5.6.1 shows that:

- Research associated with CANCER-ID was very well-cited with a citation impact of more than three and a half times the world average (3.66), and 49.18% of papers that are highly-cited.

Table 5.6.1 presents indicators where citation impact has been normalised against world average values and is an expansion of the data used in Figure 5.6.1. Table 5.6.2 shows raw citation impact and the percentage of open access papers by project for call 5-11 publications.

TABLE 5.6.1 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 5-11, 2010-2017

Project	Number of Papers	Citation Impact Normalised at field level (nci_F)	Normalised at journal level (nci_J)	Average Percentile	% Highly cited papers
AETIONOMY	32	1.06	0.77	53.69	18.75%
APPROACH	16	3.23	1.63	40.39	25.00%
CANCER-ID	61	3.66	1.66	24.11	49.18%
COMBACTE-CARE	15	2.37	2.01	35.52	20.00%
COMBACTE-MAGNET	19	1.97	1.51	55.09	21.05%
COMBACTE-NET	14	0.75	0.44	74.73	7.14%
DRIVE-AB	16	2.03	1.18	40.98	31.25%
ELF	75	1.33	1.07	44.26	20.00%
ENABLE	12	1.65	1.37	31.19	25.00%
FLUCOP	17	1.13	1.25	47.55	11.76%
GETREAL	26	3.35	1.86	33.28	34.62%
iPiE	16	1.60	1.68	49.44	18.75%
PRECISESADS	22	1.43	0.88	41.93	22.73%
SPRINTT	44	3.03	2.85	26.72	45.45%
TRANSLOCATION	84	1.50	1.13	40.14	23.81%
ULTRA-DD	109	2.11	1.17	47.17	24.77%
ZAPI	21	2.30	1.22	52.35	33.33%
Overall (IMI projects)	**3550**	**1.98**	**1.26**	**35.77**	**25.55%**

TABLE 5.6.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 5-11, 2010-2017

Project	Number of Publications	Number of Papers	% Open access journals	Citations	Raw citation impact
AETIONOMY	33	32	63.6%	130	4.06
APPROACH	17	16	70.6%	113	7.06
CANCER-ID	69	61	56.5%	638	10.36
COMBACTE-CARE	16	15	37.5%	45	3.00
COMBACTE-MAGNET	22	19	54.5%	43	2.11
COMBACTE-NET	15	14	60.0%	9	0.64
DRIVE-AB	20	16	45.0%	141	8.56
ELF	75	75	46.7%	422	5.63
ENABLE	12	12	75.0%	101	8.42
FLUCOP	17	17	70.6%	55	3.24
GETREAL	31	26	58.1%	77	2.65
iPiE	16	16	50.0%	32	2.00
PRECISESADS	29	22	34.5%	188	8.55
SPRINTT	45	44	35.6%	242	5.48
TRANSLOCATION	84	84	50.0%	695	8.27

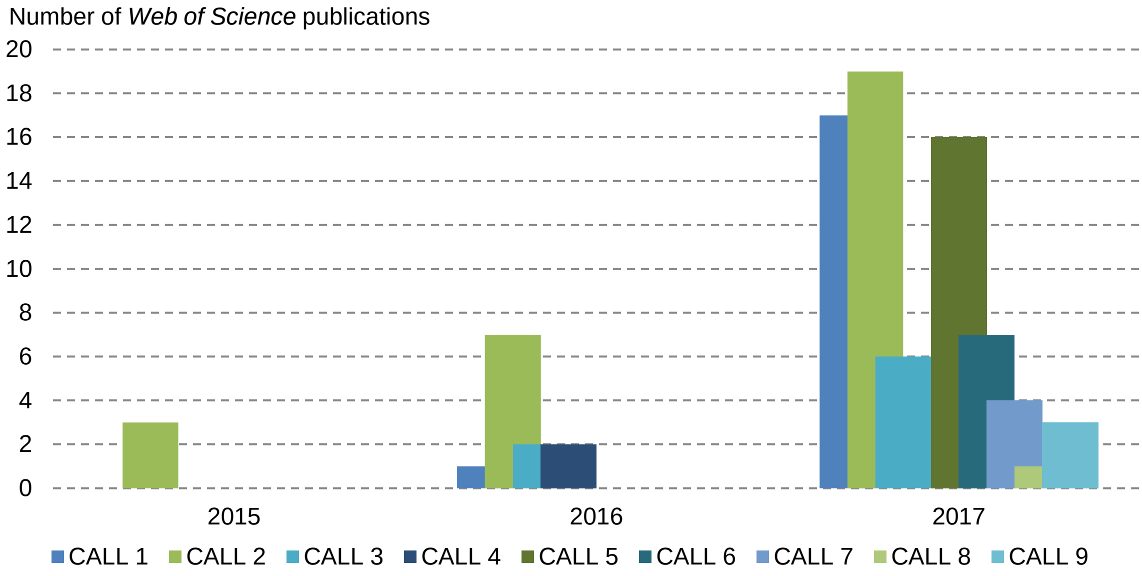
Project	Number of Publications	Number of Papers	% Open access journals	Citations	Raw citation impact
ULTRA-DD	110	109	62.7%	579	5.30
ZAPI	22	21	72.7%	125	5.86

- ENABLE has the highest percentage (75.0%) of publications in open access journals with a raw citation impact of 8.42, second highest in calls 5-7 in the range 2010-2017.
- ULTRA-DD has the highest number of publications (110) but TRANSLOCATION has the most citations (695).

5.7 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI 2 PROJECTS

Figure 5.7.1 shows trends in publication output of IMI 2 funding call projects. Table 5.7.1 presents summary bibliometric data for IMI 2 calls, including the number of publications, the number of papers, and the average citation impact.

FIGURE 5.7.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL 2015-2017 FOR IMI 2 PROJECTS



- IMI 2 projects from call 2 generated the greatest number of publications from 2015-2017.

TABLE 5.7.1 SUMMARY BIBLIOMETRIC ANALYSES OF IMI 2 PROJECTS AGGREGATED BY FUNDING CALL, 2015-2017

IMI Call	Number of Publications[11]	% Publications in Open access journals	Number of Papers	Raw citation impact	Citation Impact Normalised at field level (nci_F)	Citation Impact Normalised at journal level (nci_J)
1	18	38.9%	16	1.19	1.20	0.93
2	29	77.4%	27	3.34	1.92	0.93
3	8	62.5%	7	3.43	2.45	0.54
4	2	0.0%	2	2.00	0.67	0.36
5	16	70.6%	14	0.73	0.88	0.56
6	7	57.1%	3	0.00	0.00	0.00
7	4	75.0%	3	5.00	5.68	0.70
8	1	0.0%	1	3.00	4.46	1.24
9	3	66.7%	3	1.00	1.37	0.17

- Call 2 has the highest number of publications and the highest proportion in open access journals.

[11] Publications can be associated with more than one call.

Figure 5.6.1 and Table 5.7.3 present an analysis of IMI-supported research published by IMI 2 projects. Table 5.7.2 presents indicators where citation impact has been normalised against world average values. Table 5.7.3 shows raw citation impact and percentage of open access journals by project for IMI 2 publications.

TABLE 5.7.2 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI 2 PROJECTS, 2015-2017

Project	Number of Papers	Citation Impact: Normalised at field level (nci_F)	Citation Impact: Normalised at journal level (nci_J)	Average Percentile	% Highly cited papers
ADAPTED	1	1.62	0.56	22.21	0.0%
ADAPT-SMART	2	0.67	0.36	63.37	0.0%
AMYPAD	1	0.00	0.00	100.00	0.0%
BEAT-DKD	10	1.00	0.72	67.51	10.0%
BigData@Heart	0	0.00	0.00	0.00	0.0%
EBODAC	1	0.00	0.00	100.00	0.0%
Ebola+	1	4.46	1.24	4.80	100.0%
EbolaMoDRAD	10	0.68	0.86	71.94	0.0%
EBOVAC1	11	3.70	1.43	32.76	36.4%
EBOVAC2	2	0.00	0.00	100.00	0.0%
FILODIAG	1	0.00	0.00	100.00	0.0%
HARMONY	1	0.00	0.00	100.00	0.0%
IMPRiND	2	8.52	1.05	50.16	50.0%
INNODIA	16	1.20	0.93	71.50	12.5%
PHAGO	3	0.54	0.19	74.07	0.0%
PREFER	0	0.00	0.00	0.00	0.0%
PRISM	1	0.00	0.00	100.00	0.0%
RADAR-CNS	2	0.23	0.09	82.79	0.0%
RHAPSODY	4	4.17	0.89	30.59	50.0%
ROADMAP	1	0.00	0.00	100.00	0.0%
RTCure	3	1.37	0.17	68.27	33.3%
TransQST	1	0.00	0.00	100.00	0.0%
TRISTAN	1	0.00	0.00	100.00	0.0%
VSV-EBOVAC	4	2.04	0.69	32.17	50.0%
Overall (IMI projects)	**3550**	**1.98**	**1.26**	**35.77**	**25.5%**

TABLE 5.7.3 BIBLIOMETRIC INDICATORS FOR IMI 2 PROJECTS, 2015-2017

Project	Number of Publications	Number of Papers	% Open access journals	Citations	Raw citation impact
ADAPTED	1	1	100.0%	1	1.00
ADAPT-SMART	2	2	0.0%	4	2.00
AMYPAD	1	1	100.0%	0	0.00
BEAT-DKD	10	10	60.0%	9	0.90
BigData@Heart	1	0	0.0%	0	0.00
EBODAC	1	1	100.0%	0	0.00
Ebola+	1	1	0.0%	3	3.00
EbolaMoDRAD	10	10	50.0%	7	0.70
EBOVAC1	13	11	100.0%	68	6.09
EBOVAC2	2	2	100.0%	0	0.00
FILODIAG	1	1	100.0%	0	0.00
HARMONY	3	1	66.7%	1	0.00
IMPRiND	2	2	100.0%	15	7.50
INNODIA	18	16	38.9%	19	1.19
PHAGO	3	3	100.0%	1	0.33
PREFER	2	0	50.0%	1	0.00
PRISM	1	1	100.0%	0	0.00
RADAR-CNS	2	2	50.0%	1	0.50
RHAPSODY	5	4	60.0%	23	5.57
ROADMAP	3	1	33.3%	0	0.00
RTCure	3	3	66.7%	3	1.00
TransQST	1	1	100.0%	0	0.00
TRISTAN	1	1	100.0%	0	0.00
VSV-EBOVAC	4	4	50.0%	23	5.75

- INNODIA has the highest number of papers (16) but EBOVAC1 has the highest number of citations (68), with a raw citation impact of 6.09.
- Very low paper counts make it difficult to draw firm conclusions from average citation impact indicators. However, the IMPRiND project had the highest field normalised citation impact (8.52) followed by Ebola+ (4.46).

6 COLLABORATION ANALYSIS FOR IMI RESEARCH

6.1 COLLABORATION ANALYSIS FOR IMI RESEARCH

International research collaboration is a rapidly growing aspect of research activity.[12] The reasons for this have not been fully clarified but include increasing access to facilities, resources, knowledge, people and expertise. In addition, international collaboration has been shown to be associated with an increase in the number of citations received by research papers, although this does depend upon the partner countries involved.[13] Co-authorship is likely to be a good indicator of collaboration, although there will be collaborations that do not result in co-authored papers, and co-authored papers which may have required limited collaboration. Alternative data-based approaches, for example using information about co-funding or international exchanges, have limitations in terms of both comprehensiveness and validity.

In this report, co-authorship is used as a measure of collaboration. Table 6.1.1 compares the output and citation impact of IMI project papers that are co-authored between different sectors, institutions and countries. In this analysis the sectors are defined as academic, corporate, government, medical, or other[14]. A paper is defined as cross-sector if the listed addresses are for organisations from more than one sector. For example, if a paper has addresses corresponding to the University of Copenhagen and the company Novartis, it would be classified as cross-sector. If a paper has addresses corresponding to the University of Cambridge and Utrecht University, it would be classified as single-sector since both addresses are academic institutions. A paper is defined as cross-institution if more than one institution is listed in the addresses. A paper is defined as international if more than one country is listed in the addresses, or domestic if a single country is listed.

The data in Table 6.1.1 show that IMI project research is collaborative at the sector, institution and country level.

TABLE 6.1.1 CROSS-SECTOR, CROSS-INSTITUTION AND INTERNATIONAL OUTPUT – IMI PROJECT RESEARCH, 2010-2016

	Number of papers	Percentage of Papers	Citation impact (normalised at field level)
Cross-sector	2117	59.7%	2.72
Single-sector	1428	40.3%	2.09
Cross-institution	2954	83.3%	2.64
Single-institution	591	16.7%	1.77
International	2126	60.0%	2.80
Domestic	1419	40.0%	1.97

- Over half (59.7%) of all IMI project papers were published by researchers affiliated with different sectors.
- More than three-quarters (83.3%) of IMI project papers involved collaboration between institutions.
- More than half (60%) of all IMI project papers were internationally collaborative.

[12] Adams J (2013). Collaborations: the fourth age of research. Nature, 497, 557-560.

[13] Adams, J., Gurney, K., & Marshall, S. (2007). Patterns of international collaboration for the UK and leading partners. A report by *Evidence* Ltd to the UK Office of Science and Innovation. 27pp.

[14] These sectors are: academic, corporate, medical, government, or other. Medical includes hospitals and institutions that provide information to patients such as the American Cancer Society. Government includes state or federally funded research institutions such as NIH or the World Health Organization (WHO). Other includes any other research institutions.

- Collaborative IMI project research was internationally influential with a citation impact well over twice the world average (1.0). Collaborative IMI research also had more of an impact than non-collaborative IMI project research.

6.2 COLLABORATION ANALYSIS BY IMI PROJECT

In this section, the collaboration of IMI research is presented at the more granular level of individual projects. Table 6.2.1 shows the number, percentage and citation impact of IMI-supported research papers with authors from more than one country. Table 6.2.2 shows number, percentage, and citation impact of IMI-supported research papers with authors from more than one institution. Table 6.2.3 shows number, percentage and citation impact of IMI-supported research papers with authors from more than one sector. This section also presents maps of international collaboration for the five IMI projects with the highest number of publications. The projects included are BTCURE, EU-AIMS, NEWMEDS, EUROPAIN, and IMIDIA. The countries with the most frequent collaboration are shaded purple, those with little collaboration in white, and those with no collaboration in grey.

It should be noted that the last column in Table 6.2.1-6.2.3 does not show the citation impact of all papers for that project, rather it is the citation impact of those papers involving collaboration of the type being analysed. Therefore, in Table 6.2.1, the last column contains the citation impact of only the internationally collaborative papers for each project. Similarly, the last column in Table 6.2.2 contains only the citation impact of the papers from more than one institution, and in Table 6.2.3, the last column contains only the citation impact of cross sector papers.

The key findings of this section are:

- BTCURE had the highest number of papers with authors from more than one country, institution and sector (Table 6.1.1-6.2.3). This may due to BTCURE having the highest overall number of papers.
- EU-AIMS had the second highest number of papers with authors from more than one country, institution and sector (Table 6.1.1-6.2.3).
- The majority of collaborative papers from the top five projects were co-authored with researchers from the United States (USA) and Europe (Figure 6.2.1-6.2.5).
- For BTCURE, there were also substantial collaborations with China, and Japan (Figure 6.2.1). EU-AIMS also had substantial collaborations with Canada and China (Figure 6.2.2), and NEWMEDS also had substantial collaborations with Canada (Figure 6.2.3).

TABLE 6.2.1 NUMBER, PERCENTAGE AND CITATION IMPACT[15] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE COUNTRY, 2010-2017

Project	Number of papers	Number of internationally collaborative papers	Percentage of internationally collaborative papers	Citation impact (normalised at field level)
BTCure	541	313	57.9%	2.16
EU-AIMS	255	181	71.0%	2.50
NEWMEDS	171	109	63.7%	2.35
EMIF	155	112	72.3%	3.29
EUROPAIN	154	62	40.3%	2.94
IMIDIA	124	69	55.6%	1.96
ULTRA-DD	109	81	74.3%	2.10
ORBITO	106	60	56.6%	1.64
CHEM21	102	36	35.3%	2.29
SUMMIT	96	62	64.6%	1.53
PROTECT	94	69	73.4%	1.18
TRANSLOCATION	84	49	58.3%	1.68
eTOX	84	34	40.5%	1.62
Quic-Concept	80	55	68.8%	3.27
ELF	75	41	54.7%	1.32
MIP-DILI	75	40	53.3%	1.99
STEMBANCC	71	38	53.5%	1.90
PreDiCT-TB	70	40	57.1%	1.59
Open PHACTS	68	42	61.8%	2.60
Pharma-Cog	65	53	81.5%	1.73
CANCER-ID	61	29	47.5%	5.07
DDMoRe	58	36	62.1%	0.70
U-BIOPRED	54	35	64.8%	3.22
COMPACT	54	25	46.3%	1.85
Onco Track	50	24	48.0%	3.06
ABIRISK	48	22	45.8%	1.52
MARCAR	48	23	47.9%	1.51
BioVacSafe	46	21	45.7%	1.48
SPRINTT	44	28	63.6%	3.27
COMBACTE	39	15	38.5%	1.56
RAPP-ID	36	17	47.2%	0.98
K4DD	35	20	57.1%	2.55
Predect	34	24	70.6%	1.96
DIRECT	34	24	70.6%	3.39
AETIONOMY	32	15	46.9%	1.10
GETREAL	26	23	88.5%	2.86
ND4BB	24	13	54.2%	1.46
PRO-active	24	20	83.3%	2.51
PRECISESADS	22	17	77.3%	1.52

[15] The last column is the citation impact of only the internationally collaborative papers.

Project	Number of papers	Number of internationally collaborative papers	Percentage of internationally collaborative papers	Citation impact (normalised at field level)
eTRIKS	22	21	95.5%	2.84
ZAPI	21	15	71.4%	2.36
COMBACTE-MAGNET	19	14	73.7%	2.10
INNODIA	17	13	76.5%	1.48
FLUCOP	17	13	76.5%	1.42
APPROACH	16	15	93.8%	3.45
DRIVE-AB	16	10	62.5%	2.07
iPiE	16	3	18.8%	0.91
EHR4CR	16	11	68.8%	1.42
SAFE-T	15	9	60.0%	2.01
COMBACTE-CARE	15	13	86.7%	2.50
COMBACTE-NET	14	8	57.1%	1.27
ENABLE	12	5	41.7%	1.14
EBOVAC1	11	7	63.6%	4.95
EbolaMoDRAD	10	6	60.0%	1.13
EBiSC	10	8	80.0%	1.29
BEAT-DKD	10	7	70.0%	0.82
ADVANCE	7	6	85.7%	1.49
EPAD	6	5	83.3%	1.60
WEB-RADR	5	5	100.0%	3.21
VSV-EBOVAC	4	3	75.0%	1.93
RHAPSODY	4	3	75.0%	1.89
Structural Genomic Consortium	3	2	66.7%	0.00
PHAGO	3	3	100.0%	0.54
RTCure	3	0	0.0%	0.00
iABC	3	2	66.7%	3.19
SafeSciMET	3	3	100.0%	1.52
RADAR-CNS	2	2	100.0%	0.23
IMPRiND	2	1	50.0%	17.05
EUPATI	2	2	100.0%	1.01
Eu2P	2	1	50.0%	0.00
EBOVAC2	2	2	100.0%	0.00
ADAPT-SMART	2	1	50.0%	1.33
TransQST	1	1	100.0%	0.00
TRISTAN	1	1	100.0%	0.00
ADAPTED	1	1	100.0%	1.62
AMYPAD	1	0	0.0%	0.00
EBODAC	1	1	100.0%	0.00
Ebola+	1	1	100.0%	4.46
EMTRAIN	1	1	100.0%	0.16
FILODIAG	1	0	0.0%	0.00
HARMONY	1	1	100.0%	0.00
Pharmatrain	1	1	100.0%	0.00

Project	Number of papers	Number of internationally collaborative papers	Percentage of internationally collaborative papers	Citation impact (normalised at field level)
PRISM	1	0	0.0%	0.00
ROADMAP	1	1	100.0%	0.00
PREFER	0	0	0.0%	0.00
BigData@Heart	0	0	0.0%	0.00

TABLE 6.2.2 NUMBER, PERCENTAGE AND CITATION IMPACT[16] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE INSTITUTION, 2010-2017

Project	Number of papers	Number of papers from more than one institution	Percentage of papers from more than one institution	Citation impact (normalised at field level)
BTCure	541	437	80.8%	2.06
EU-AIMS	255	239	93.7%	2.38
NEWMEDS	171	155	90.6%	2.34
EMIF	155	143	92.3%	2.97
EUROPAIN	154	99	64.3%	2.68
IMIDIA	124	100	80.6%	1.79
ULTRA-DD	109	101	92.7%	2.10
ORBITO	106	79	74.5%	1.53
CHEM21	102	58	56.9%	1.94
SUMMIT	96	79	82.3%	1.40
PROTECT	94	93	98.9%	1.07
TRANSLOCATION	84	65	77.4%	1.51
eTOX	84	57	67.9%	2.07
Quic-Concept	80	68	85.0%	3.05
ELF	75	54	72.0%	1.27
MIP-DILI	75	58	77.3%	1.72
STEMBANCC	71	55	77.5%	1.87
PreDiCT-TB	70	58	82.9%	1.43
Open PHACTS	68	59	86.8%	3.02
Pharma-Cog	65	63	96.9%	1.57
CANCER-ID	61	55	90.2%	3.85
DDMoRe	58	47	81.0%	0.64
U-BIOPRED	54	47	87.0%	2.67
COMPACT	54	41	75.9%	1.76
Onco Track	50	44	88.0%	2.89
ABIRISK	48	43	89.6%	1.56
MARCAR	48	34	70.8%	1.32
BioVacSafe	46	34	73.9%	1.51
SPRINTT	44	32	72.7%	3.43
COMBACTE	39	32	82.1%	1.41
RAPP-ID	36	26	72.2%	0.98
K4DD	35	30	85.7%	2.22
DIRECT	34	32	94.1%	3.06
Predect	34	28	82.4%	1.84
AETIONOMY	32	32	100.0%	1.06
GETREAL	26	26	100.0%	3.35
ND4BB	24	21	87.5%	1.27
PRO-active	24	24	100.0%	2.17
PRECISESADS	22	22	100.0%	1.43

[16] The last column in is only the citation impact of the papers from more than one institution.

Project	Number of papers	Number of papers from more than one institution	Percentage of papers from more than one institution	Citation impact (normalised at field level)
eTRIKS	22	22	100.0%	2.71
ZAPI	21	18	85.7%	1.99
COMBACTE-MAGNET	19	16	84.2%	2.32
FLUCOP	17	15	88.2%	1.28
INNODIA	17	16	94.1%	1.23
APPROACH	16	16	100.0%	3.23
DRIVE-AB	16	12	75.0%	2.16
iPiE	16	13	81.3%	1.67
EHR4CR	16	16	100.0%	1.19
SAFE-T	15	15	100.0%	1.64
COMBACTE-CARE	15	15	100.0%	2.37
COMBACTE-NET	14	12	85.7%	0.87
ENABLE	12	11	91.7%	1.38
EBOVAC1	11	11	100.0%	3.70
BEAT-DKD	10	10	100.0%	1.00
EBiSC	10	9	90.0%	1.43
EbolaMoDRAD	10	9	90.0%	0.75
ADVANCE	7	6	85.7%	1.49
EPAD	6	6	100.0%	1.33
WEB-RADR	5	5	100.0%	3.21
VSV-EBOVAC	4	3	75.0%	1.93
RHAPSODY	4	3	75.0%	1.89
SafeSciMET	3	3	100.0%	1.52
iABC	3	3	100.0%	2.13
RTCure	3	1	33.3%	0.00
PHAGO	3	3	100.0%	0.54
Structural Genomic Consortium	3	3	100.0%	0.00
ADAPT-SMART	2	2	100.0%	0.67
EBOVAC2	2	2	100.0%	0.00
Eu2P	2	2	100.0%	1.96
EUPATI	2	2	100.0%	1.01
IMPRiND	2	1	50.0%	17.05
RADAR-CNS	2	2	100.0%	0.23
ROADMAP	1	1	100.0%	0.00
PRISM	1	1	100.0%	0.00
Pharmatrain	1	1	100.0%	0.00
HARMONY	1	1	100.0%	0.00
FILODIAG	1	1	100.0%	0.00
EMTRAIN	1	1	100.0%	0.16
Ebola+	1	1	100.0%	4.46
EBODAC	1	1	100.0%	0.00
AMYPAD	1	1	100.0%	0.00
ADAPTED	1	1	100.0%	1.62

Project	Number of papers	Number of papers from more than one institution	Percentage of papers from more than one institution	Citation impact (normalised at field level)
TRISTAN	1	1	100.0%	0.00
TransQST	1	1	100.0%	0.00
PREFER	0	0	0.0%	0.00
BigData@Heart	0	0	0.0%	0.00

TABLE 6.2.3 NUMBER, PERCENTAGE AND CITATION IMPACT[17] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE SECTOR, 2010-2017

Project	Number of papers	Number of cross sector papers	Percentage of cross sector papers	Citation impact (normalised at field level)
BTCure	541	332	61.4%	2.17
EU-AIMS	255	171	67.1%	2.43
NEWMEDS	170	108	63.5%	2.38
EMIF	155	123	79.4%	2.64
EUROPAIN	154	78	50.6%	2.82
IMIDIA	124	64	51.6%	2.03
ULTRA-DD	109	63	57.8%	2.72
ORBITO	106	57	53.8%	1.77
CHEM21	102	21	20.6%	2.39
SUMMIT	96	68	70.8%	1.36
PROTECT	94	92	97.9%	1.07
TRANSLOCATION	84	30	35.7%	1.54
eTOX	84	24	28.6%	1.78
Quic-Concept	80	56	70.0%	2.22
ELF	75	27	36.0%	1.34
MIP-DILI	75	52	69.3%	1.79
STEMBANCC	71	38	53.5%	2.02
PreDiCT-TB	70	39	55.7%	1.31
Open PHACTS	68	41	60.3%	3.15
Pharma-Cog	65	56	86.2%	1.69
CANCER-ID	61	46	75.4%	4.10
DDMoRe	58	33	56.9%	0.71
COMPACT	54	8	14.8%	3.55
U-BIOPRED	54	41	75.9%	2.87
Onco Track	50	28	56.0%	2.86
ABIRISK	48	31	64.6%	1.51
MARCAR	48	21	43.8%	1.37
BioVacSafe	46	20	43.5%	1.46
SPRINTT	43	22	51.2%	3.42
COMBACTE	39	23	59.0%	1.65
RAPP-ID	36	11	30.6%	0.99
K4DD	35	16	45.7%	1.97
DIRECT	34	24	70.6%	2.12
Predect	34	24	70.6%	4.23
AETIONOMY	32	20	62.5%	1.43
GETREAL	26	21	80.8%	3.65
PRO-active	24	24	100.0%	2.17
ND4BB	23	11	47.8%	1.31
eTRIKS	22	15	68.2%	3.26

[17] The last column is only citation impact of cross sector papers.

Project	Number of papers	Number of cross sector papers	Percentage of cross sector papers	Citation impact (normalised at field level)
PRECISESADS	22	15	68.2%	1.55
ZAPI	21	12	57.1%	2.68
COMBACTE-MAGNET	18	12	66.7%	2.31
FLUCOP	17	16	94.1%	1.20
INNODIA	17	9	52.9%	1.41
DRIVE-AB	16	10	62.5%	2.12
APPROACH	16	11	68.8%	2.63
iPiE	16	9	56.3%	0.64
EHR4CR	16	14	87.5%	1.22
COMBACTE-CARE	15	15	100.0%	2.37
SAFE-T	15	15	100.0%	1.64
COMBACTE-NET	14	12	85.7%	0.87
ENABLE	12	4	33.3%	1.30
EBOVAC1	11	6	54.5%	5.77
EBiSC	10	5	50.0%	1.77
EbolaMoDRAD	10	4	40.0%	0.82
BEAT-DKD	10	6	60.0%	0.79
ADVANCE	7	4	57.1%	1.85
EPAD	6	5	83.3%	1.60
WEB-RADR	5	3	60.0%	3.37
RHAPSODY	4	1	25.0%	11.02
VSV-EBOVAC	4	2	50.0%	2.89
PHAGO	3	2	66.7%	0.00
RTCure	3	1	33.3%	0.00
SafeSciMET	3	3	100.0%	1.52
Structural Genomic Consortium	3	2	66.7%	0.00
iABC	3	2	66.7%	3.19
IMPRiND	2	0	0.0%	0.00
ADAPT-SMART	2	2	100.0%	0.67
EUPATI	2	2	100.0%	1.01
Eu2P	2	1	50.0%	0.00
RADAR-CNS	2	1	50.0%	0.45
EBOVAC2	2	1	50.0%	0.00
EMTRAIN	1	1	100.0%	0.16
ROADMAP	1	1	100.0%	0.00
Pharmatrain	1	1	100.0%	0.00
PRISM	1	0	0.0%	0.00
FILODIAG	1	1	100.0%	0.00
AMYPAD	1	0	0.0%	0.00
Ebola+	1	1	100.0%	4.46
TransQST	1	1	100.0%	0.00
TRISTAN	1	0	0.0%	0.00
ADAPTED	1	0	0.0%	0.00

Project	Number of papers	Number of cross sector papers	Percentage of cross sector papers	Citation impact (normalised at field level)
EBODAC	1	0	0.0%	0.00
PREFER	0	0	0.0%	0.00
HARMONY	0	0	0.0%	0.00
BigData@Heart	0	0	0.0%	0.00

FIGURE 6.2.1 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: BTCURE, 2010-2017

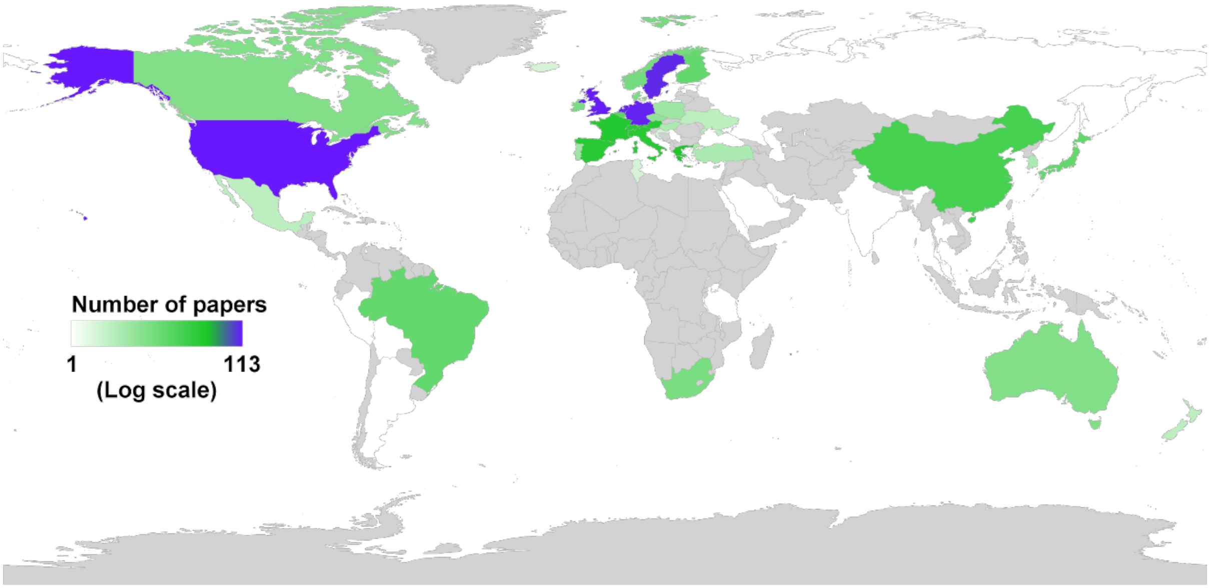


FIGURE 6.2.2 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: EU-AIMS, 2010-2017

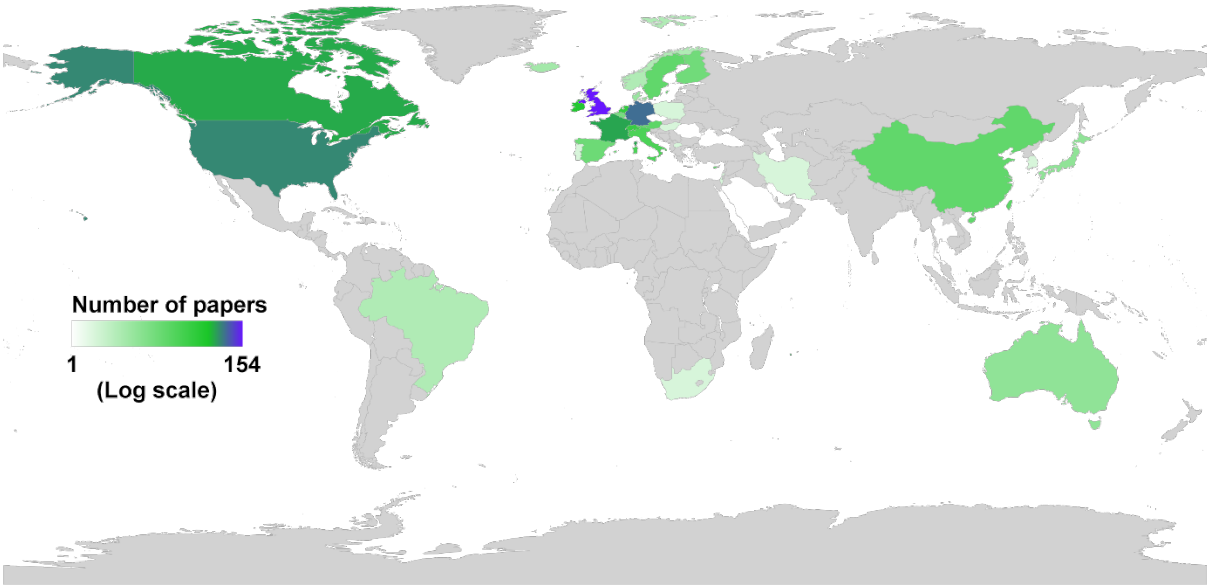


FIGURE 6.2.3 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: NEWMEDS, 2010-2017

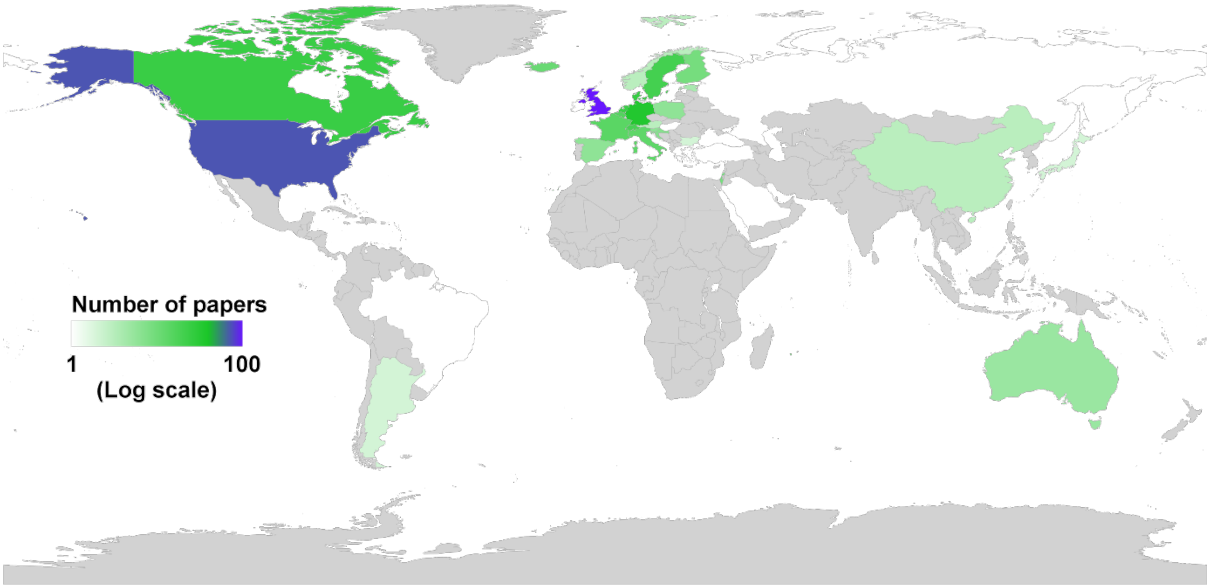


FIGURE 6.2.4 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: EUROPAIN, 2010-2017

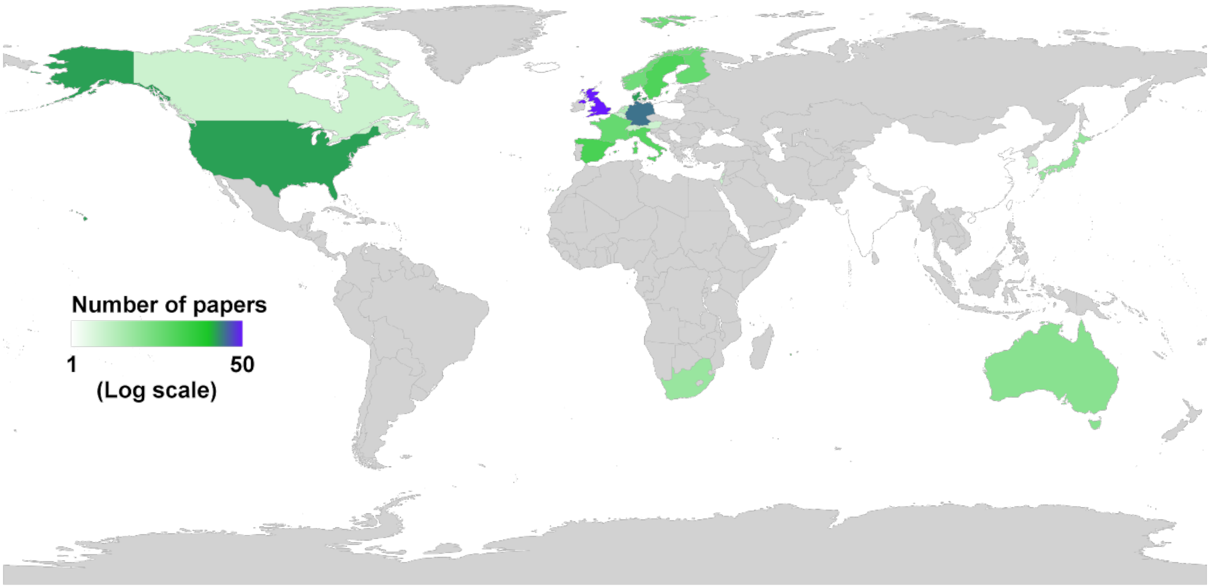
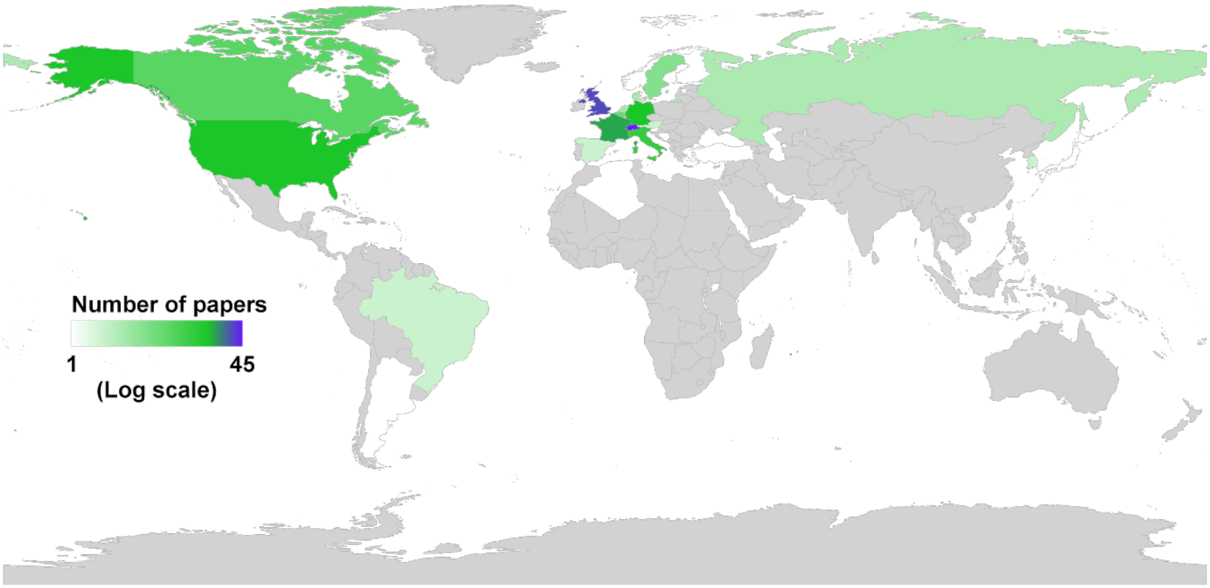


FIGURE 6.2.5 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: IMIDIA, 2010-2017



6.3 COLLABORATION METRICS FOR IMI RESEARCH

This section of the report analyses the types of collaboration that occurred within each IMI project publication and examines the intensity of collaborations within each project. In common with other metrics based on publications and citations, the indicators we present here work best with larger sample sizes. Indicators based on small numbers of publications will be less informative than those calculated for larger bodies of work. Therefore, the analysis presented in this section is for projects with at least 20 publications published between 2010 and 2017. The results for all projects are shown in Annex 3.

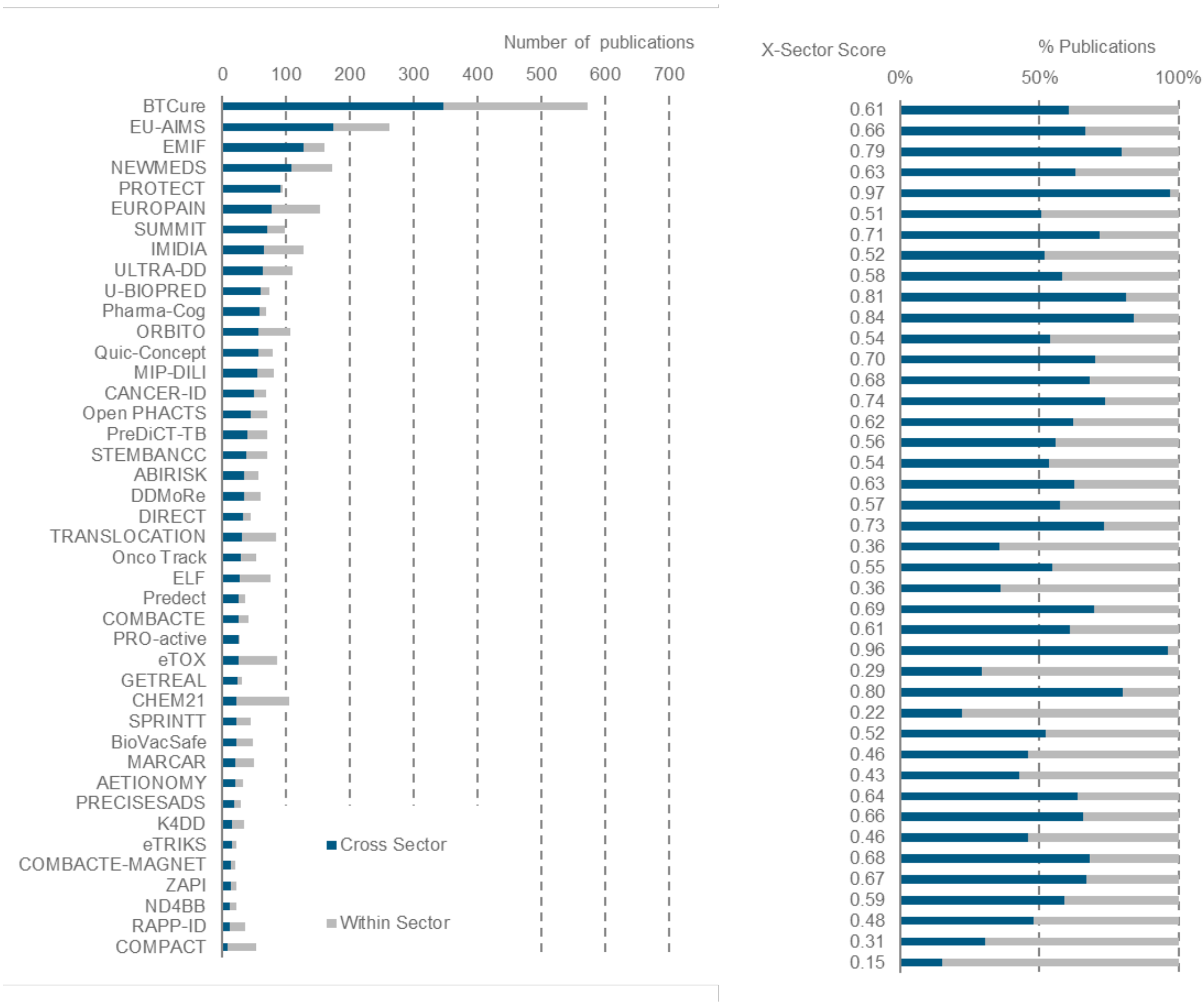
Three metrics were used to evaluate the collaborative nature of IMI projects:

- Metric 1 – Fraction of publications with co-authors affiliated to institutions in different sectors. The institutions affiliated with each author on a publication within the dataset were manually assigned by Clarivate Analytics to the relevant sector. Author affiliations were obtained through Web of Science.
- Metric 2 – Percentage of internationally collaborative publications. The country location of each author was determined using author addresses extracted in the Web of Science.
- Metric 3 – Intensity of collaboration. Pairs of collaborating institutions were identified for each IMI project publication and the intensity of each pair was assessed. The collaboration intensities of the pairs of institutions for each IMI project were averaged.
- The collaboration index is a sum of all three metrics.

6.3.1 METRIC 1: FRACTION OF CROSS SECTOR COLLABORATIVE PUBLICATIONS

The sectors involved in each IMI project publication were used to classify each publication as "within one sector" or "cross sector". Figure 6.3.1.1 shows the total number of publications for each project. Projects are ordered by the number of cross sector collaborative publications. Only projects with more than 20 associated publications are shown. The dark blue bars represent the number of publications or fraction of publications that include at least one cross sector collaboration. The fraction of publications in each project that involve cross-sector collaborations is referred to in the diagram by the abbreviation "X-Sector Score".

FIGURE 6.3.1.1 FRACTION OF CROSS-SECTOR COLLABORATIVE PUBLICATIONS BY PROJECT, 2010-2017



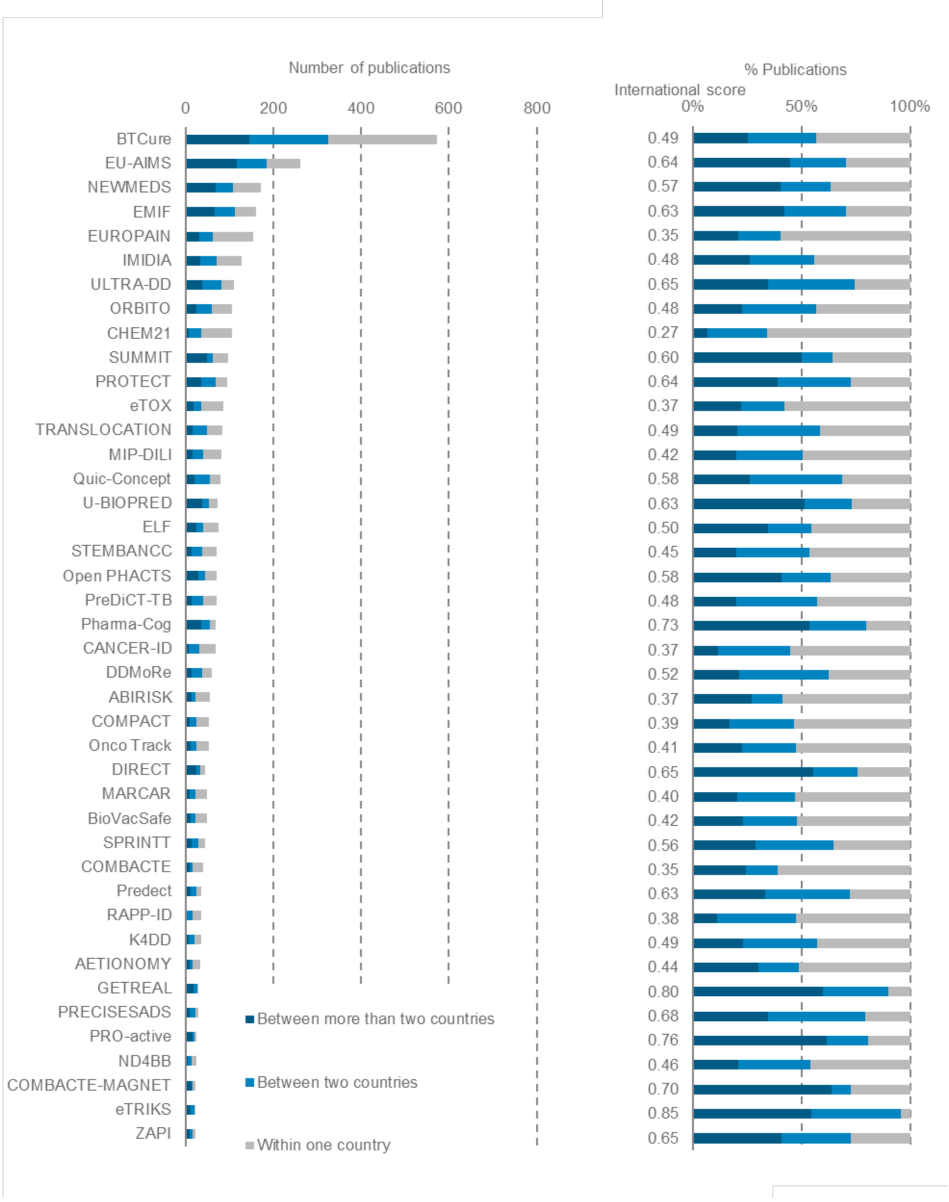
BTCURE had the greatest number of cross-sector collaborative publications, 347 out of 572. PRO-active, Protect and PHARMA-COG had the highest percentage of cross-sector collaborative publications (96.8%, 96.2% and 84.1% respectively).

6.3.2 METRIC 2: FRACTION OF INTERNATIONALLY COLLABORATIVE PUBLICATIONS

Author names and affiliations were extracted from the Web of Science for all IMI project publications. The number of countries in the author affiliations for each publication was counted and used to classify the publication as "more than two countries", "two countries" or "within one country".

Figure 6.3.2.1 below shows the total number of publications for each project. Projects are ordered by the number of publications with author affiliations from more than one country. The bar colours reflect the fraction of publications that include international collaboration. Only projects with more than 20 associated publications are shown. The International Score was calculated by weighting each publication that involved only two countries by 0.75 and each publication that involved more than two countries by 1.00. The sum of the weighted publications was then divided by the total number of publications.

FIGURE 6.3.2.1 FRACTION OF INTERNATIONALLY COLLABORATIVE PUBLICATIONS BY PROJECT, 2010-2017

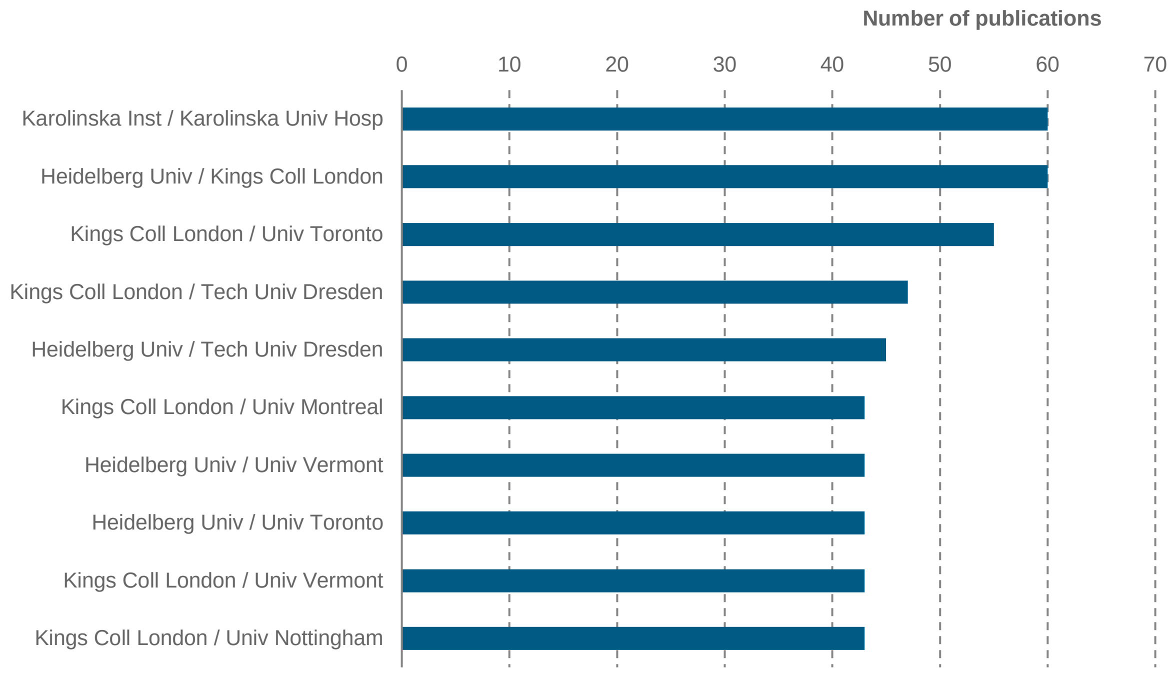


BTCURE had the most internationally collaborative publications involving two or more countries (326 out of 573), with an International Score of 0.49. eTRICKS, GETREAL and PRO-active, had the highest International Score (0.85, 0.80 and 0.76 respectively).

6.3.3 METRIC 3: TOP COLLABORATING INSTITUTIONS PER PUBLICATION

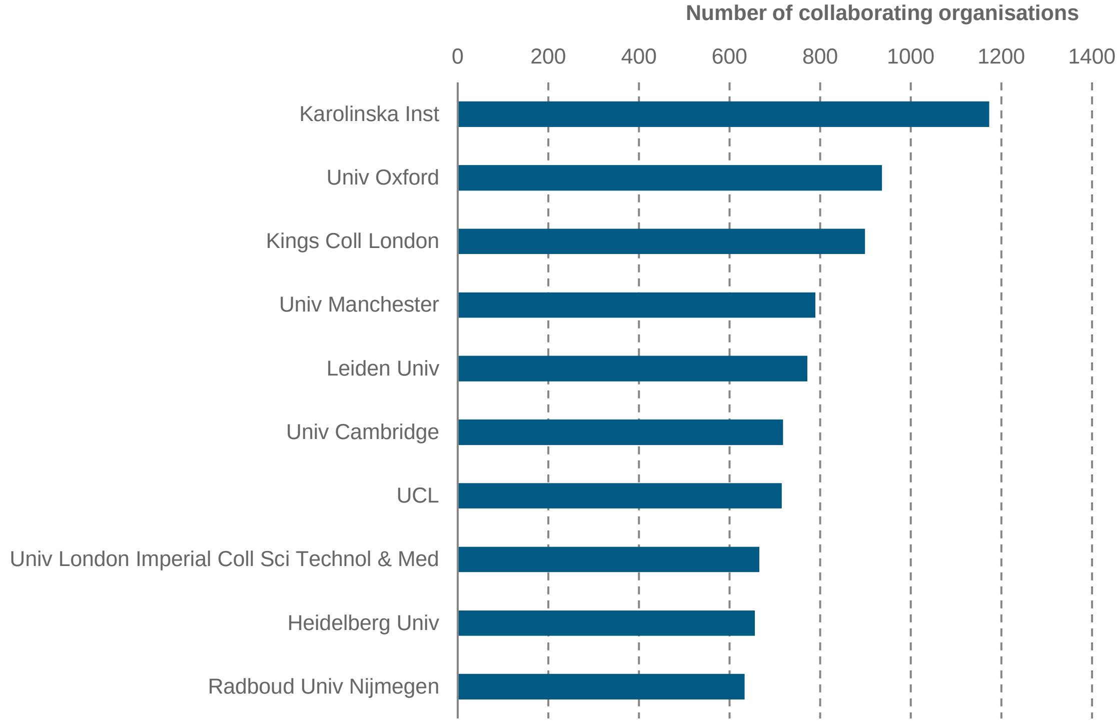
Metric 3 focuses on the most frequently collaborating institutions and the number of those institutions involved in publications associated with each project. Figure 6.3.3.1 shows the top ten 10 collaborating institutions pairs and the total number of collaborating publications for each pair. Figure 6.3.3.2 shows the number of collaborating institutions for each institution. Figure 6.3.3.3 shows the distribution of metric 3 scores for each project.

FIGURE 6.3.3.1 THE TEN MOST PRODUCTIVE PAIRS OF COLLABORATING INSITUTIONS, 2010-2017



The institutions that collaborated most frequently on IMI project publications were the Karolinska Institute and the Karolinska University Hospital.

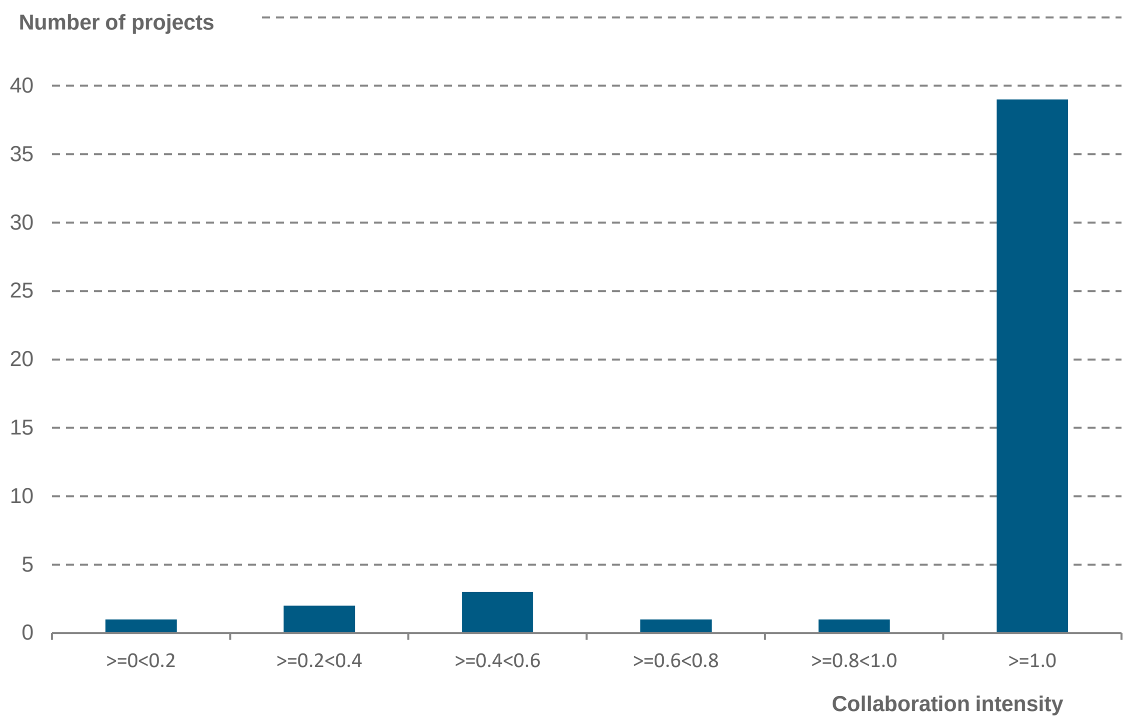
FIGURE 6.3.3.2 THE TEN MOST DIVERSE COLLABORATIVE INSTITUTIONS, 2010-2017



Karolinska Institute has collaborated with 1,173 different institutions within the IMI project publications.

The top 50 most diverse collaborating insitutions were used to assign each project a score (metric 3). For each project, the number of publications affiliated with the top 50 collaborating institutions was calculated, publications were counted more than once if they were affiliated with more than one top 50 institution. This value was then divided by the total number of publications for that project. If the result was greater than or equal to one, the value of metric three for that project was set to one. If the result was less than one, then metric was set to that value. For example, for BTCure the summed count of publications affiliated with the top 50 institutions was 1,440, and it published a total of 595 publications, so the result for metric 3 was 2.42 and this was consequently set to 1.0.

FIGURE 6.3.3.3 METRIC 3 SCORE DISTRIBUTION, 2010-2017



6.4 COLLABORATION INDEX

Metrics 1 and 2 (described above) measure different types of collaboration diversity. The first measures the fraction of publications that involve cross sector collaborations, and the second measures the fraction of publications that involve international collaborations. Metric 3 is based on the average number of top collaborating institutions per publication within each project. We compute a "collaboration index" across IMI projects as the sum of all three of the metrics described above (Table 6.4.1). PROTECT had the highest overall collaboration index score (2.61) followed by Pharma-Cog (2.57). For most projects the Collaboration Index is lower than in last years report as in this report if Metric 3 was greater than or equal to one, the value was set to one.

TABLE 6.4.1 SUMMARY SCORE FOR COLLABORATION METRICS, TOTAL NUMBER PUBLICATIONS, AND CITATION IMPACT FOR IMI PROJECTS, 2010-2017

Project	X-sector Score	International score	Metric 3	Collaboration Index	Total Papers publications	Citation impact (field normalised)
BTCure	0.61	0.49	1.00	2.10	573	1.86
EU-AIMS	0.66	0.64	1.00	2.30	262	2.32
NEWMEDS	0.63	0.57	1.00	2.20	173	2.25
EMIF	0.79	0.63	1.00	2.42	160	2.72
EUROPAIN	0.51	0.35	1.00	1.86	154	2.39
IMIDIA	0.52	0.48	1.00	2.00	127	1.66
ULTRA-DD	0.58	0.65	1.00	2.23	110	2.10
ORBITO	0.54	0.48	1.00	2.02	107	1.59
CHEM21	0.22	0.27	0.59	1.08	105	1.69
SUMMIT	0.71	0.60	1.00	2.31	99	1.27
PROTECT	0.97	0.64	1.00	2.61	95	1.06
eTOX	0.29	0.37	0.38	1.04	86	1.72
TRANSLOCATION	0.36	0.49	0.32	1.17	84	1.50
MIP-DILI	0.68	0.42	1.00	2.10	82	1.70
Quic-Concept	0.70	0.58	1.00	2.28	80	2.74
U-BIOPRED	0.81	0.63	1.00	2.44	79	1.72
ELF	0.36	0.50	1.00	1.86	75	1.33
Open PHACTS	0.62	0.58	1.00	2.20	71	2.68
STEMBANCC	0.54	0.45	1.00	1.99	71	1.73
PreDiCT-TB	0.56	0.48	1.00	2.04	70	1.31
CANCER-ID	0.74	0.37	1.00	2.11	69	3.27
Pharma-Cog	0.84	0.73	1.00	2.57	69	1.46
DDMoRe	0.57	0.52	1.00	2.09	61	0.69
ABIRISK	0.63	0.37	1.00	2.00	57	1.26
COMPACT	0.15	0.39	1.00	1.54	54	1.89
Onco Track	0.55	0.41	1.00	1.96	53	2.51
DIRECT	0.73	0.65	1.00	2.38	49	2.23
MARCAR	0.43	0.40	1.00	1.83	49	1.18
BioVacSafe	0.46	0.42	1.00	1.88	48	1.49
SPRINTT	0.52	0.56	0.43	1.51	45	2.99
COMBACTE	0.61	0.35	1.00	1.96	41	1.52
Predect	0.69	0.63	1.00	2.32	36	1.87
RAPP-ID	0.31	0.38	0.65	1.34	36	1.01

Project	X-sector Score	International score	Metric 3	Collaboration Index	Total Papers publications	Citation impact (field normalised)
K4DD	0.46	0.49	1.00	1.95	35	2.01
AETIONOMY	0.64	0.44	1.00	2.08	33	1.02
GETREAL	0.80	0.80	1.00	2.60	31	3.36
PRECISESADS	0.66	0.68	1.00	2.34	29	1.08
PRO-active	0.96	0.76	1.00	2.72	26	2.00
ND4BB	0.48	0.46	0.46	1.40	24	1.15
COMBACTE-MAGNET	0.67	0.70	1.00	2.37	22	1.87
eTRIKS	0.68	0.85	1.00	2.53	22	2.71
ZAPI	0.59	0.65	1.00	2.24	22	2.31

7 BENCHMARKING ANALYSIS – IMI PROJECT RESEARCH AGAINST RESEARCH FROM SELECTED COMPARATORS

This section of the report analyses the output and citation impact of IMI project research benchmarked against research associated with other selected Public-Private Partnerships, and funders of biomedical research across Europe, Asia and North America.

The publications funded by each comparator were identified using specific keyword searches of the funding acknowledgment data provided by authors and extracted in Web of Science. This is the same process by which IMI project publications have been identified. Authors may not always acknowledge their sources of funding and may not always do so correctly. Therefore, the coverage of the datasets used in these analyses may not be complete and may not be entirely accurate; however, the sample represented by these datasets is sufficient to allow a comparison to be made.

7.1 IDENTIFYING COMPARATORS

The seven funders listed in Table 7.1.1 were used as comparators for IMI in this report. They are the same comparators as in the previous report (2017). Each of them had sufficient publications to allow a robust analysis.

TABLE 7.1.1 SUMMARY OF INFORMATION OF IMI-SELECTED COMPARATORS, 2010-2017

Comparator	Publications (2010-2017)	Papers (2010-2017)	Country	Region
Critical Path (C-Path)	346	340	USA	North America
Commonwealth Scientific and Industrial Research Organization (CSIRO) [18]	614	611	Australia	Australia
Foundation for the National Institutes of Health (FNIH)	2,355	2,315	USA	North America
Grand Challenges in Global Health (GCGH)	796	796	USA	North America
Indian Council of Medical Research (ICMR)	9,061	8,984	India	Asia
Medical Research Council (MRC)	40,856	40,161	UK	Europe
Wellcome Trust (WT)	51,744	48,763	UK	Europe

[18] The total publications for CSIRO between 2010 and 2017 was 14,504; the dataset used for analysis has been reduced to include only medically related publications. A list of Web of Science journal categories which capture medically related publications is given in Annex 2.

7.2 TRENDS IN OUTPUT: IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS

This section of the report analyses trends in the performance of IMI project research and the selected comparators.

7.2.1 TRENDS IN OUTPUT: IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS

The output of IMI and the comparators varies widely (some produced many papers and some relatively few), therefore a visual comparison of absolute paper counts would not provide an understanding of their growth relative to one another. To provide a more easily interpretable comparison, Figure 7.2.1.1 shows the the organisation's papers published in each year as a percentage of the total number of papers published between 2010 and 2017. Table 7.2.1.1 shows the same data as in Figure 7.2.1.1. Table 7.2.1.2 gives the number of papers per year for IMI and the selected comparators.

FIGURE 7.2.1.1 TRENDS IN OUTPUT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

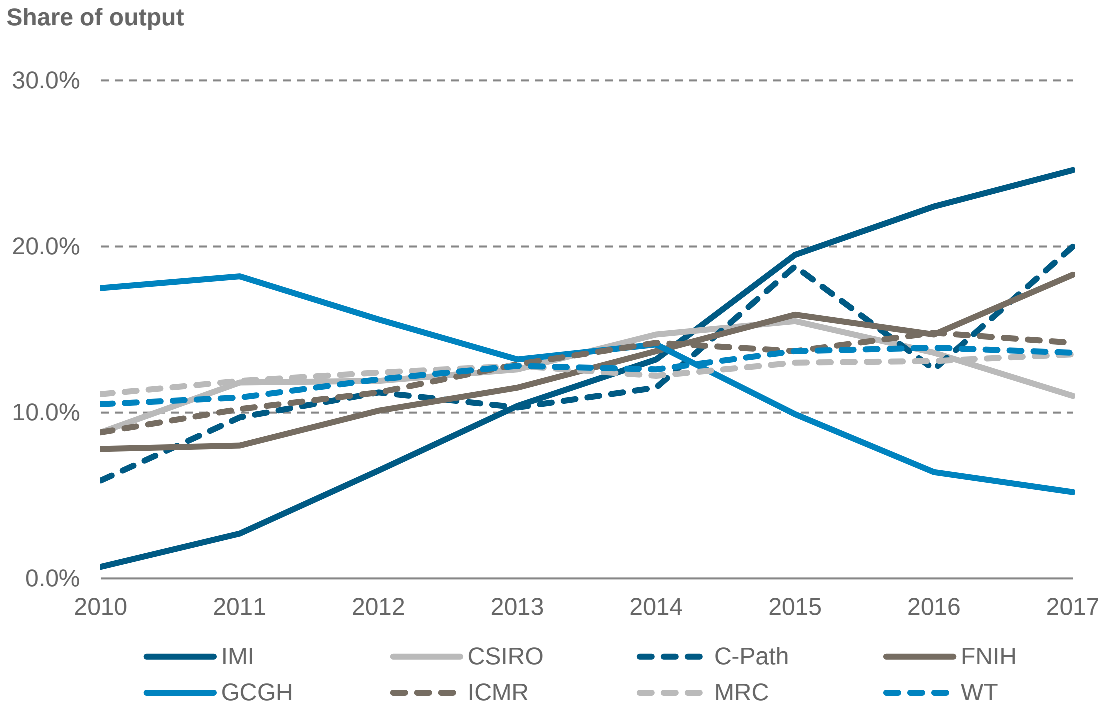


TABLE 7.2.1.1 SHARE OF OUPUT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	0.7%	8.8%	5.9%	7.8%	17.5%	8.8%	11.1%	10.5%
2011	2.7%	11.8%	9.7%	8.0%	18.2%	10.2%	11.9%	10.9%
2012	6.5%	11.9%	11.2%	10.1%	15.6%	11.2%	12.4%	12.0%
2013	10.4%	12.6%	10.3%	11.5%	13.2%	12.9%	12.8%	12.8%
2014	13.2%	14.7%	11.5%	13.7%	14.1%	14.2%	12.2%	12.6%
2015	19.5%	15.5%	18.8%	15.9%	9.9%	13.7%	13.0%	13.7%
2016	22.4%	13.6%	12.6%	14.7%	6.4%	14.8%	13.1%	13.9%
2017	24.6%	11.0%	20.0%	18.3%	5.2%	14.2%	13.5%	13.6%

TABLE 7.2.1.2 NUMBER OF PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	26	54	20	180	139	790	4441	5136
2011	97	72	33	186	145	913	4772	5321
2012	231	73	38	234	124	1006	4961	5837
2013	370	77	35	267	105	1160	5152	6232
2014	467	90	39	316	112	1277	4919	6151
2015	691	95	64	368	79	1230	5224	6681
2016	796	83	43	341	51	1334	5260	6761
2017	872	67	68	423	41	1274	5432	6644
Total	**3,550**	**611**	**340**	**2,315**	**796**	**8,984**	**40,161**	**48,763**

- Except GCGH, both IMI and the other comparators had a generally upward trend in papers published between 2010 and 2017.
- In contrast to other, more established funders, IMI had a steady increase in papers since 2010. The papers that were published in the last two years, 2016 and 2017, account for nearly half the total.

7.2.2 TRENDS IN FIELD NORMALISED CITATION IMPACT: IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS

As discussed in Section 3, citations accumulate over time at a rate that is dependent upon the field of research. Therefore, it is standard bibliometric practice to normalise citation counts for these two factors. In this report, nci_F has been calculated by dividing the citations received by each publication by the world average citations per publication for the relevant year and field. Figure 7.2.2.1 shows the nci_F of IMI and the comparators between 2010 and 2017. Table 7.2.2.1 has the same data as in Figures 7.2.2.1 and 7.2.2.1.

FIGURE 7.2.2.1 TRENDS IN NCI_F – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

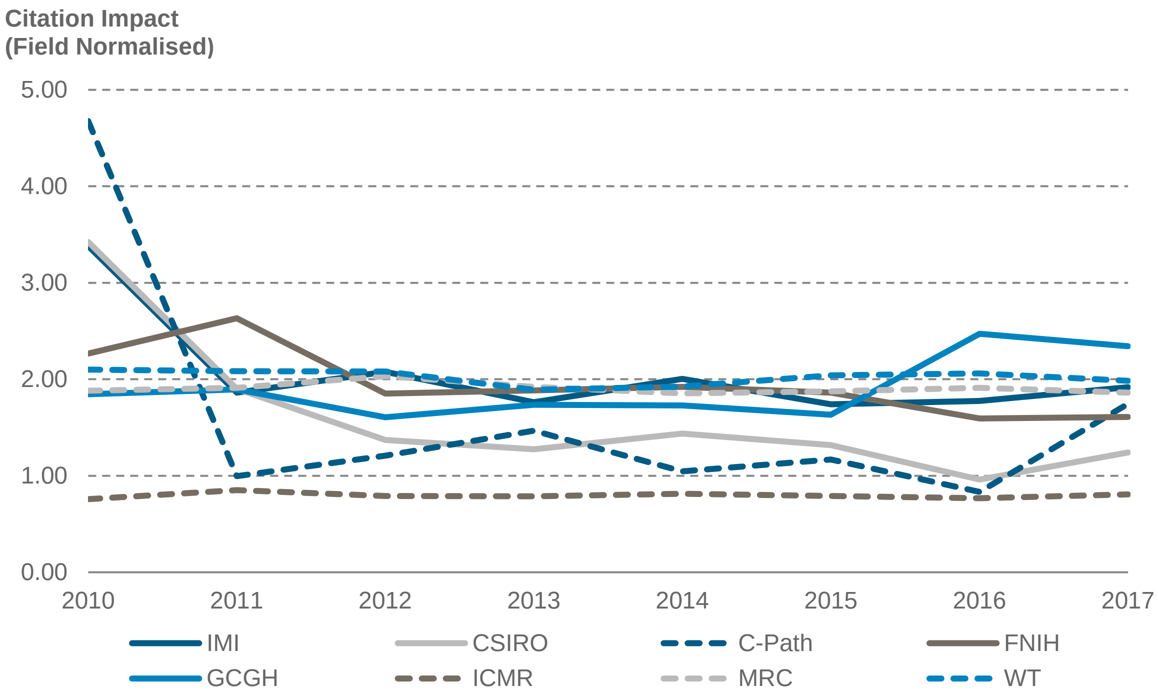


TABLE 7.2.2.1 NCI_F – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	3.38	3.42	4.68	2.27	1.84	0.76	1.88	2.10
2011	1.86	1.90	0.99	2.63	1.89	0.85	1.91	2.08
2012	2.08	1.37	1.21	1.85	1.61	0.79	2.03	2.08
2013	1.76	1.27	1.47	1.89	1.73	0.79	1.92	1.89
2014	2.00	1.44	1.05	1.92	1.73	0.82	1.85	1.93
2015	1.74	1.32	1.17	1.86	1.63	0.79	1.87	2.04
2016	1.78	0.96	0.83	1.59	2.47	0.77	1.91	2.06
2017	1.92	1.24	1.74	1.61	2.34	0.81	1.86	1.98
AVG	**1.98**	**1.55**	**1.44**	**1.89**	**1.83**	**0.80**	**1.91**	**2.02**

- In 2012 and 2014, IMI had the highest citation impact (2.08 and 2.00 respectively) of the funding organisations analysed.
- The citation impact of MRC and the WT were stable at around twice the world average between 2010 and 2017, indicating highly-cited, internationally significant research.

- The exceptionally high citation impact of IMI, CSIRO and C-Path project research in 2010 was driven by a small number of highly-cited papers.

7.2.3 TRENDS IN JOURNAL NORMALISED CITATION IMPACT: IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS

As discussed in Section 3, an alternative indicator to nci_F is nci_J. This is calculated by dividing the number of citations a paper received by the average for the year and the journal in which the paper is published. Figure 7.2.3.1 shows the nci_J of IMI and the comparators between 2010 and 2017. Table 7.2.3.1 shows the same data as in Figure 7.2.3.1.

FIGURE 7.2.3.1 TRENDS IN NCI_J – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

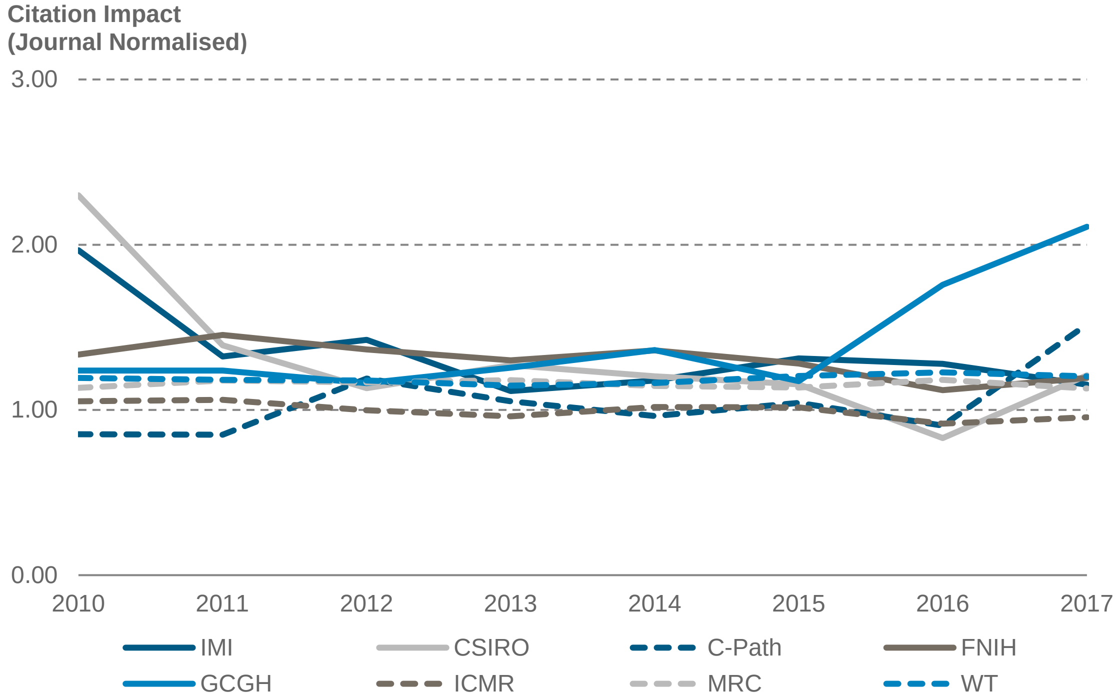


TABLE 7.2.3.1 NCI_J – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	1.97	2.30	0.85	1.34	1.24	1.05	1.13	1.19
2011	1.32	1.39	0.85	1.45	1.24	1.06	1.18	1.18
2012	1.42	1.13	1.19	1.37	1.16	1.00	1.17	1.18
2013	1.11	1.27	1.05	1.30	1.26	0.96	1.18	1.15
2014	1.18	1.20	0.96	1.36	1.36	1.02	1.15	1.16
2015	1.31	1.15	1.04	1.28	1.17	1.02	1.13	1.21
2016	1.28	0.83	0.90	1.12	1.76	0.92	1.18	1.23
2017	1.15	1.21	1.52	1.19	2.11	0.96	1.13	1.20
AVG	**1.29**	**1.27**	**1.10**	**1.29**	**1.32**	**0.99**	**1.16**	**1.19**

- IMI had the joint third highest nci_J (1.29).
- The nci_J of the ICMR, MRC and WT remained relatively stable, while that of CSIRO and GCGH showed greater variability. This is to be expected given the smaller number of papers funded by CSIRO and GCGH, and their growth relative to the output of more established research institutions like the MRC and Wellcome Trust.

7.2.4 TRENDS IN RAW CITATION IMPACT: IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS

The raw (un-normalised) citation impact of a group of papers is calculated by dividing the sum of citations by the total number of papers. This indicator must be used with caution as it is not normalised to field or year. Figure 7.2.4.1 shows the average raw citation impact of IMI and the comparators between 2010 and 2017. Table 7.2.4.1 has the same data as in Figure 7.2.4.1.

FIGURE 7.2.4.1 TRENDS IN RAW CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

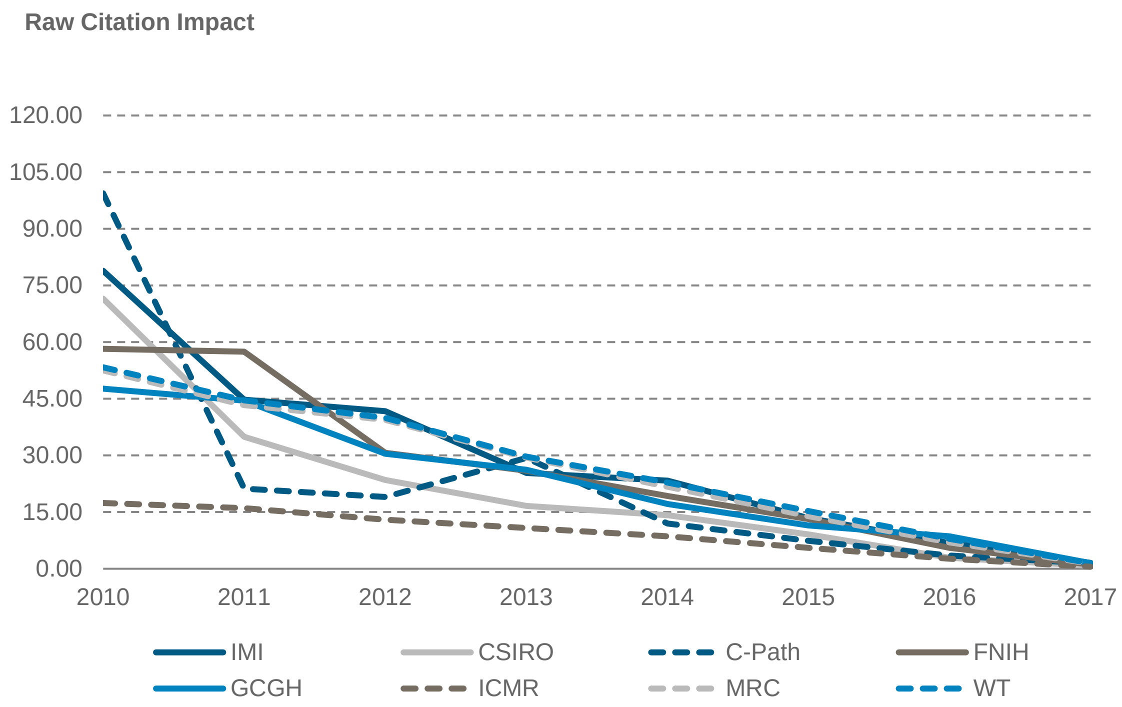


TABLE 7.2.4.1 RAW CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	78.88	71.50	99.40	58.23	47.68	17.41	52.51	53.34
2011	44.77	34.96	21.18	57.45	44.50	16.00	43.35	44.56
2012	41.71	23.51	18.97	30.71	30.44	12.95	39.41	39.93
2013	25.35	16.65	29.31	25.95	26.24	10.80	29.40	29.67
2014	23.34	14.14	11.97	19.22	17.13	8.62	21.68	22.79
2015	13.45	9.07	7.39	13.14	11.49	5.54	13.91	15.26
2016	6.80	2.95	3.47	5.53	8.57	2.62	7.01	7.90
2017	1.55	0.81	1.41	1.12	1.49	0.54	1.38	1.47
AVG	**14.75**	**19.33**	**16.53**	**20.97**	**28.81**	**8.45**	**25.17**	**25.31**

- The raw citation impact of all organisations decreased from 2010 to 2017. This is expected as more recent publications have had less time to accumulate citations, and the raw citation impact is not normalised.
- In 2017 IMI's raw citation impact was the highest among the comparator group (1.55).

7.2.5 TRENDS IN UNCITED RESEARCH: IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS

Most publication datasets will include papers which have no citations. Figure 7.2.5.1 shows the percentage of uncited papers between 2010 and 2017 for IMI and the selected comparators. Table 7.2.5.1 has the same data as in Figure 7.2.5.1.

FIGURE 7.2.5.1 TRENDS IN UNCITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

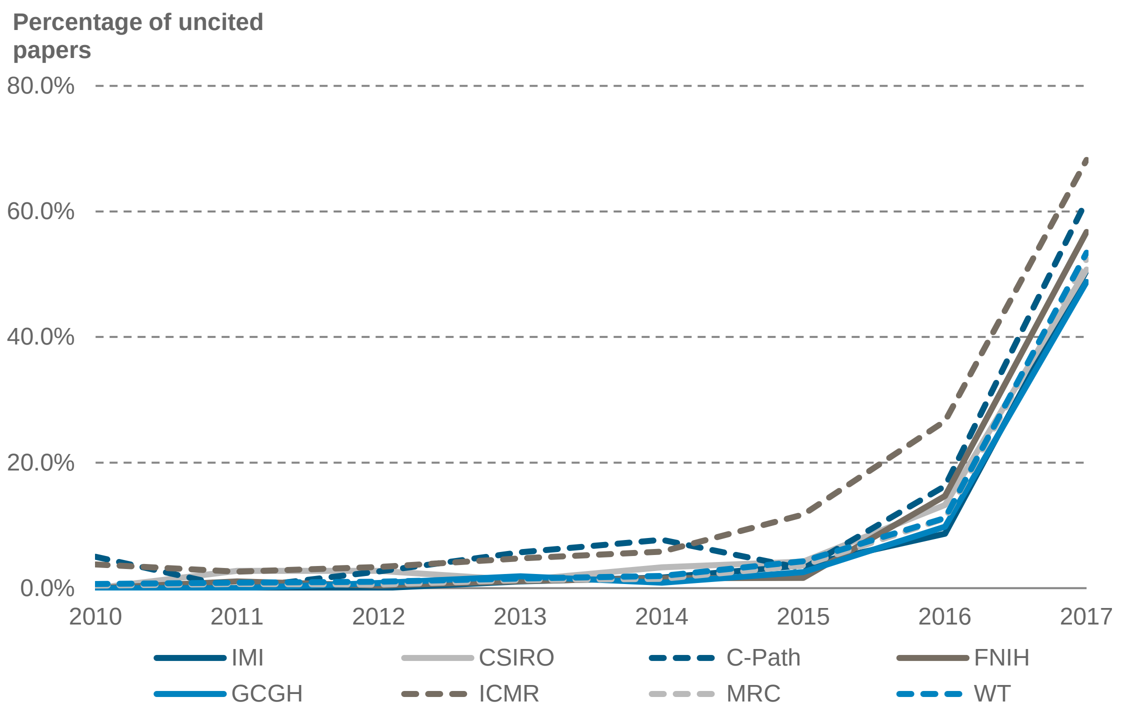


TABLE 7.2.5.1 PERCENTAGE OF UNCITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	0.0%	0.0%	5.0%	0.0%	0.0%	3.8%	0.4%	0.7%
2011	0.0%	2.8%	0.0%	1.1%	0.0%	2.6%	0.7%	0.9%
2012	0.0%	2.7%	2.6%	0.4%	0.8%	3.4%	0.6%	1.0%
2013	1.1%	1.3%	5.7%	1.1%	1.9%	4.7%	1.3%	1.5%
2014	1.7%	3.3%	7.7%	1.6%	0.9%	5.8%	1.5%	2.0%
2015	3.6%	4.2%	3.1%	1.6%	2.5%	11.7%	3.6%	4.3%
2016	8.7%	13.3%	16.3%	14.7%	9.8%	26.6%	11.1%	11.2%
2017	50.6%	50.7%	61.8%	56.7%	48.8%	68.2%	52.4%	53.4%
Total	**15.4%**	**9.3%**	**17.1%**	**13.3%**	**3.9%**	**17.6%**	**9.6%**	**10.1%**

- A little over one sixth of papers published from IMI project research were uncited. The proportion of uncited research is similar to the comparators, except GCGH. Less than 4% of GCGH papers were uncited overall between 2010 and 2017.
- No IMI project papers published between 2010 and 2012 are uncited. Its share of uncited research in the most recent year, 2017, is among the lowest of the comparators.
- The similar trends in uncited papers indicate the similar citation life-cycle for biomedical research funded across all the benchmarking organisations. More recent publications are less likely to be cited than older publications. Therefore, the higher percentage of uncited papers in

most recent years should not be taken as evidence that these articles are more likely to remain uncited.

7.2.6 TRENDS IN HIGHLY- CITED RESEARCH: IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS

As discussed in Section 3, highly-cited work is recognised as having a greater impact, and Clarivate Analytics correlates this with other qualitative evaluations of research performance, such as peer review. For institutional research evaluation, we have found that the world's top 10% of most highly-cited papers is often a suitable definition of highly-cited work. Therefore, if more than 10% of an entity's publications are in the top 10% of the world's most highly-cited papers, then it has performed better than expected. Figure 7.2.6.1 shows the percentage of highly-cited papers between 2010 and 2017 for IMI and the selected comparators. Table 7.2.6.1 has the same data as in Figure 7.2.6.1.

FIGURE 7.2.6.1 TRENDS IN HIGHLY CITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

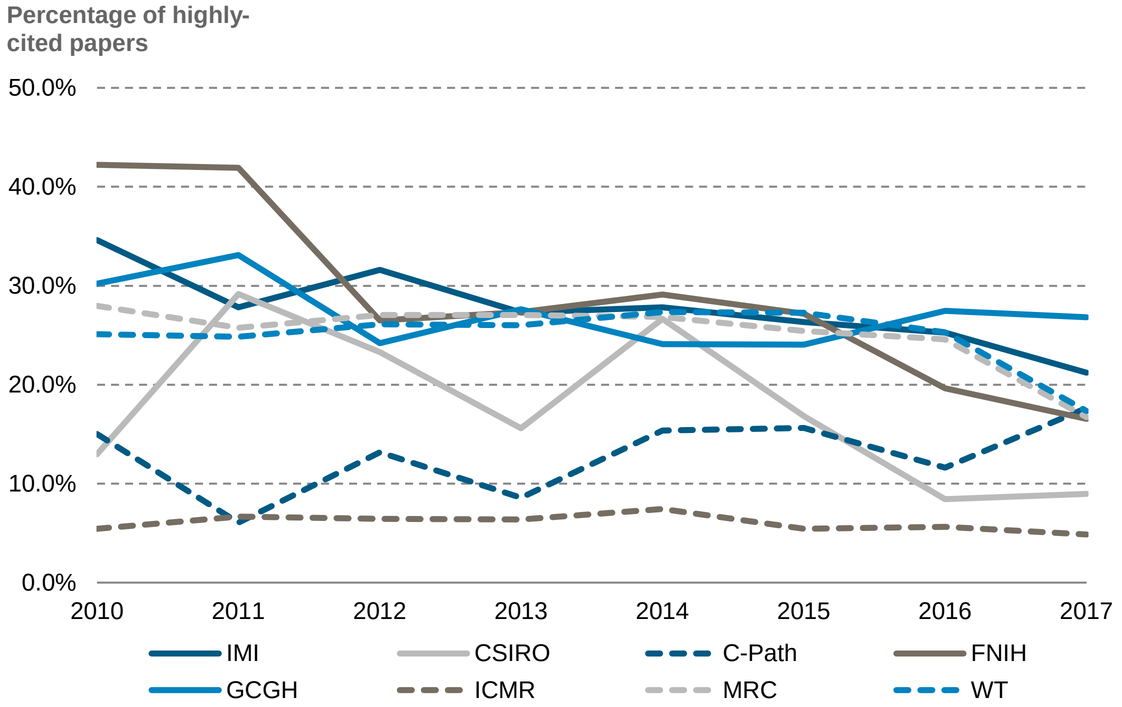


TABLE 7.2.6.1 PERCENTAGE OF HIGHLY CITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	34.6%	13.0%	15.0%	42.2%	30.2%	5.4%	28.0%	25.1%
2011	27.8%	29.2%	6.1%	41.9%	33.1%	6.7%	25.8%	24.8%
2012	31.6%	23.3%	13.2%	26.5%	24.2%	6.5%	27.0%	26.1%
2013	27.3%	15.6%	8.6%	27.3%	27.6%	6.4%	27.0%	26.0%
2014	27.8%	26.7%	15.4%	29.1%	24.1%	7.4%	26.9%	27.3%
2015	26.3%	16.8%	15.6%	27.2%	24.1%	5.4%	25.4%	27.3%
2016	25.3%	8.4%	11.6%	19.6%	27.5%	5.6%	24.6%	25.3%
2017	21.2%	9.0%	17.6%	16.5%	26.8%	4.9%	16.7%	17.3%
Total	**25.6%**	**18.0%**	**13.5%**	**26.7%**	**27.6%**	**6.0%**	**25.0%**	**24.9%**

- Approximately one quarter of papers published by IMI and most of the comparators between 2010 and 2017 were highly cited. ICMR and C-Path were notable exceptions.
- In 2012, IMI had the highest share of highly-cited papers in the group. In 2010, 2014 and 2016 IMI had the second highest proportion of highly-cited papers.

7.2.7 TRENDS IN OPEN ACCESS RESEARCH: IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS

Figure 7.2.7.1 shows the percentage of IMI publications that were published as open access between 2010 and 2017 for IMI and the selected comparators. Table 7.2.7.1 shows the same data as in Figure 7.2.7.1.

FIGURE 7.2.7.1 TRENDS IN OPEN ACCESS PUBLICATIONS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

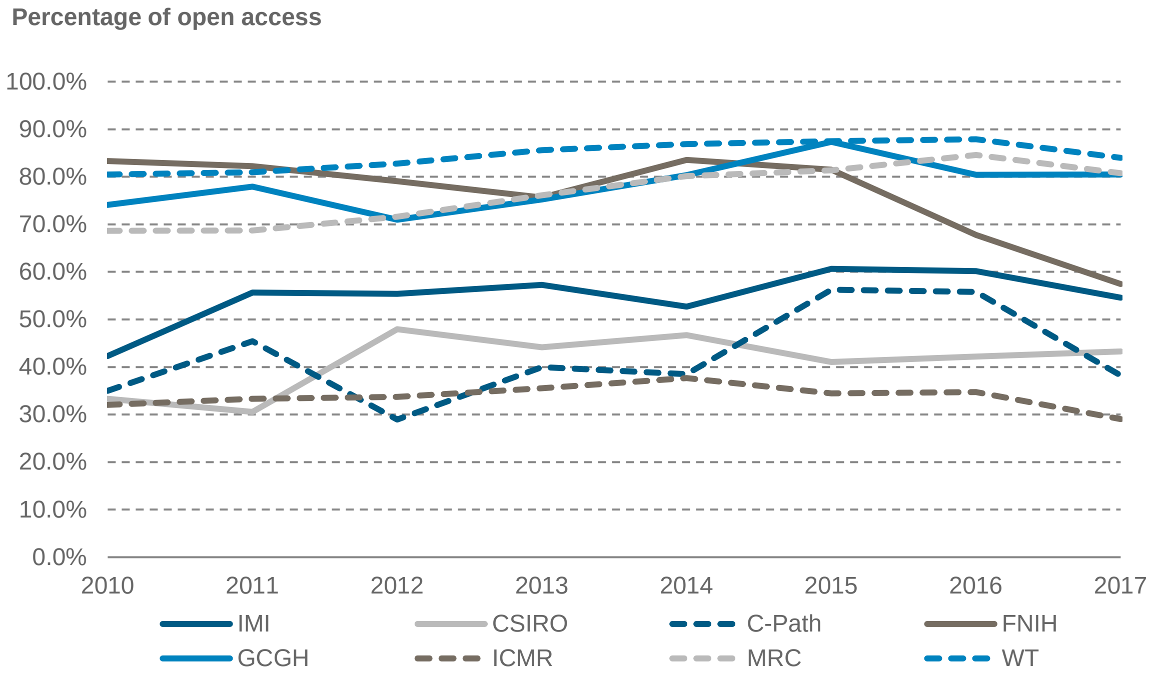


TABLE 7.2.7.1 PERCENTAGE OF OPEN ACCESS PUBLICATIONS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	42.3%	33.3%	35.0%	83.3%	74.1%	32.0%	68.6%	80.5%
2011	55.7%	30.6%	45.5%	82.3%	77.9%	33.3%	68.7%	80.9%
2012	55.4%	47.9%	28.9%	79.1%	71.0%	33.7%	71.6%	82.8%
2013	57.3%	44.2%	40.0%	75.7%	75.2%	35.5%	76.1%	85.6%
2014	52.7%	46.7%	38.5%	83.5%	80.4%	37.7%	80.1%	86.9%
2015	60.6%	41.1%	56.3%	81.5%	87.3%	34.5%	81.4%	87.5%
2016	60.2%	42.2%	55.8%	67.7%	80.4%	34.7%	84.6%	87.9%
2017	54.6%	43.3%	38.2%	57.4%	80.5%	29.0%	80.8%	84.0%
Total	**57.0%**	**41.6%**	**43.5%**	**74.6%**	**77.4%**	**33.9%**	**76.8%**	**84.7%**

- The majority of organisations, including IMI, have more than 40% of open access publications.
- WT has the highest percentage of open access publications in all years between 2010 and 2017 in the group. Overall, it had over three-quarters of publication avalible via open access 2010 and 2017, while C-Path only had about a third of such publication.
- There is a step change increase in the percentage of publication seen in open access journals compared to the previous reports. This step is likely not representative of a real difference in publishing behaviour, but a result of increased resolution as Clarivate Analytics adapts its database to be consistent with modern publishing practices.

7.3 SUMMARY OF BIBLIOMETRIC INDICATORS: IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS

Even though IMI is a 'young' funding agency, its performance is on par with well-established funding bodies like the MRC and Wellcome Trust, as indicated by its citation impact, and percentage of highly-cited papers (Table 7.3.1).

TABLE 7.3.1 SUMMARY OF BIBLIOMETRIC INDICATORS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2017

	Number of papers	Citation impact (normalised at field level)	Percentage of uncited papers	Percentage of highly-cited papers
IMI	3,550	1.98	15.4%	25.6%
CSIRO	611	1.55	9.3%	18.0%
C-Path	340	1.44	17.1%	13.5%
FNIH	2,315	1.89	13.3%	26.7%
GCGH	796	1.83	3.9%	27.6%
ICMR	8,984	0.80	17.6%	6.0%
MRC	40,161	1.91	9.6%	25.0%
WT	48,763	2.02	10.1%	24.9%

8 COLLABORATION NETWORK ANALYSIS BY IMI PROJECT

This section of the report analyses changes in institutional collaborations on IMI projects over time. The projects analysed are BTCURE (Call 2), EU-AIMS (Call 3), EUROPAIN (Call 1), IMIDIA (Call 1), and NEWMEDS (Call 1). In this report, co-authorship of publications is used as an index of collaborative research; where two institutions appear together in the authors address list on a publication this is recorded as an instance of collaboration. These five projects generated the greatest number of publications among the IMI projects from 2010 to 2017. Changes in collaborations are compared across two time periods, 2010-2013 and 2014-2017 – this allows changes in collaboration between the periods initially after the project commenced to be compared with patterns of collaboration once the projects had matured.

Network graphs for each project and period are shown in Section 8.2. The nodes of the network graphs represent unified institutions appearing in the author address lists of publications (including all the institutions that are participating in the project[19]). The number of papers co-authored between institutions is represented by the thickness of the line linking them. Graph nodes are coloured according to their corresponding sector. As in the section 6 collaboration analysis, the sectors assigned to the institutions are academic, corporate, government, medical, or other[14]. The top ten collaborative institutions are labeled, where the font size is linearly proportional to the number of collaborations it has. The graphs show the amount of change in collaborations from period 1 to period 2.

The numbers of publications co-published by institutions and the network graphics illustrating these linkages show that the collaborative research activity of the selected IMI projects has increased over time. These collaborations involve a range of institutions across multiple sectors and countries. It is also clear from the data that there is significant collaboration with institutions that were not formal participants in the IMI-supported projects and that the involvement of such partners has grown with time.

The results of this section have not been normalised since many factors, known and unknown, may affect the occurrence of publication collaborations. It is important, however, to keep in mind while reviewing the results some of the context that may be affecting publication collaborations for these five projects. Table 8.1 provides the start and end date as well as the total funding support for each of the five projects. All projects were supported between 5 to 6 years. BTCURE and EU-AIMS received substantially more funding than the other three projects.

TABLE 8.1 OVERVIEW OF THE FIVE IMI PROJECTS WITH GREATEST PUBLICATION OUTPUT[19]

PROJECT	START DATE	END DATE	TOTAL FUNDING SUPPORT
BTCURE	1/4/2011	31/03/2017	€39,371,092
EU-AIMS	1/4/2012	31/03/2018	€37,480,613
EUROPAIN	1/10/2009	30/09/2015	€22,550,083
IMIDIA	1/4/2011	30/09/2015	€27,447,009
NEWMEDS	1/9/2009	28/02/2015	€24,849,675

[19] Information about IMI's ongoing projects including the participants of those projects is available on its website: https://www.imi.europa.eu/content/ongoing-projects.

8.1 COLLABORATION PATTERNS ACROSS THE FIVE IMI PROJECTS WITH THE GREATEST PUBLICATION PRODUCTIVITY

In this subsection the changes from period 1 (2010-2013) to period 2 (2014-2017) in the number and types of institutions contributing to IMI publications as well as the changes in the number of publication collaborations between sectors are reviewed.

Table 8.1.1 tabulates for each of the five projects the number of institutions that were IMI participants by sector.

- The BTCURE project had the largest number of academia, corporate and medical institutions (17, 10 and 6, respectively) as IMI participants among these five projects.
- EU-AIMS had the largest number of government institutions (3) as IMI participants.

TABLE 8.1.1 NUMBER OF IMI PARTICIPATING ORGANIZATIONS[19]

SECTOR	BTCURE	EU-AIMS	EUROPAIN	NEWMEDS	IMIDIA
ACADEMIA	17	14	11	8	8
CORPORATE	10	5	6	8	9
GOVERNMENT	0	3	0	0	0
MEDICAL	6	4	3	1	1
OTHER	2	1	0	0	1

Academia institutions include universities and other institutions that focus on a combination of education and research such as Kings College London and the Karolinska Institute. Corporate institutions are commercial institutions such as pharmaceutical companies (use chemical materials to create medicines) and biotechnology companies (use live organisms to create medicines) such as AstraZeneca and Janssen Biotechnology Company. Government institutions, often an appointed commission, are a part of a government that is responsible for the oversight and administration of specific functions such as the United States Department of Health and Human Services, Deutsches Rheuma-Forschungszentrum, and The European Medicines Agency. Medical institutions include hospitals and patient-care institutions such as CHU Montpellier and the Central Institute of Mental Health Mannheim. Other institutions include institutions that either have reach across multiple sectors such as CSIC or those that do not align with one of the other sector categorizations such as the non-governmental, non-profit association the Max Planck Society.

Among the institutions co-authoring IMI publications, the academic and medical sectors had the greatest changes in the number of non-IMI participating institutions across the five projects.

Table 8.1.2 provides the number of institutions by sector for all five projects. The unshaded and grey shaded rows provide the information for the IMI participating and non-IMI participating institutions respectively. Only non-participating medical institutions in the NEWMEDS project were fewer in the second period compared to the first.

Table 8.1.2 THE NUMBER OF ORGANIZATIONS BY SECTOR AND PROJECT IN TWO PERIODS P1 (2010-2013) AND P2 (2014-2017) FOR PARTICIPATING AND NON-PARTICIPATING INSTITUTIONS

SECTOR	STATUS	BTCURE		EU-AIMS		EUROPAIN		NEWMEDS		IMIDIA	
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
ACADEMIA	IMI participating	10	17	3	14	6	9	3	8	5	8
	IMI non-participating	54	308	73	264	33	81	74	162	47	81
CORPORATE	IMI participating	1	10	1	5	1	6	4	8	1	8
	IMI non-participating	7	25	5	14	2	12	4	20	1	6
GOVERNMENT	IMI participating	0	0	1	3	0	0	0	0	0	0
	IMI non-participating	1	19	5	16	3	5	2	10	0	1
MEDICAL	IMI participating	1	6	3	4	1	3	1	1	0	1
	IMI non-participating	34	208	15	99	19	42	70	47	11	27
OTHER	IMI participating	1	2	0	1	0	0	0	0	0	1
	IMI non-participating	6	35	3	21	3	5	5	8	1	6

Figure 8.1.1 graphs the number of collaborating institutions for period 1 and period 2 for the academic sector. Note that these data do not include multiple instances of collaboration between the same two institutions.

- For all five projects either all or nearly all of the IMI participating academic institutions contributed to publications during period 2.
- All five projects had an increase in the number of IMI participating and non-IMI participating academic institutions from period 1 to period 2.
    - BTCURE and EU-AIMS had the largest increases from period 1 to period 2 in the number of non-IMI participating academic institutions that contributed to IMI publications (+254 and +191, respectively or 4.7 and 2.6 times more of these collaborations in period 2 compared to period 1, respectively).
    - EU-AIMS had the largest change in participating institutions between period 1 and period 2 (11 or 4.7 times)

FIGURE 8.1.1 NUMBER OF COLLABORATING INSTITUTIONS FROM THE **ACADEMIC** SECTOR IN PERIOD 1 (2010-2013) AND IN PERIOD 2 (2014-2017)

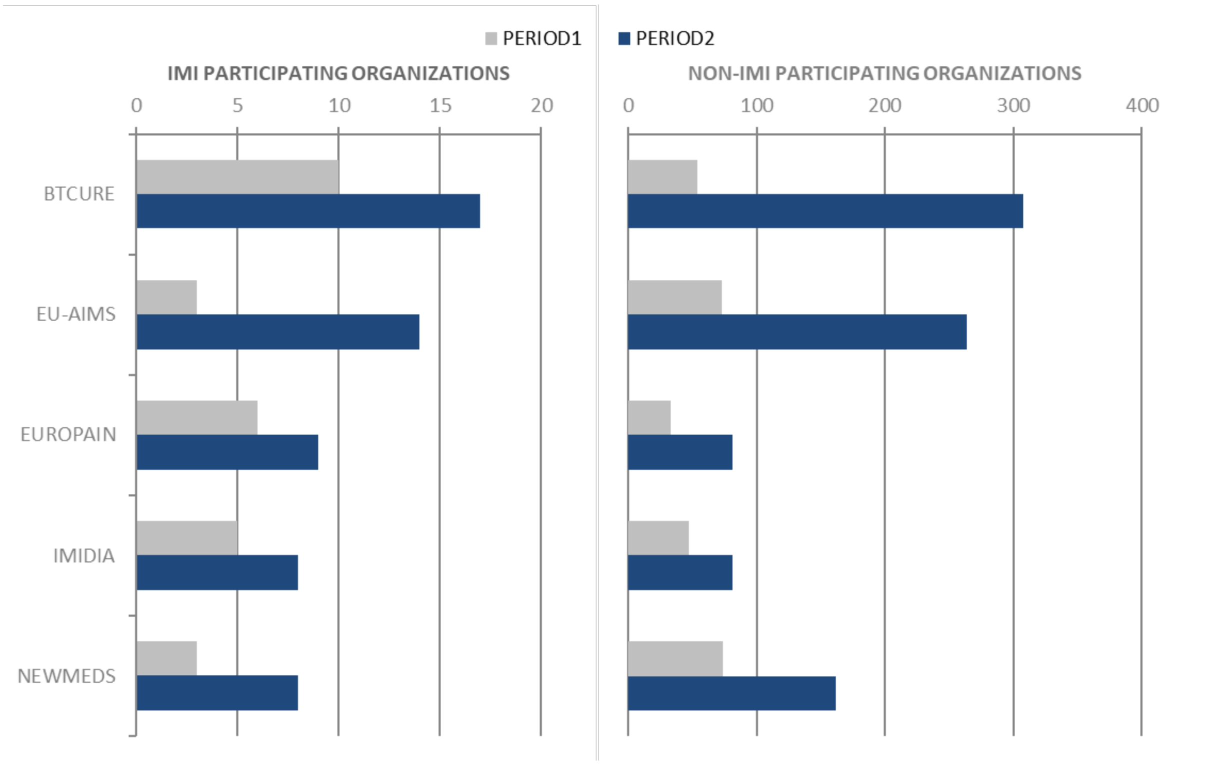


Figure 8.1.2 graphs the number of collaborating institutions for both periods for the medical sector. Note that these data do not include multiple instances of collaboration between the same two institutions.

- IMIDIA had no contributions from IMI participating institutions
- All projects except NEWMEDS had an increase in the number of non-IMI participating medical institutions contributing to IMI publications.
- BTCURE and EU-AIMS had the largest increase in the number of non-IMI participating medical institutions from period 1 to period 2 (+174 and +84, respectively which corresponds to 6.1 and 6.6 times more collaborations in period 2).

FIGURE 8.1.2 NUMBER OF COLLABORATING INSTITUTIONS FROM THE **MEDICAL** SECTOR IN PERIOD 1 (2010-2013) AND IN PERIOD 2 (2014-2017)

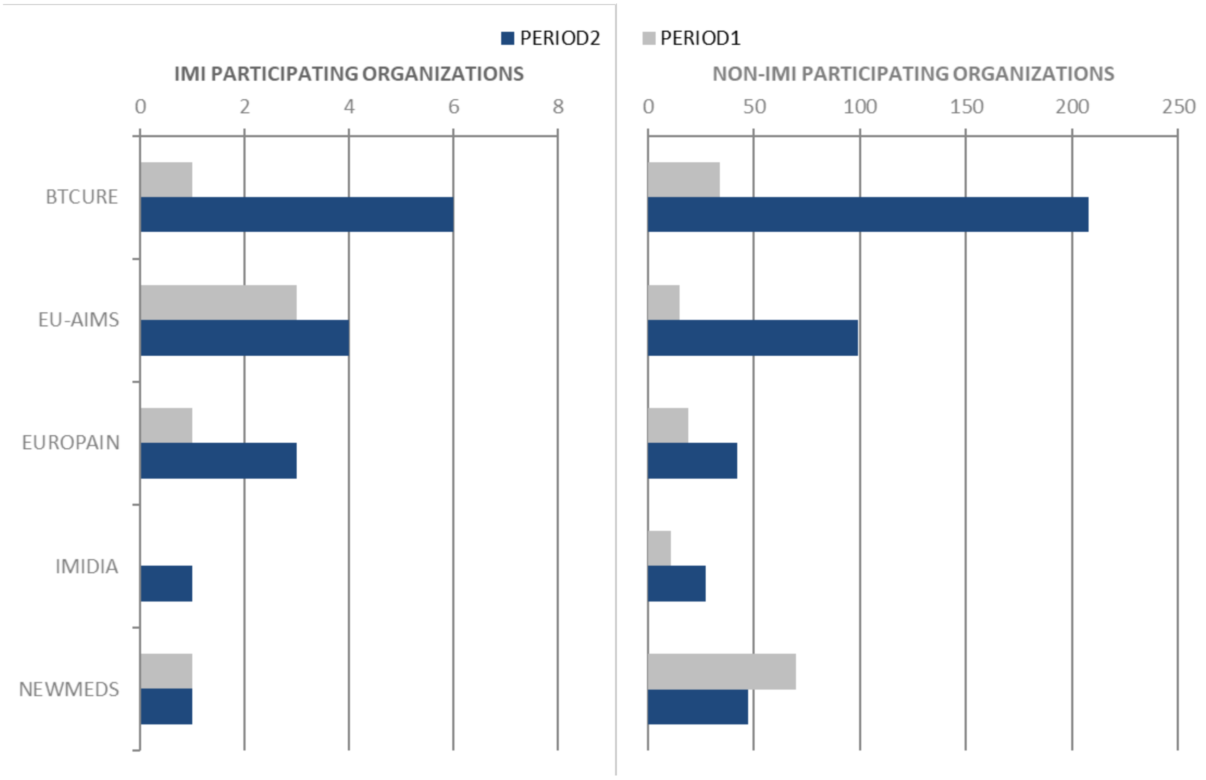


Table 8.1.3 provides data on the number of cross (and self) collaborations between sectors. The numbers represent the number of publications so, in many cases, include multiple collaborations between the same institutions.

- EU-AIMS had the largest increase in publication collaborations between academia institutions (+4,145).
- EU-AIMS also had the largest increase in collaborations between academia and medical institutions (+1,268).
- NEWMEDS had a decrease in publication collaborations between academia and medical institutions (-105).

TABLE 8.1.3 THE NUMBER PUBLICATION COLLABORATIONS BY SECTOR IN P1 (2010-20113) AND P2 (2014-2017)

SECTOR 1	SECTOR 2	BTCURE		EU-AIMS		EUROPAIN		NEWMEDS		IMIDIA	
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
ACADEMIA	ACADEMIA	1731	2663	6519	7982	526	823	2509	3099	374	462
	CORPORATE	18	58	24	48	28	57	96	182	5	43
	GOVERNMENT	8	56	88	140	3	13	45	84	0	1
	MEDICAL	335	576	379	819	76	115	541	509	71	87
	OTHER	20	94	43	64	3	0	23	11	0	7
CORPORATE	CORPORATE	3	11	4	15	9	49	60	79	2	12
	GOVERNMENT	1	2	2	4	0	1	8	8	0	0
	MEDICAL	24	61	14	46	19	43	107	96	9	17
	OTHER	3	8	0	8	1	1	4	1	1	2
GOVERNMENT	GOVERNMENT	0	3	11	10	1	1	1	4	0	0
	MEDICAL	4	13	48	89	1	3	3	10	0	0
	OTHER	0	6	2	5	0	0	0	0	0	0
MEDICAL	MEDICAL	512	1045	153	272	77	76	1349	252	9	14
	OTHER	30	70	15	33	9	1	76	6	1	0
OTHER	OTHER	5	19	2	8	0	0	1	0	0	1

Figure 8.1.3 to Figure 8.1.6 graphs the change in the number of publication collaborations from period 1 to period 2 for collaborations between academia and academia institutions, academia and corporate institutions, academia and government institutions, academia and medical institutions, and academia and other institutions.

FIGURE 8.1.3 CHANGE IN THE NUMBER OF PUBLICATION COLLABORATIONS FROM PERIOD 1 TO PERIOD 2 BETWEEN **ACADEMIA** INSTITUTIONS AND INSTITUTIONS FROM EACH OF THE FIVE SECTORS

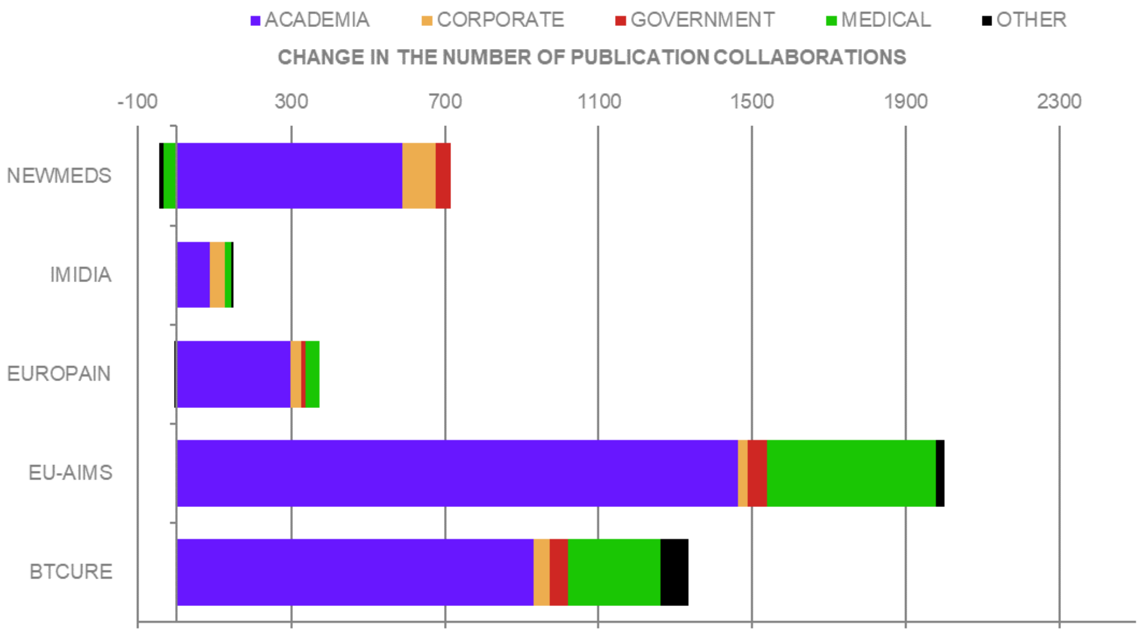


Figure 8.1.4 graphs the change in the number of publication collaborations from period 1 to period 2 for collaborations between corporate and academia institutions, corporate and corporate institutions, corporate and government institutions, corporate and medical institutions, and corporate and other institutions.

- NEWMEDS had the largest increase in corporate - academic collaborations (+86) but had a small decrease in corporate - medical collaborations
- EUROPAIN had the largest increase in corporate – corporate collaborations (+40).

FIGURE 8.1.4 CHANGE IN THE NUMBER OF PUBLICATION COLLABORATIONS FROM PERIOD 1 TO PERIOD 2 BETWEEN **CORPORATE** INSTITUTIONS AND INSTITUTIONS FROM EACH OF THE FIVE SECTORS

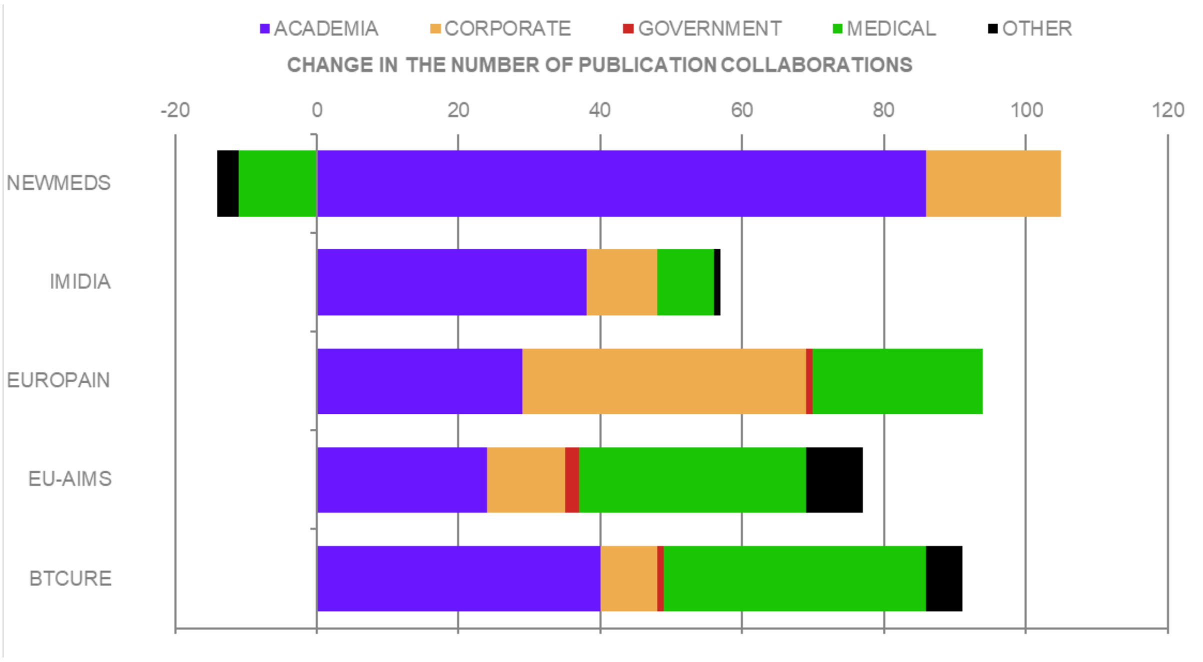


Figure 8.1.5 graphs the change in the number of publication collaborations from period 1 to period 2 for collaborations between government and academia institutions, government and corporate institutions, government and government institutions, government and medical institutions, and government and other institutions.

- EU-AIMS had the largest increase in collaborations between government and academia institutions (+52) and in collaborations between government and medical institutions (+41).

FIGURE 8.1.5 CHANGE IN THE NUMBER OF PUBLICATION COLLABORATIONS FROM PERIOD 1 TO PERIOD 2 BETWEEN **GOVERNMENT** INSTITUTIONS AND INSTITUTIONS FROM EACH OF THE FIVE SECTORS

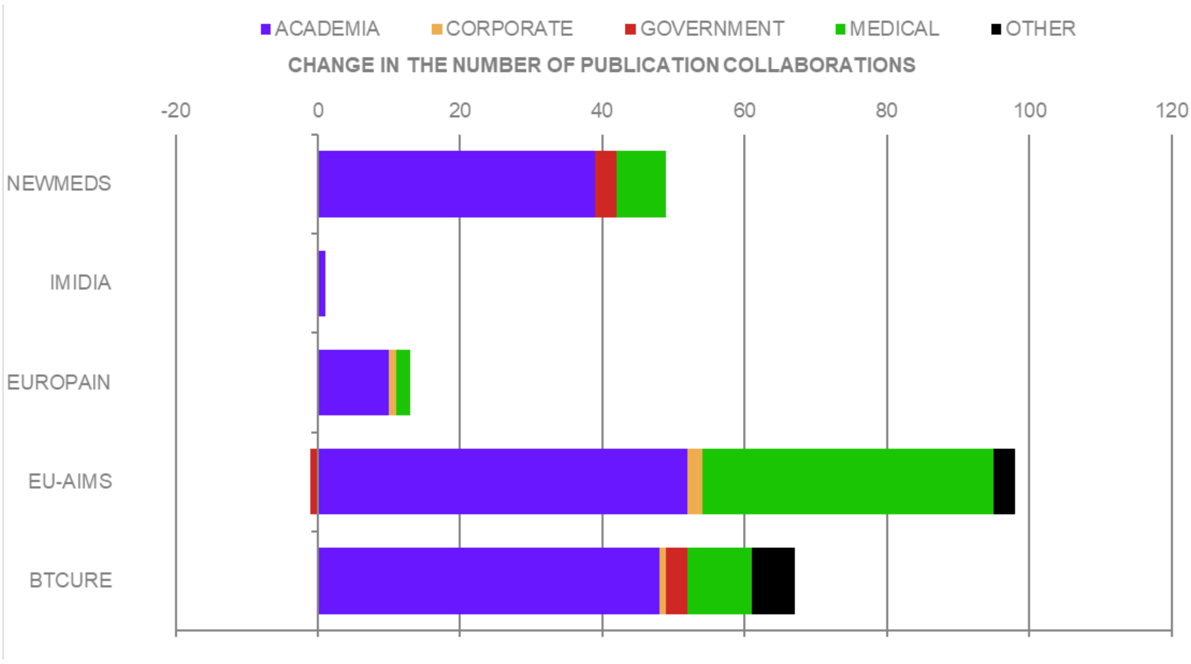
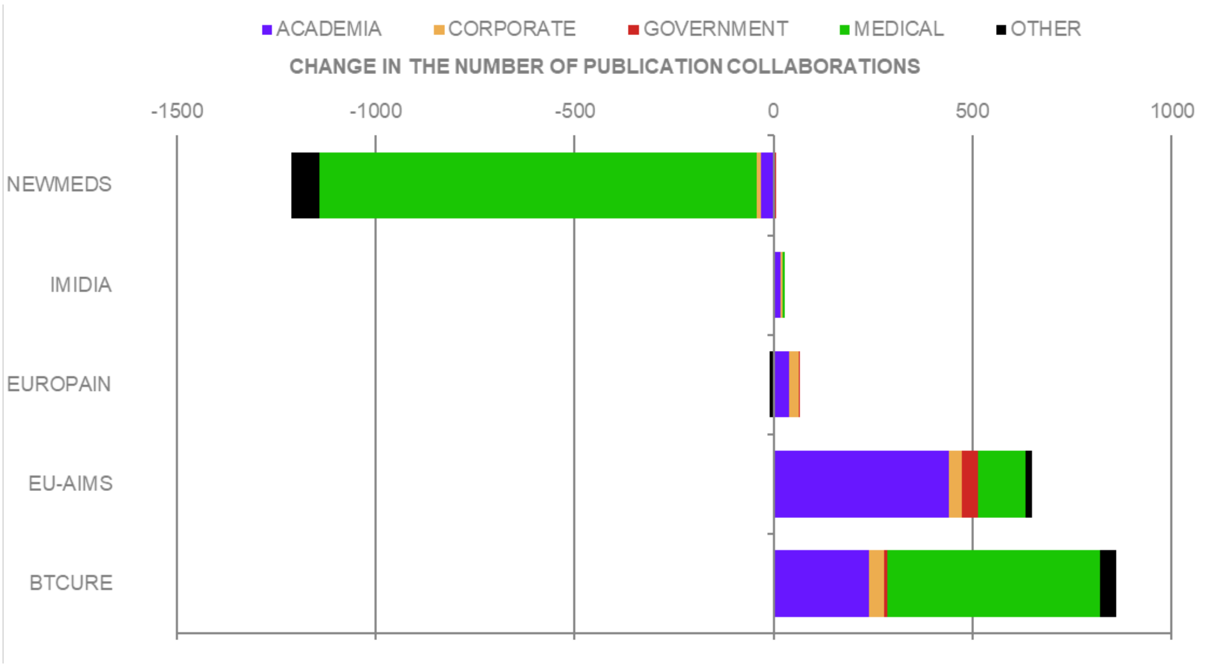


Figure 8.1.6 graphs the change in the number of publication collaborations from period 1 to period 2 for collaborations between medical and academia institutions, medical and corporate institutions, medical and government institutions, medical and medical institutions, and medical and other institutions.

- BTCURE had the largest increase in collaborations between medical institutions (+241)
- NEWMEDS had a large decrease in the number of medical – medical collaborations (-1097)

FIGURE 8.1.6 CHANGE IN THE NUMBER OF PUBLICATION COLLABORATIONS FROM PERIOD 1 TO PERIOD 2 BETWEEN **MEDICAL** INSTITUTIONS AND INSTITUTIONS FROM EACH OF THE FIVE SECTORS



8.2 COLLABORATION NETWORK GRAPHS BY IMI PROJECT

Figures 8.2.1 to 8.2.10 show network graphs of collaborative publication for each project in two periods, period 1 (2010-2013) and period 2 (2014-2017). The network nodes represent distinct unified institutions and are coloured according to the sector to which the institution belongs. The top ten collaborative institutions for each project are titled and the font size is linearly proportional to the number of collaborations with other institutions (including repeated collaborations). An edge denotes collaboration between institutions and is represented by a line, where the line weighting is linearly proportional to number of shared publications. Each network is independently scaled so the font sizes and line weights are not comparable between figures. The network diameter is the shortest distance between the two most distant nodes in the network.

In all five projects collaboration activity increased between period 1 and period 2. Below is an overview of some statistics for the graphed projects in period 2:

- BTCURE has three non-academic institutions in the top ten. It has 314 nodes, 2732 edges and a network diameter of 5.
- EU-AIMS has only academic institutions in the top ten and is the largest network. There are 6228 edges connecting the 423 institutions.
- EUROPAIN is the smallest network with 140 nodes but it has 1179 edges and a network diameter of 6, the largest of the five graphed.
- NEWMEDS has 246 nodes which are connected by 4895 edges (nearly twice that of BTCURE but with fewer nodes). The graph shows a regular array of institutions with many low weight edges linking them.
- IMIDIA is the second smallest network with 143 nodes but has 681 edges, the fewest of the five graphed.

FIGURE 8.2.1 COLLABORATION NETWORK ANALYSIS: BTCURE PERIOD 1 (2010-2013)

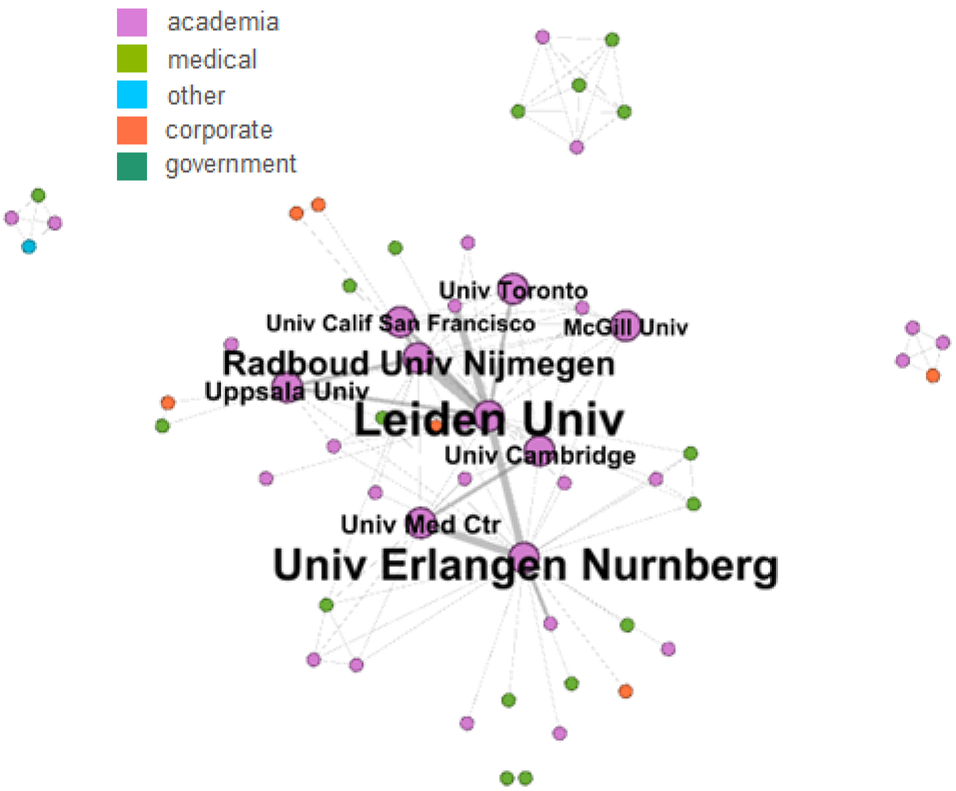


FIGURE 8.2.2 COLLABORATION NETWORK ANALYSIS: BTCURE PERIOD 2 (2014-2017)

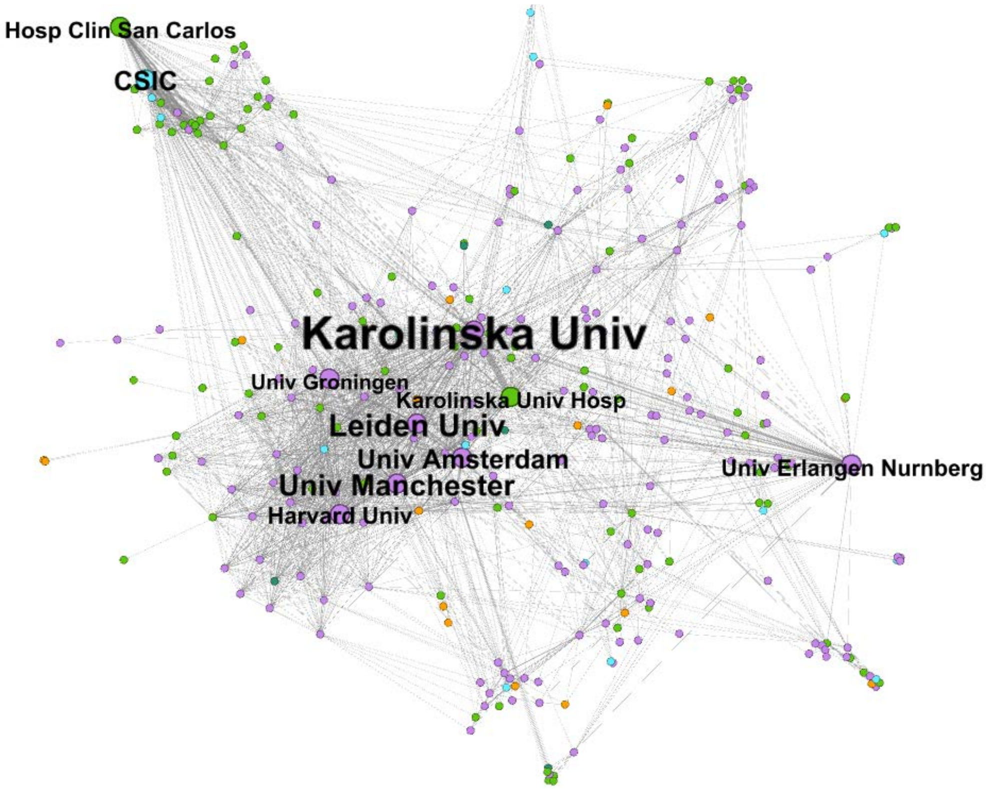


FIGURE 8.2.3 COLLABORATION NETWORK ANALYSIS: EU-AIMS PERIOD 1 (2010-2013)

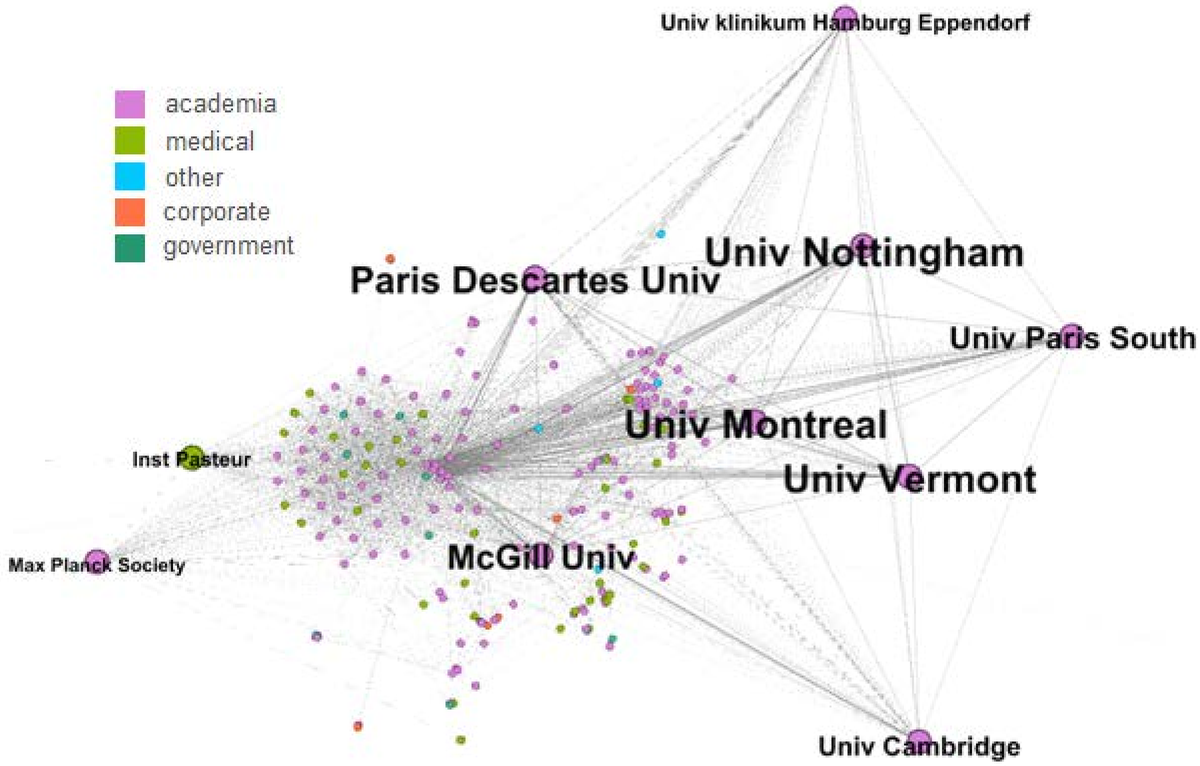


FIGURE 8.2.4 COLLABORATION NETWORK ANALYSIS: EU-AIMS PERIOD 2 (2014-2017)

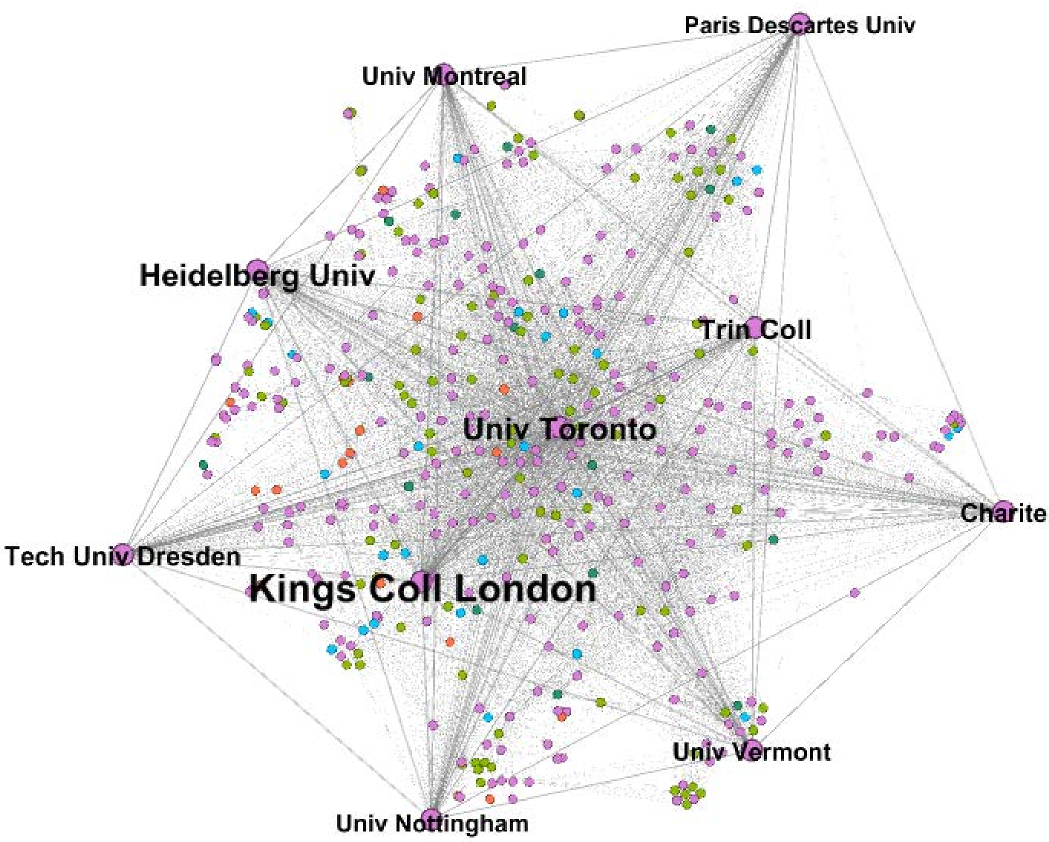


FIGURE 8.2.5 COLLABORATION NETWORK ANALYSIS: EUROPAIN PERIOD 1 (2010-2013)

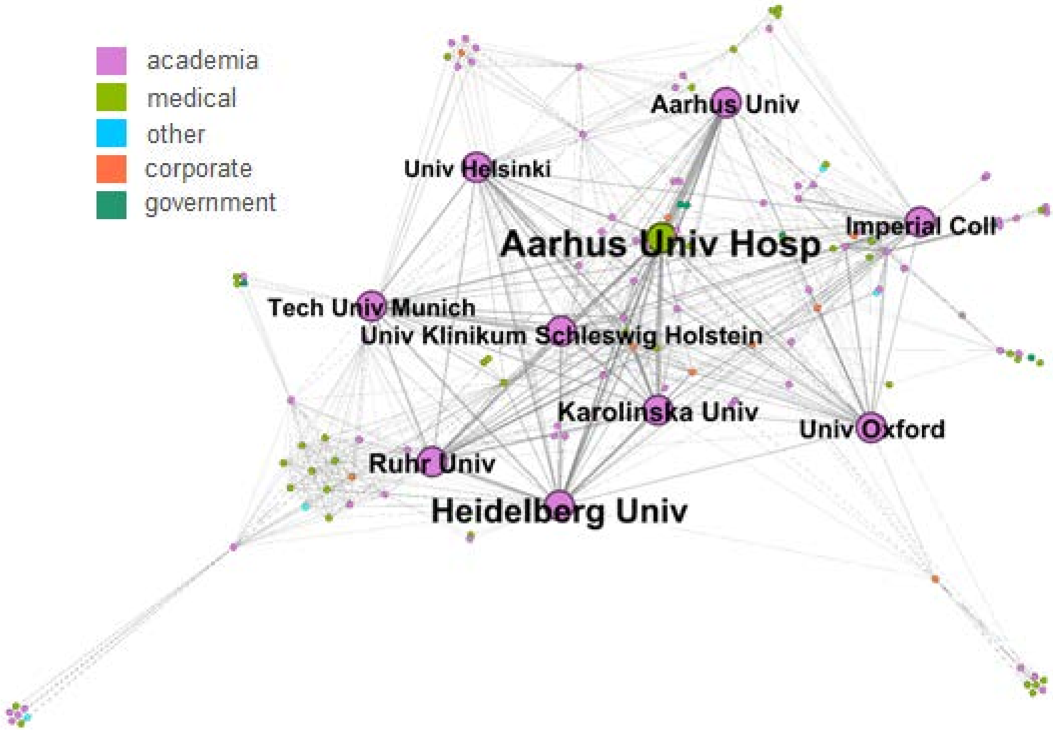


FIGURE 8.2.6 COLLABORATION NETWORK ANALYSIS: EUROPAIN PERIOD 2 (2014-2017)

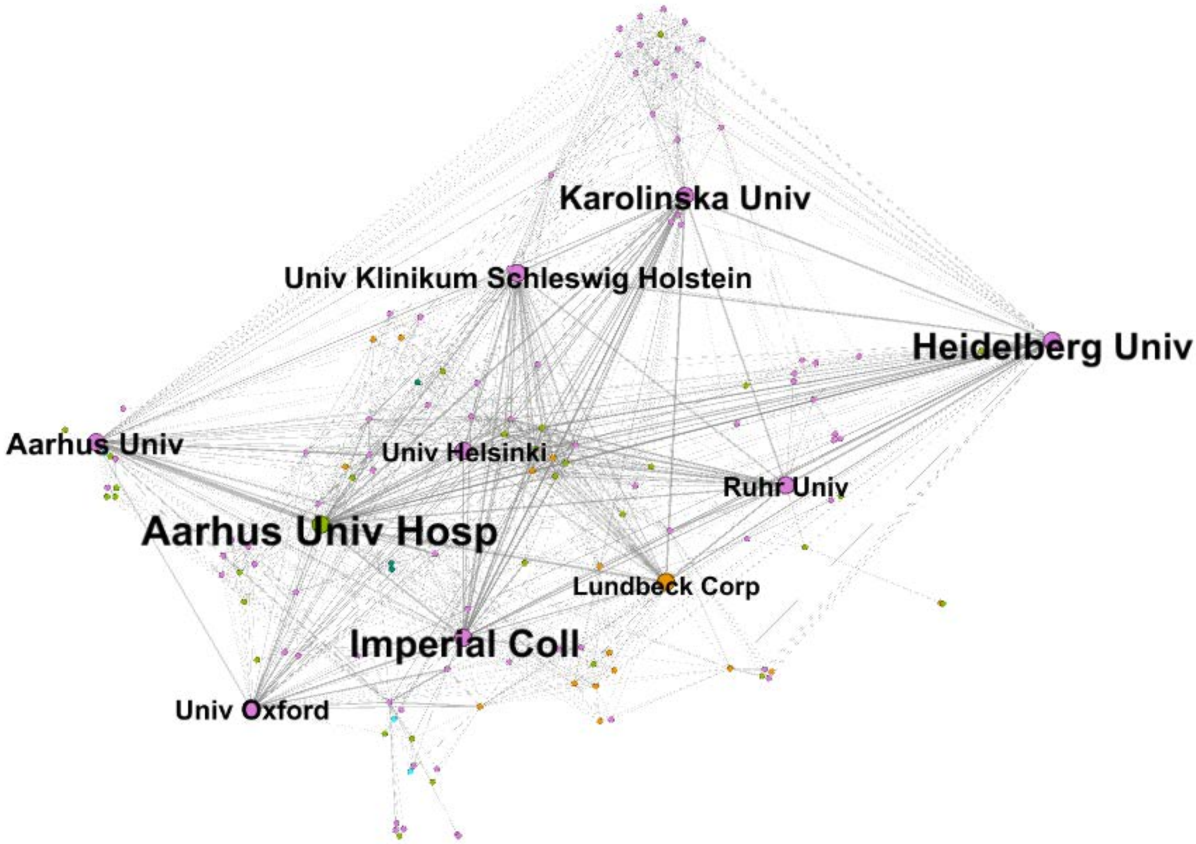


Figure 8.2.7 COLLABORATION NETWORK ANALYSIS: NEWMEDS PERIOD 1 (2010-2013)

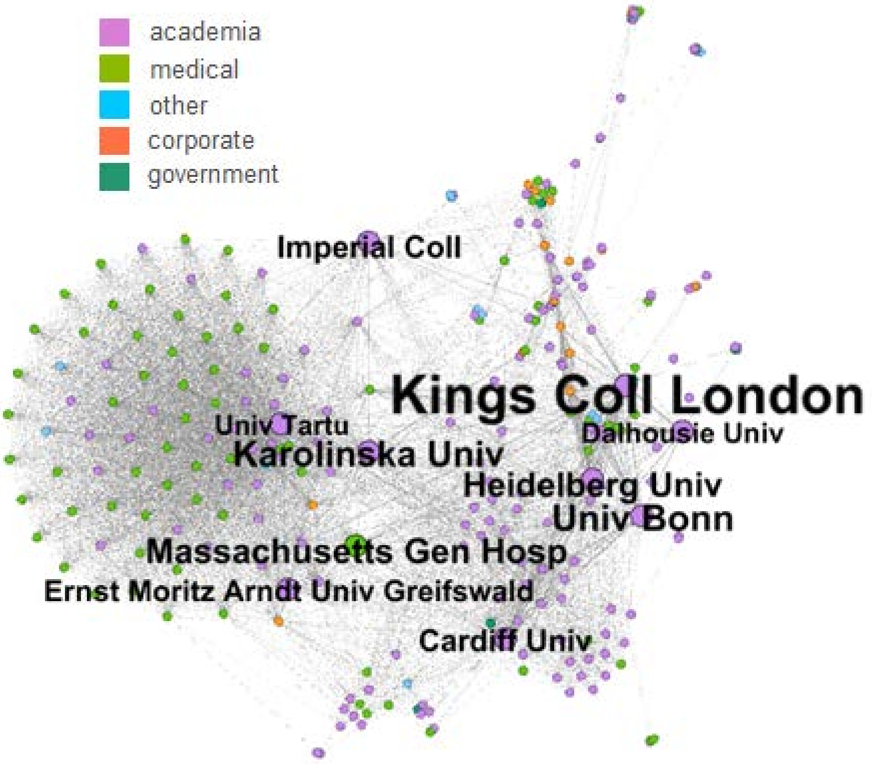


FIGURE 8.2.8 COLLABORATION NETWORK ANALYSIS: NEWMEDS PERIOD 2 (2014-2017)

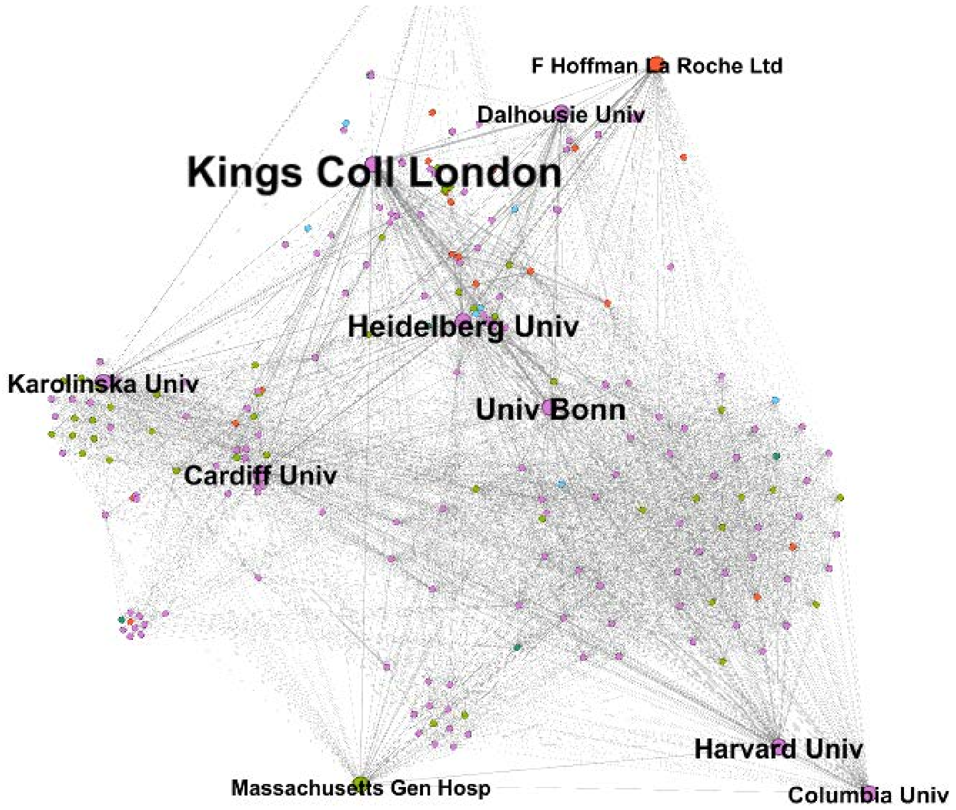


FIGURE 8.2.9 COLLABORATION NETWORK ANALYSIS: IMIDIA PERIOD 1 (2010-2013)

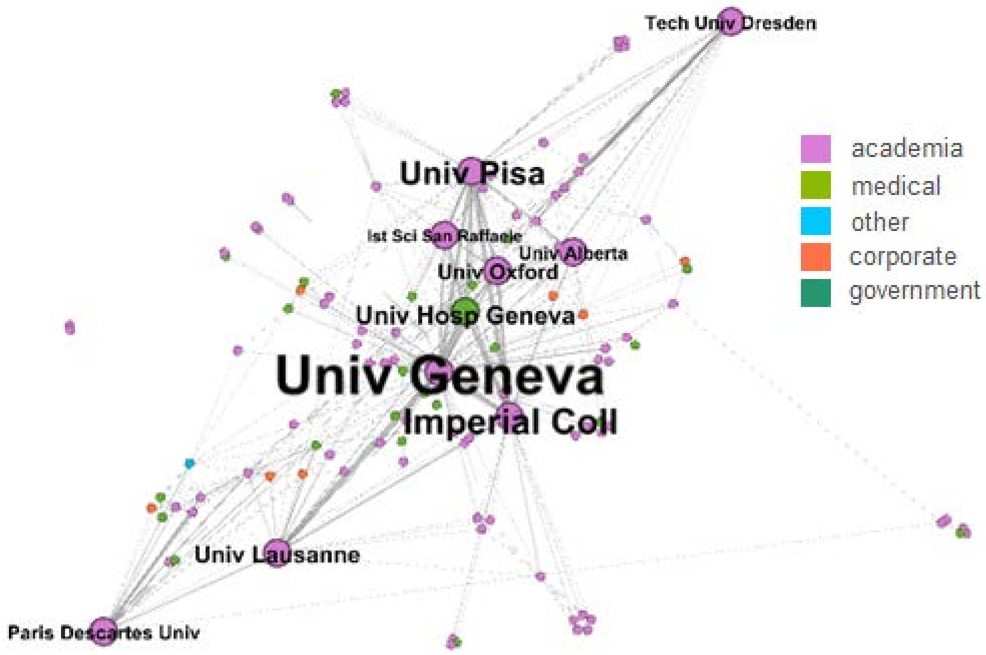
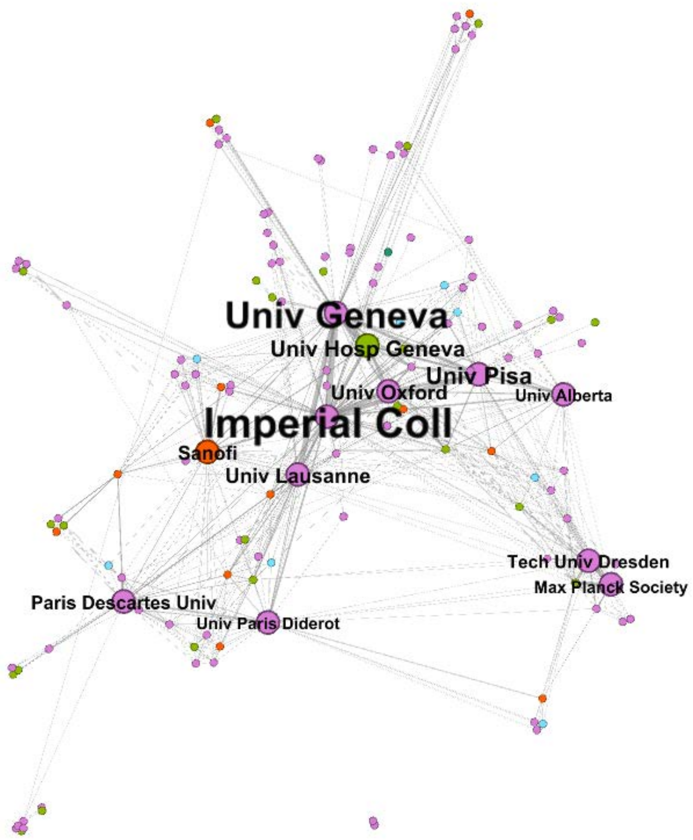


FIGURE 8.2.10 COLLABORATION NETWORK ANALYSIS: IMIDIA PERIOD 2 (2014-2017)



9 GEOGRAPHIC CLUSTERING ANALYSIS

This Section of the report analyses where IMI project research is taking place. It provides data on geographic clusters where IMI research activity occurs, including bibliometric data and it identifies the constituent institutions within the clusters.

Substantive clusters of research activity were identified in Europe and North America. While IMI project research also involves institutions in other parts of the world, publication rates for other geographies were low. This analysis, therefore, focuses on Europe and North America and we have identified the 36 and 15 geographic clusters respectively with the highest output within a 20km radius.

The clusters in both Europe and North America tend to focus on major cities with an existing strong academic research base. The largest European clusters are London (680 publications), Amsterdam (580), Stockholm (353), Copenhagen (271) and Cambridge (194). The largest clusters in North America are Boston (134), Toronto (132), Bethesda (74), New York (69) and Montreal (62). It is also clear that the citation impact of the research IMI supports within these clusters is higher than the average national benchmark. A relatively high percentage of IMI supported research, in the Spanish clusters in particular, is published in Open Access journals. It should be noted that in previous sections the Open Access status of a publication was determind per publication, regardless of the journal, here we report publications from Open Access journals.

Rates of international collaboration are very high for most clusters. Around 35-40% of EU-28 biomedical research typically involves international co-authorship whereas the lowest rate of international co-authorship for the European clusters analysed was 61.4% (Madrid). In addition, around two thirds of the European clusters have rates of international co-authorship of at least 75%. High rates of international collaboration are to be expected for the North American clusters because IMI is a European funding organisation.

The clusters are visualised as maps in Figure 9.1 and 9.2. Both maps are scaled separately so that the most intensive areas of output are shaded red and the lowest areas of output are blue. This means that the same colour shading is not comparable between maps. Tables 9.1 to 9.4 show the research publication outputs of the individual clusters along with bibliometric indicators of their research performance. The citations metrics in Tables 9.2 and 9.4 are shaded green when the performance of a cluster of IMI-supported research outperforms the national average performance for biomedical research.

The institutions that constitute the top five clusters within each of the European and North American regions are shown in Tables 9.5 and 9.6 respectively. The five journal subject categories in which the top five clusters published most frequently within each of the European and North American regions are shown in Tables 9.7 and 9.8 respectively.

FIGURE 9.1 MAP SHOWING EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2017

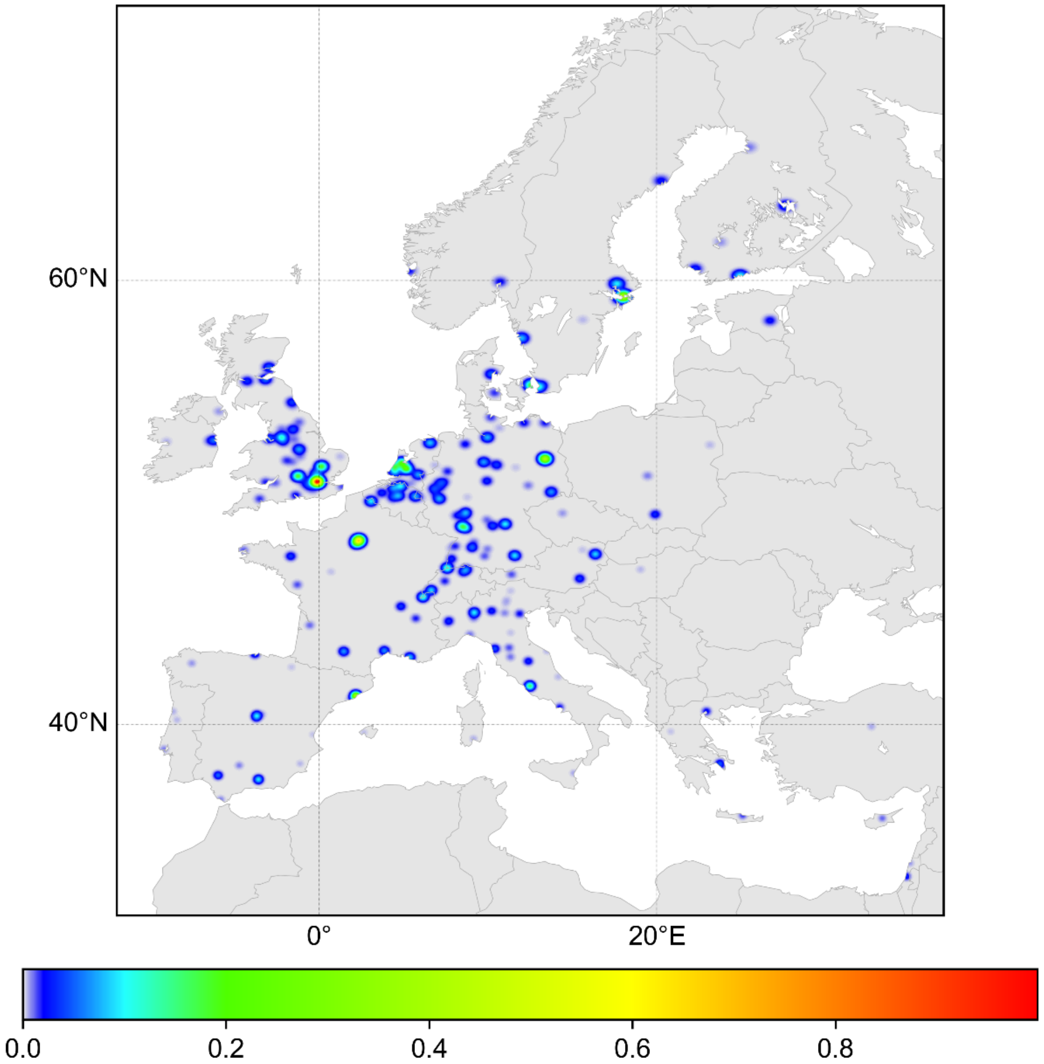


FIGURE 9.2 MAP SHOWING NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2017

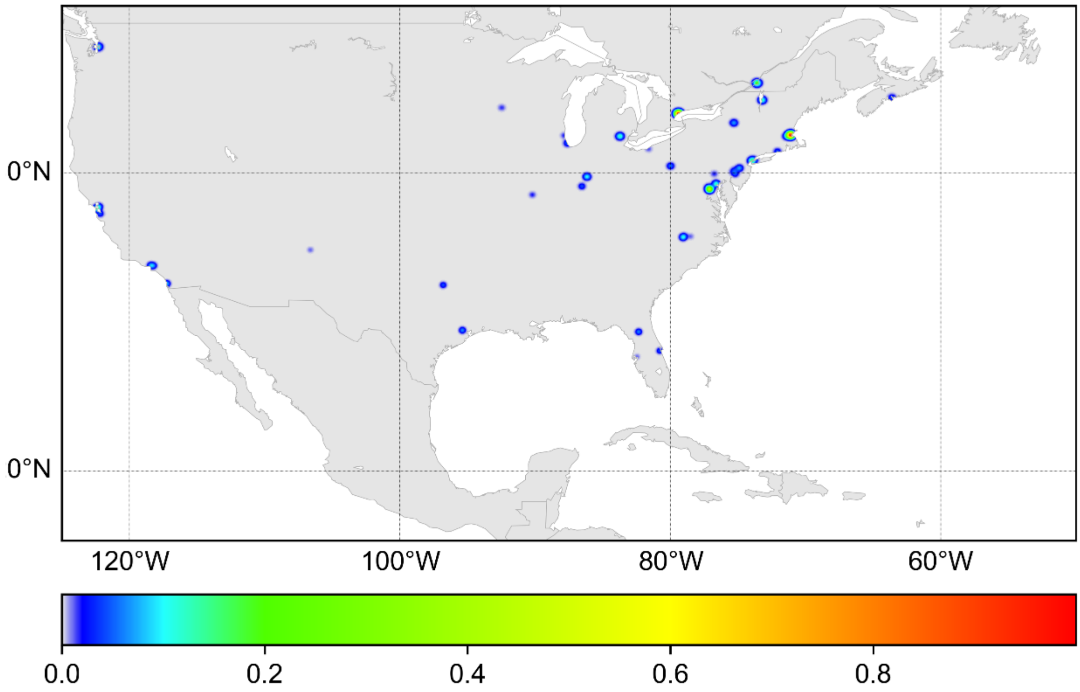


TABLE 9.1 OUTPUT AND RESEARCH PERFORMANCE OF EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2017

Cluster	Publications	Papers	Percentage publications open access	Raw Citation Impact	Percentage of internationally collaborative publications
London (UK)	680	651	15.8%	19.20	82.1%
Amsterdam (Netherlands)	581	542	12.9%	19.04	75.2%
Stockholm (Sweden)	353	337	17.2%	18.42	73.7%
Paris (France)	278	267	14.6%	18.91	82.4%
Copenhagen (Denmark)	271	258	15.9%	13.68	74.9%
Cambridge (UK)	194	183	24.0%	20.72	89.2%
Oxford (UK)	190	180	21.1%	15.47	81.1%
Barcelona (Spain)	169	161	24.8%	15.29	68.0%
Berlin (Germany)	167	159	15.1%	17.01	72.5%
Basel (Switzerland)	156	149	17.4%	14.48	92.9%
Mannheim (Germany)	154	151	13.2%	25.91	84.4%
Geneva (Switzerland)	142	131	13.0%	22.94	82.4%
Manchester (UK)	135	119	16.8%	15.37	84.4%
Rome (Italy)	129	117	19.7%	15.15	74.4%
Uppsala (Sweden)	126	119	10.9%	10.60	71.4%
Beerse (Belgium)	120	117	12.8%	11.25	75.8%
Erlangen (Germany)	115	114	7.9%	22.83	68.7%
Vienna (Austria)	105	103	16.5%	12.13	70.5%
Groningen (Netherlands)	103	101	5.9%	21.41	75.7%
Molndal (Sweden)	102	95	12.6%	13.91	89.2%
Munich (Germany)	97	90	17.8%	20.56	78.4%
Hamburg (Germany)	96	90	16.7%	12.84	77.1%
Milan (Italy)	86	82	12.2%	16.49	86.0%
Maastricht (Netherlands)	86	84	16.7%	32.44	87.2%
Nijmegen (Netherlands)	84	82	18.3%	24.80	83.3%
Nottingham (UK)	80	75	9.3%	11.56	92.5%
Frankfurt (Germany)	77	74	9.5%	10.88	87.0%
Helsinki (Finland)	72	72	18.1%	14.86	90.3%
Madrid (Spain)	70	67	25.4%	14.80	61.4%
Leuven (Belgium)	69	65	20.0%	21.39	76.8%
Lausanne (Switzerland)	60	59	20.3%	27.93	73.3%
Bonn (Germany)	56	54	27.8%	22.02	78.6%
Marseille (France)	55	49	22.4%	13.38	87.3%
Granada (Spain)	42	36	36.1%	18.79	66.7%
Lille (France)	37	34	14.7%	13.35	94.6%

TABLE 9.2 RESEARCH PERFORMANCE OF EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH COMPARED TO NATIONAL BENCHMARKS, 2010-2017

	Field normalised citation impact		Journal normalised citation impact		Percentage of highly-cited papers	
Cluster	Cluster	National	Cluster	National	Cluster	National
London (UK)	2.61	1.4	1.42	1.13	32.26%	15.63%
Amsterdam (Netherlands)	2.54	1.56	1.36	1.18	30.63%	17.97%
Stockholm (Sweden)	2.50	1.44	1.32	1.13	30.27%	15.79%
Paris (France)	2.45	1.23	1.31	1.06	30.34%	13.33%
Copenhagen (Denmark)	1.86	1.59	1.11	1.21	22.09%	17.98%
Cambridge (UK)	2.86	1.4	1.25	1.13	32.24%	15.63%
Oxford (UK)	3.05	1.4	1.59	1.13	33.89%	15.63%
Barcelona (Spain)	2.17	1.18	1.55	1.06	27.33%	12.56%
Berlin (Germany)	2.19	1.28	1.36	1.11	32.70%	14.21%
Basel (Switzerland)	1.87	1.62	1.45	1.21	28.86%	18.6%
Mannheim (Germany)	2.76	1.28	1.20	1.11	34.44%	14.21%
Geneva (Switzerland)	2.59	1.62	1.33	1.21	29.77%	18.6%
Manchester (UK)	2.66	1.4	1.39	1.13	36.13%	15.63%
Rome (Italy)	2.62	1.25	1.67	1.15	33.33%	13.46%
Uppsala (Sweden)	1.58	1.44	1.18	1.13	21.85%	15.79%
Beerse (Belgium)	2.28	1.45	1.62	1.18	24.79%	16.1%
Erlangen (Germany)	2.48	1.28	1.37	1.11	35.09%	14.21%
Vienna (Austria)	1.60	1.39	1.06	1.17	20.39%	15.26%
Groningen (Netherlands)	3.00	1.56	1.25	1.18	31.68%	17.97%
Molndal (Sweden)	2.89	1.44	2.00	1.13	42.11%	15.79%
Munich (Germany)	2.78	1.28	1.30	1.11	32.22%	14.21%
Hamburg (Germany)	2.60	1.28	1.05	1.11	27.78%	14.21%
Milan (Italy)	2.46	1.25	1.08	1.15	30.49%	13.46%
Maastricht (Netherlands)	4.34	1.56	2.41	1.18	51.19%	17.97%
Nijmegen (Netherlands)	2.88	1.56	1.43	1.18	32.93%	17.97%
Nottingham (UK)	2.54	1.4	1.12	1.13	28.00%	15.63%
Frankfurt (Germany)	2.48	1.28	1.47	1.11	36.49%	14.21%
Helsinki (Finland)	2.55	1.4	1.34	1.13	31.94%	14.65%
Madrid (Spain)	2.12	1.18	1.07	1.06	22.39%	12.56%
Leuven (Belgium)	3.54	1.45	1.87	1.18	44.62%	16.1%
Lausanne (Switzerland)	2.64	1.62	1.38	1.21	32.20%	18.6%
Bonn (Germany)	2.15	1.28	1.22	1.11	27.78%	14.21%
Marseille (France)	2.19	1.23	1.10	1.06	30.61%	13.33%
Granada (Spain)	2.44	1.18	0.80	1.06	22.22%	12.56%
Lille (France)	2.03	1.23	1.00	1.06	29.41%	13.33%

TABLE 9.3 OUTPUT AND RESEARCH PERFORMANCE OF NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2017

Cluster	Publications	Papers	Percentage publications open access	Raw Citation Impact	Percentage of internationally collaborative publications
Boston (USA)	134	131	16.79%	39.66	98.51%
Toronto (Canada)	132	131	15.27%	19.77	91.67%
Bethesda (USA)	74	74	14.86%	28.22	97.30%
New York (USA)	69	68	10.29%	21.45	98.55%
Montreal (Canada)	62	62	17.74%	17.18	100.00%
Burlington (USA)	42	42	9.52%	14.38	100.00%
San Francisco (USA)	40	40	20.00%	52.48	100.00%
Indianapolis (USA)	39	38	5.26%	20.41	97.44%
Baltimore (USA)	35	35	11.43%	24.54	100.00%
Chapel Hill (USA)	29	28	28.57%	30.41	93.10%
Ann Arbor (USA)	25	25	12.00%	18.16	100.00%
La Jolla (USA)	22	22	36.36%	31.14	100.00%
Seattle (USA)	22	22	13.64%	48.77	100.00%
Los Angeles (USA)	21	21	0.00%	49.10	95.24%
Titusville (USA)	15	14	7.14%	11.67	86.67%

TABLE 9.4 RESEARCH PERFORMANCE OF NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH COMPARED TO NATIONAL BENCHMARKS, 2010-2017

	Field normalised citation impact		Journal normalised citation impact		Percentage of highly-cited papers	
Cluster	Cluster	National	Cluster	National	Cluster	National
Boston (USA)	4.17	1.32	1.78	1.06	16.79%	14.99%
Toronto (Canada)	2.46	1.32	1.24	1.08	15.27%	14.17%
Bethesda (USA)	3.63	1.32	1.50	1.06	14.86%	14.99%
New York (USA)	2.11	1.32	1.05	1.06	10.29%	14.99%
Montreal (Canada)	1.96	1.32	1.14	1.08	17.74%	14.17%
Burlington (USA)	2.00	1.32	1.00	1.06	9.52%	14.99%
San Francisco (USA)	5.82	1.32	1.63	1.06	20.00%	14.99%
Indianapolis (USA)	2.88	1.32	1.36	1.06	5.26%	14.99%
Baltimore (USA)	5.08	1.32	1.61	1.06	11.43%	14.99%
Chapel Hill (USA)	5.19	1.32	1.92	1.06	28.57%	14.99%
Ann Arbor (USA)	3.70	1.32	1.03	1.06	12.00%	14.99%
La Jolla (USA)	5.12	1.32	1.79	1.06	36.36%	14.99%
Seattle (USA)	4.58	1.32	1.66	1.06	13.64%	14.99%
Los Angeles (USA)	2.99	1.32	0.82	1.06	0.00%	14.99%
Titusville (USA)	1.00	1.32	1.61	1.06	7.14%	14.99%

TABLE 9.5 INSTITUTIONS CONSTITUTING EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2017

Cluster	Country	Institutions	Publications
London	**United Kingdom**	Kings College London	263
		Imperial College London	182
		University College London	139
		GlaxoSmithKline	109
		London School of Hygiene & Tropical Medicine	28
		Guy's & St Thomas' NHS Foundation Trust	25
		Queen Mary University London	23
		Birkbeck University London	22
		South London & Maudsley NHS Trust	18
		European Med Agcy	15
		Royal Brompton Hosp	14
		Med & Healthcare Prod Regulatory Agcy	9
		University of London	9
		EMA	6
		MRC Social Genet & Dev Psychiat SGDP Ctr	6
		Royal Brompton & Harefield NHS Fdn Trust	6
		South London & Maudsley NHS Fdn	6
		St Georges University London	6
		Heptares Therapeut	5
		London School Economics & Political Science	5
Amsterdam	**Netherlands**	Leiden University	190
		Vrije Universiteit Amsterdam	150
		Utrecht Univ	141
		Erasmus University Rotterdam	93
		University of Amsterdam	91
		Utrecht Univ Med Ctr	56
		Acad Med Ctr	10
		Netherlands National Institute for Public Health & the Environment	10
		Jan van Breemen Res Inst Reade	6
Stockholm	**Sweden**	Karolinska Institutet	321
		Karolinska Univ Hosp	111
		Stockholm City Council	20
		Stockholm University	17
		AstraZeneca	16
		Royal Institute of Technology	15
Paris	**France**	Institut National de la Sante et de la Recherche Medicale (Inserm)	131
		Universite Paris Saclay (ComUE)	80
		Univ Paris Descartes	75
		Univ Paris Sud	63
		CEA	44
		Univ Sorbonne Paris Cite-USPC ComUE	42
		Centre National de la Recherche Scientifique (CNRS)	37
		Hopital Universitaire Pitie-Salpetriere - APHP	37
		Univ Paris Diderot	32

Cluster	Country	Institutions	Publications
		Hopital Universitaire Cochin - APHP	27
		Inst Pasteur Paris	24
		Le Reseau International des Instituts Pasteur (RIIP)	24
		Sanofi France	22
		Assistance Publique Hopitaux Paris (APHP)	21
		Univ Paris 06	16
		Hopital Universitaire Europeen Georges-Pompidou - APHP	10
		Orsay Hosp	9
		Hopital Universitaire Necker-Enfants Malades - APHP	8
		Institut de Recherches Internationales Servier	8
		PSL Research University Paris	6
		University of Versailles Saint-Quentin-En-Yvelines	6
		Hop Univ Ambroise-Pare APHP	4
		Inst Ecol Environment	4
		Museum Natl Histoire Nat	2
		Sanofi-Aventis	1
		Servier	1
Copenhagen	**Denmark**	University of Copenhagen	123
		Lund University	70
		Lundbeck Corporation	38
		Skane University Hospital	38
		Technical University of Denmark	35
		Steno Diabet Ctr	19
		Novo Nordisk	18
		Novo Nordisk Foundation	10
		Statens Serum Inst	5

TABLE 9.6 INSTITUTIONS CONSTITUTING NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2017

Cluster	Country	Institutions	Publications
Boston	**USA**	Harvard University	111
		VA Boston Healthcare System	50
		Harvard Univ Medical Affiliates	35
		Broad Institute	29
		Pfizer	16
		Boston University	12
		Dana-Farber Cancer Institute	11
		Boston Child Hosp	9
		Massachusetts Gen Hosp	7
		NIH National Heart Lung & Blood Institute (NHLBI)	6
		US Dept Hlth Human Services	4
		Framingham Heart Study	3
		Massachusetts Institute of Technology (MIT)	1
Toronto	**Canada**	University of Toronto	132
		Struct Genom Consortium	39
		Hospital for Sick Children (SickKids)	28
		Univ Toronto Affiliates	19
		Princess Margaret Canc Ctr	17
		Centre for Addiction & Mental Health - Canada	7
		Univ Hlth Network Toronto	5
		Lunenfeld Tanenbaum Res Inst	1
		Mt Sinai Hosp Toronto	1
Bethesda	**USA**	Natl Inst Hlth USA	47
		US Dept Hlth Human Services	23
		NIH National Heart Lung & Blood Institute (NHLBI)	14
		AstraZeneca	7
		NIH National Institute of Mental Health (NIMH)	6
		NIH National Institute on Aging (NIA)	6
		NIH Natl Canc Inst	4
		Natl Inst Allergy Infectious Dis (NIAID)	3
New York	**USA**	Pfizer	23
		Columbia University	22
		New York University	16
		Northwell Health	7
		Albert Einstein College of Medicine	6
Montreal	**Canada**	University of Montreal	46
		McGill University	36

TABLE 9.7 FIVE JOURNAL SUBJECT CATEGORIES IN WHICH EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH PUBLISHED MOST FREQUENTLY, 2010-2017

Cluster	Country	Journal Subject Category	Publications
London	**United Kingdom**	NEUROSCIENCES	166
		PSYCHIATRY	101
		PHARMACOLOGY & PHARMACY	77
		CLINICAL NEUROLOGY	72
		BIOCHEMISTRY & MOLECULAR BIOLOGY	44
Amsterdam	**Netherlands**	RHEUMATOLOGY	105
		PHARMACOLOGY & PHARMACY	85
		NEUROSCIENCES	54
		IMMUNOLOGY	50
		PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	43
Stockholm	**Sweden**	RHEUMATOLOGY	77
		NEUROSCIENCES	46
		IMMUNOLOGY	45
		CLINICAL NEUROLOGY	36
		BIOCHEMISTRY & MOLECULAR BIOLOGY	27
Paris	**France**	NEUROSCIENCES	64
		PSYCHIATRY	33
		PHARMACOLOGY & PHARMACY	31
		ENDOCRINOLOGY & METABOLISM	20
		CLINICAL NEUROLOGY	19
Copenhagen	**Denmark**	ENDOCRINOLOGY & METABOLISM	42
		PHARMACOLOGY & PHARMACY	42
		NEUROSCIENCES	33
		CLINICAL NEUROLOGY	32
		ANESTHESIOLOGY	31

TABLE 9.8 FIVE JOURNAL SUBJECT CATEGORIES in which North American GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH published most frequently, 2010-2017

Cluster	Country	Journal Subject Category	Publications
Boston	**USA**	GENETICS & HEREDITY	19
		NEUROSCIENCES	17
		RHEUMATOLOGY	15
		ENDOCRINOLOGY & METABOLISM	14
		BIOCHEMISTRY & MOLECULAR BIOLOGY	11
Toronto	**Canada**	PSYCHIATRY	32
		BIOCHEMISTRY & MOLECULAR BIOLOGY	31
		NEUROSCIENCES	29
		CHEMISTRY, MEDICINAL	15
		GENETICS & HEREDITY	13
Bethesda	**USA**	PHARMACOLOGY & PHARMACY	17
		PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	15
		TOXICOLOGY	14
		GENETICS & HEREDITY	11
		BIOCHEMISTRY & MOLECULAR BIOLOGY	9
New York	**USA**	PHARMACOLOGY & PHARMACY	29
		NEUROSCIENCES	15
		PSYCHIATRY	14
		PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	13
		TOXICOLOGY	10
Montreal	**Canada**	PSYCHIATRY	26
		NEUROSCIENCES	24
		PSYCHOLOGY, DEVELOPMENTAL	8
		BIOCHEMISTRY & MOLECULAR BIOLOGY	6
		GENETICS & HEREDITY	6

ANNEX 1: BIBLIOMETRICS AND CITATION ANALYSIS

Bibliometrics are about publications and their citations. The academic field emerged from 'information science' and now usually refers to the methods used to study and index texts and information.

Publications cite other publications. These citation links grow into networks, and their numbers are likely to be related to the significance or impact of the publication. The meaning of the publication is determined from keywords and content. Citation analysis and content analysis have therefore become a common part of bibliometric methodology. Historically, bibliometric methods were used to trace relationships amongst academic journal citations. Now, bibliometrics are important in indexing research performance.

Bibliometric data have particular characteristics of which the user should be aware, and these are considered here.

Journal papers (publications, sources) report research work. Papers refer to or 'cite' earlier work relevant to the material being reported. New papers are cited in their turn. Papers that accumulate more citations are thought of as having greater 'impact', which is interpreted as significance or influence on their field. Citation counts are therefore recognised as a measure of impact, which can be used to index the excellence of the research from a particular group, institution or country.

The origins of citation analysis as a tool that could be applied to research performance can be traced to the mid-1950s, when Eugene Garfield proposed the concept of citation indexing and introduced the Science Citation Index, the Social Sciences Citation Index and the Arts & Humanities Citation Index, produced by the Institute of Scientific Information (now Clarivate Analytics).[20]

We can count citations, but they are only 'indicators' of impact or quality – not metrics. Most impact indicators use average citation counts from groups of papers, because some individual papers may have unusual or misleading citation profiles. These outliers are diluted in larger samples.

Data source

The data we use come from the Clarivate Analytics Web of Science databases which give access not only to journals but also to conference proceedings, books, patents, websites, and chemical structures, compounds and reactions. It has a unified structure that integrates all data and search terms together and therefore provides a level of comparability not found in other databases. It is widely acknowledged to be the world's leading source of citation and bibliometric data. The Clarivate Analytics Web of Science Core Collection is part of the Web of Science, and focuses on research published in journals and conferences in science, medicine, arts, humanities and social sciences.

The Web of Science was originally created as an awareness and information retrieval tool but it has acquired an important primary use as a tool for research evaluation, using citation analysis and bibliometrics. Data coverage is both current and retrospective in the sciences, social sciences, arts and humanities, in some cases back to 1900. Within the research community this data source was previously referred to by the acronym 'ISI'.

Unlike other databases, the Web of Science and underlying databases are selective, that is: the journals abstracted are selected using rigorous editorial and quality criteria. The authoritative, multidisciplinary content covers over 12,000 of the highest impact journals worldwide, including Open Access journals, and over 150,000 conference proceedings. The abstracted journals encompass the majority of significant, frequently cited scientific reports and, more importantly, an even greater proportion of the scientific research output which is cited. This selective process ensures that the citation counts remain

[20] Garfield, E (1955) Citation Indexes for Science – New dimension in documentation through association of ideas. *Science*: **122**, 108-111.

relatively stable in given research fields and do not fluctuate unduly from year to year, which increases the usability of such data for performance evaluation.

Clarivate Analytics has extensive experience with databases on research inputs, activity and outputs and has developed innovative analytical approaches for benchmarking and interpreting international, national and institutional research impact.

Database categories

The source data can be grouped in various classification systems. Most of these are based on groups of journals that have a relatively high cross-citation linkage and naturally cluster together. Custom classifications use subject maps in third-party data such as the OECD categories set out in the Frascati manual.

Clarivate Analytics frequently uses the broader field categories in the InCites: Essential Science Indicators *system* and the finer journal categories in the Web of Science. There are 22 fields in Essential Science Indicators and 254 fields in Web of Science. In either case, our bibliometric analyses draw on the full range of data available in the underlying database, so analyses in our reports will differ slightly from anything created 'on the fly' from data in the web interface.

The lists of journal categories in these systems are attached at the end of this document.

Most analyses start with an overall view across the data, then move to a view across broad categories and only then focus in at a finer level in the areas of greatest interest to policy, programme or organisational purpose.

Assigning papers to addresses

A paper is assigned to each country and each organisation whose address appears at least once for any author on that paper. One paper counts once and only once for each assignment, however many address variants occur for the country or organisation. No weighting is applied.

For example, a paper has five authors, thus:

Author	Organisation	Country		
Gurney, KA	Univ Leeds	UK	**Counts for Univ Leeds**	**Counts for UK**
Adams, J	Univ Leeds	UK	No gain for Univ Leeds	No gain for UK
Kochalko, D	Univ C San Diego	USA	**Counts for UCSD**	**Counts for USA**
Munshi, S	Gujarat Univ	India	**Counts for Gujarat Univ**	**Counts for India**
Pendlebury, D	Univ Oregon	USA	**Counts for Univ Oregon**	No gain for USA

So this one paper with five authors would be included once in the tallies for each of four universities and once in the tallies for each of three countries.

Work carried out within Clarivate Analytics, and research published elsewhere, indicates that fractional weighting based on the balance of authors by organisation and country makes little difference to the conclusions of an analysis at an aggregate level. Such fractional analysis can introduce unforeseen errors in the attempt to create a detailed but uncertain assignment. Partitioning credit would make a greater difference at a detailed, group level but the analysis can then be manually validated.

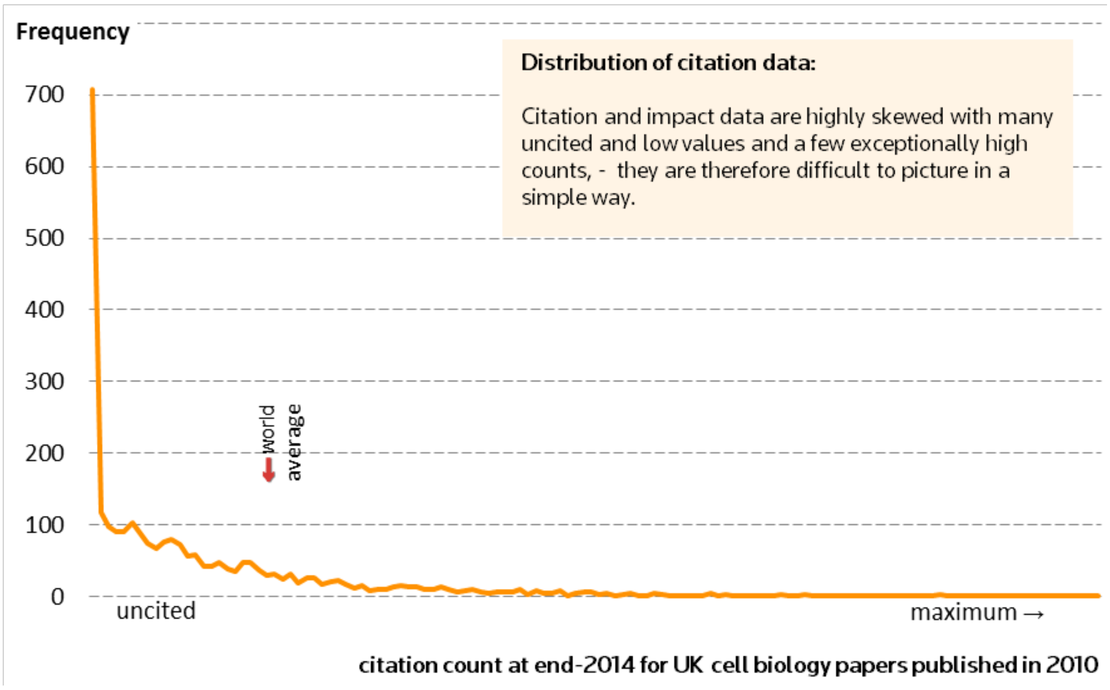
Citation counts

A publication accumulates citation counts when it is referred to by more recent publications. Some papers get cited frequently and many get cited rarely or never, so the distribution of citations is highly skewed.

Why are many papers never cited? Certainly some papers remain uncited because their content is of little or no impact, but that is not the only reason. It might be because they have been published in a journal not read by researchers to whom the paper might be interesting. It might be that they represent important but 'negative' work reporting a blind alley to be avoided by others. The publication may be a commentary in an editorial, rather than a normal journal article and thus of general rather than research interest. Or it might be that the work is a 'sleeping beauty' that has yet to be recognised for its significance.

Other papers can be very highly cited: hundreds, even thousands of times. Again, there are multiple reasons for this. Most frequently cited work is being recognised for its innovative significance and impact on the research field of which it speaks. Impact here is a good reflection of quality: it is an indicator of excellence. But there are other papers which are frequently cited because their significance is slightly different: they describe key methodology; they are a thoughtful and wide-ranging review of a field; or they represent contentious views which others seek to refute.

Citation analysis cannot make value judgments about why an article is uncited nor about why it is highly cited. The analysis can only report the citation impact that the publication has achieved. We normally assume, based on many other studies linking bibliometric and peer judgments, that high citation counts correlate on average with the quality of the research.



The figure shows the skewed distribution of more or less frequently cited papers from a sample of UK authored publications in cell biology. The skew in the distribution varies from field to field. It is to compensate for such factors that actual citation counts must be normalised, or rebased, against a world baseline.

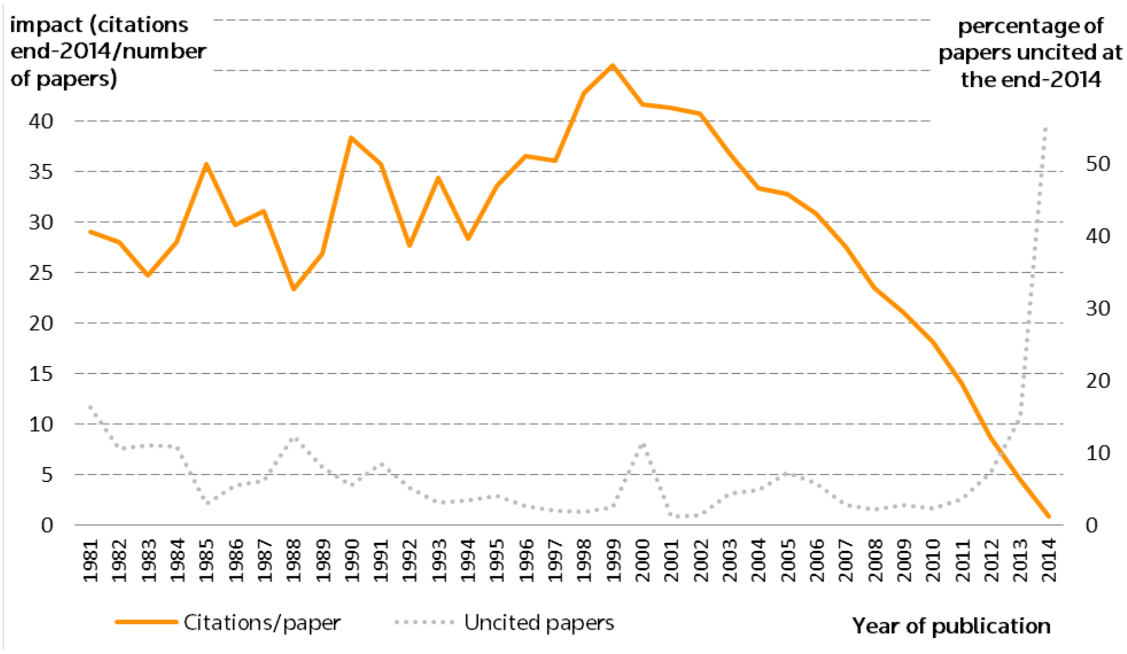
We do not seek to account separately for the effect of self-citation. If the citation count is significantly affected by self-citation then the paper is likely to have been infrequently cited. This is therefore only of consequence for low impact activity. Studies show that for large samples at national and organisational level the effect of self-citation has little or no effect on the analytical outcomes and would not alter interpretation of the results.

Time factors

Citations accumulate over time. Older papers therefore have, on average, more citations than more recent work. The graph below shows the pattern of citation accumulation for a set of 33 journals in the journal category ***Materials Science, Biomaterials***. Papers less than eight years old are, on average, still accumulating additional citations. The citation count goes on to reach a plateau for older sources.

The graph shows that the percentage of papers that have never been cited drops over about five years. Beyond five years, between 5% and 10% or more of papers remain uncited.

Account must be taken of these time factors in comparing current research with historical patterns. For these reasons, it is sometimes more appropriate to use a fixed five-year window of papers and citations to compare two periods than to look at the longer term profile of citations and of uncitedness for a recent year and an historical year.



Discipline factors

Citation rates vary between disciplines and fields. For the UK science base as a whole, ten years produces a general plateau beyond which few additional citations would be expected. On the whole, citations accumulate more rapidly and plateau at a higher level in biological sciences than physical sciences, and natural sciences generally cite at a higher rate than social sciences.

Papers are assigned to disciplines (journal categories or research fields) by Clarivate Analytics, bringing cognate research areas together. The journal category classification scheme has been recently revised and updated. Before 2007, journals were assigned to the older, well established Current Contents categories which were informed by extensive work by Thomson and with the research community since the early 1960s. This scheme has been superseded by the 252 Web of Science journal categories which allow for greater disaggregation for the growing volume of research which is published and abstracted.

Papers are allocated according to the journal in which the paper is published. Some journals may be considered to be part of the publication record for more than one research field. As the example below illustrates, the journal *Acta Biomaterialia* is assigned to two journal categories: ***Materials Science, Biomaterials*** and ***Engineering, Biomedical***.

Very few papers are not assigned to any research field and as such will not be included in specific analyses using normalised citation impact data. The journals included in the Clarivate Analytics databases and how they are selected are detailed here http://scientific.thomsonreuters.com/mjl/.
Some journals with a very diverse content, including the prestigious journals *Nature* and *Science* were classified as ***Multidisciplinary*** in databases created prior to 2007. The papers from these

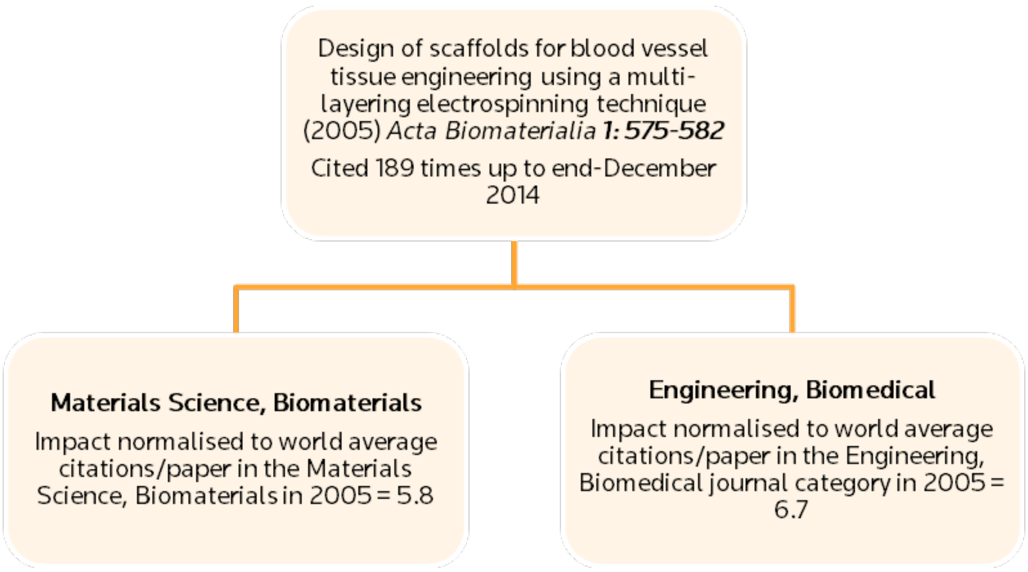
Multidisciplinary journals are now re-assigned to more specific research fields using an algorithm based on the research area(s) of the references cited by the article.

Normalised citation impact

Because citations accumulate over time at a rate that is dependent upon the field of research, all analyses must take both field and year into account. In other words, because the absolute citation count for a specific article is influenced by its field and by the year it was published, we can only make comparisons of indexed data after normalising with reference to these two variables.

We only use citation counts for reviews and articles in calculations of impact, because document type influences the citation count. For example, a review will often be cited more frequently than an article in the same field, but editorials and meeting abstracts are rarely cited and citation rates for conference proceedings are extremely variable. The most common normalisation factors are the average citations per paper for (1) the year and (2) either the field or the journal in which the paper was published. This normalisation is also referred to as 'rebasing' the citation count.

Impact is therefore most commonly analysed in terms of 'normalised impact', or NCI. The following schematic illustrates how the normalised citation impact is calculated at paper level and journal category level.



This article in the journal *Acta Biomaterialia* is assigned to two journal categories: ***Materials Science, Biomaterials*** and ***Engineering, Biomedical***. The world average baselines for, as an example, ***Materials science, Biomaterials*** are calculated by summing the citations to all the articles and reviews published worldwide in the journal *Acta Biomaterialia* and the other 32 journals assigned to this category for each year, and dividing this by the total number of articles and reviews published in the journal category. This gives the category-specific normalised citation impact (in the above example the category-specific NCI_F for ***Materials Science, Biomaterials*** is 5.8 and the category-specific NCI_F for ***Engineering, Biomedical*** is higher at 6.7). Most papers (nearly two-thirds) are assigned to a single journal category whilst a minority are assigned to more than 5.

Citation data provided by Clarivate Analytics are assigned on an annual census date referred to as the Article Time Period. For the majority of publications the Article Time Period is the same as the year of publication, but for a few publications (especially those published at the end of the calendar year in less main-stream journals) the Article Time Period may vary from the actual year of publication.

World average impact data are sourced from the Clarivate Analytics National Science Indicators baseline data for 2016.

Mean normalised citation impact

Research performance has historically been indexed by using average citation impact, usually compared to a world average that accounts for time and discipline. As noted, however, the distribution of citations amongst papers is highly skewed because many papers are never cited while a few papers accumulate very large citation counts. That means that an average may be misleading if assumptions are made about the distribution of the underlying data.

In fact, almost all research activity metrics are skewed: for research income, PhD numbers and publications there are many low activity values and a few exceptionally high values. In reality, therefore, the skewed distribution means that average impact tends to be greater than and often significantly different from either the median or mode in the distribution. This should be borne in mind when reviewing analytical outcomes.

The average (normalised) citation impact can be calculated at an individual paper level where it can be associated with more than one journal category. It can also be calculated for a set of papers at any level from a single country to an individual researcher's output. In the example above, the average citation impact of the *Acta Biomaterialia* paper can be expressed as ((5.8 + 6.7)/2) = 6.3.

Impact Profiles®

We have developed a bibliometric methodology[21] that shows the proportion of papers that are uncited and the proportion that lie in each of eight categories of relative citation rates, normalised (rebased) to world average. An Impact Profile® enables an examination and analysis of the strengths and weaknesses of published outputs relative to world average and relative to a reference profile. This provides much more information about the basis and structure of research performance than conventionally reported averages in citation indices.

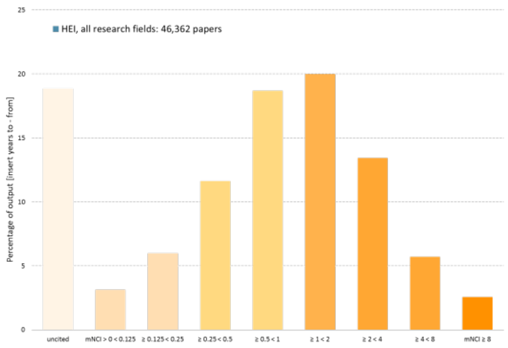
Papers which are "highly-cited" are often defined in our reports as those with an average citation impact (NCI_F) greater than or equal to 4.0, i.e. those papers which have received greater than or equal to four times the world average number of citations for papers in that subject published in that year. This differs from Clarivate Analytics database of global highly-cited papers, which are the top 1% most frequently cited for their field and year. The top percentile is a powerful indicator of leading performance but is too stringent a threshold for most management analyses.

The proportion of uncited papers in a dataset can be compared to the benchmark for the UK, the USA or any other country. Overall, in a typical ten-year sample, around one-quarter of papers have not been cited within the 10-year period; the majority of these are, of course, those that are most recently published.

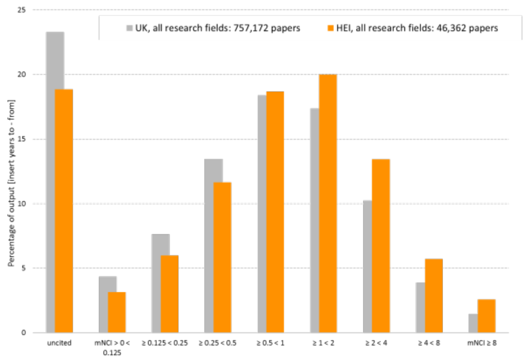
[21] Adams J, Gurney K & Marshall S (2007) Profiling citation impact: A new methodology. *Scientometrics* **72**: 325-344.

The Impact Profile® histogram can be presented in a number of ways which are illustrated below.

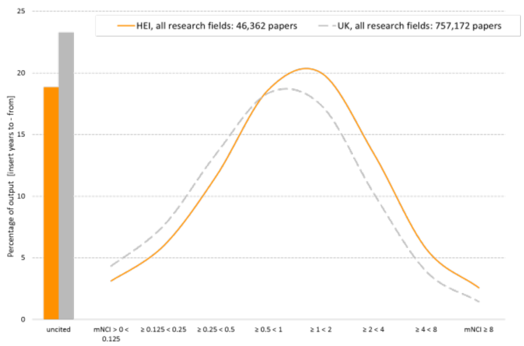
A



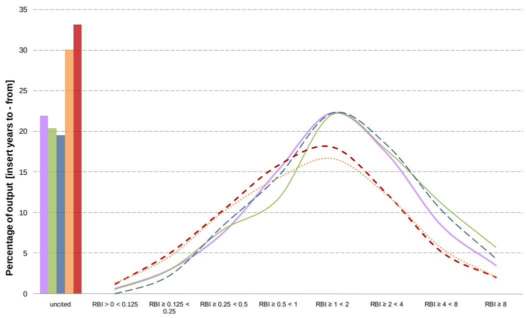
B



C



D



A: is used to represent the total output of an individual country, institution or researcher with no benchmark data. Visually it highlights the numbers of uncited papers (weaknesses) and highly cited papers (strengths).
B & **C**: are used to represent the total output of an individual country, institution or researcher (**client**) against an appropriate benchmark dataset (**benchmark**). The data are displayed as either histograms (B) or a combination of histogram and profile (C). Version C prevents the 'travel' which occurs in histograms where the eye is drawn to the data most offset to the right, but can be less easy to interpret as categorical data.
D: illustrates the complexity of data which can be displayed using an Impact Profile®. These data show research output in defined journal categories against appropriate benchmarks: **client, research field X**; **client, research field Y**; **client, research field Z**; **benchmark, research field X+Y**; **benchmark, research field, Z**.

Impact Profiles® enable an examination and analysis of the balance of published outputs relative to world average and relative to a reference profile. This provides much more information about the basis and structure of research performance than conventionally reported averages in citation indices.

An Impact Profile® shows what proportion of papers are uncited and what proportion are in each of eight categories of relative citation rates, normalised to world average (which becomes 1.0 in this graph). Normalised citation rates above 1.0 indicate papers cited more often than world average for the field in which that journal is categorised and in their year of publication.

Attention should be paid to:

- The proportion of uncited papers on the left of the chart
- The proportion of cited papers either side of world average (1.0)

- The location of the most common (modal) group near the centre
- The proportion of papers in the most highly-cited categories to the right, (≥4 x world, ≥8 x world).

What are uncited papers?

It may be a surprise that some journal papers are never subsequently cited after publication, even by their authors. This accounts for about half the total global output for a typical, recent 10-year period. We cannot tell why papers are not cited. It is likely that a significant proportion of papers remain uncited because they are reporting negative results which are an essential matter of record in their field but make the content less likely to be referenced in other papers. Inevitably, other papers are uncited because their content is trivial or marginal to the mainstream. However, it should not be assumed that this is the case for all such papers.

There is variation in non-citation between countries and between fields. For example, relatively more engineering papers tend to remain uncited than papers in other sciences, indicative of a disciplinary factor but not a quality factor. While there is also an obvious increase in the likelihood of citation over time, most papers that are going to be cited will be cited within a few years of publication.

What is the threshold for 'highly cited'?

Clarivate Analytics has traditionally used the term 'Highly Cited Paper' to refer to the world's 1% of most frequently cited papers, taking into account year of publication and field. In rough terms, UK papers cited more than eight times as often as relevant world average would fall into the Thomson Highly Cited category. About 1-2% of papers (all papers, cited or uncited) typically pass this hurdle. Such a threshold certainly delimits exceptional papers for international comparisons but, in practice, is an onerous marker for more general management purposes.

After reviewing the outcomes of a number of analyses, we have chosen a more relaxed definition for our descriptive and analytical work. We deem papers that are cited more often than four times the relevant world average to be relatively highly-cited for national comparisons. This covers the two most highly-cited categories in our graphical analyses.

Another bibliometric indicator which can be very useful in small datasets is the Clarivate Analytics quality index. This indicator is calculated from the citation impact relative to the specific journal in which the paper is published.

For the paper on page 65 which has been cited 189 times to the end-December 2014, the expected citation rate for a paper in *Acta Biomaterialia* published in 2005 would be 49.57. Therefore, this paper has been cited more than expected for the journal. For a set of papers, we calculate the quality index as the percentage of papers which are cited more than expected for the relevant journals.

This indicator should be considered alongside that of normalised citation impact as they are complementary. For example, a given set of publications may have a high Clarivate Analytics quality index and relatively low citation impact. This would imply that these papers were well cited in relation to other papers in that journal and that year but when considered in relation to other papers published in more highly-cited journals in the same research field did not perform as well. The interpretation would be that the publications are in relatively low impact journals.

Journal category systems used in our analyses

WEB OF SCIENCE

Acoustics
Agricultural economics & policy
Agricultural engineering
Agriculture, dairy & animal science
Agriculture, multidisciplinary
Agriculture, soil science
Agronomy
Allergy
Anatomy & morphology
Andrology
Anesthesiology
Anthropology
Applied linguistics
Archaeology
Architecture
Area studies
Art
Asian studies
Astronomy & astrophysics
Automation & control systems
Behavioral sciences
Biochemical research methods
Biochemistry & molecular biology
Biodiversity conservation
Biology
Biology, miscellaneous
Biophysics
Biotechnology & applied microbiology
Business
Business, finance
Cardiac & cardiovascular systems
Cell biology
Chemistry, analytical
Chemistry, applied
Chemistry, inorganic & nuclear
Chemistry, medicinal
Classics
Clinical neurology
Communication
Computer science, artificial intelligence
Computer science, cybernetics
Computer science, hardware & architecture
Computer science, information systems
Computer science, interdisciplinary applications
Computer science, software engineering
Computer science, theory & methods
Construction & building technology
Criminology & penology
Critical care medicine
Crystallography
Dance
Demography
Dentistry, oral surgery & medicine
Dermatology
Developmental biology
Ecology
Economics
Education & educational research
Education, scientific disciplines
Education, special
Electrochemistry
Emergency medicine
Endocrinology & metabolism
Energy & fuels
Engineering, aerospace
Engineering, biomedical
Engineering, chemical
Engineering, civil
Engineering, electrical & electronic
Engineering, environmental
Engineering, geological
Engineering, industrial
Engineering, multidisciplinary
Engineering, ocean
Engineering, petroleum
Entomology
Environmental sciences
Environmental studies
Ergonomics
Ethics
Ethnic studies
Evolutionary biology
Family studies
Film, radio, television
Fisheries
Folklore
Food science & technology
Forestry
Gastroenterology & hepatology
Genetics & heredity
Geochemistry & geophysics
Geography
Geography, physical
Geology
Geosciences, multidisciplinary
Geriatrics & gerontology
Health care sciences & services
Health policy & services
Hematology
History
History & philosophy of science
History of social sciences
Horticulture
Humanities, multidisciplinary
Imaging science & photographic technology
Immunology
Industrial relations & labor
Infectious diseases

Chemistry, multidisciplinary	Engineering, manufacturing	Information & library science
Chemistry, organic	Engineering, marine	Instruments & instrumentation
Chemistry, physical	Engineering, mechanical	Integrative & complementary medicine
International relations	Mining & mineral processing	Psychology
Language & linguistics	Multidisciplinary sciences	Psychology, applied
Language & linguistics theory	Music	Psychology, biological
Law	Mycology	Psychology, clinical
Limnology	Nanoscience & nanotechnology	Psychology, developmental
Linguistics	Neuroimaging	Psychology, educational
Literary reviews	Neurosciences	Psychology, experimental
Literary theory & criticism		Psychology, mathematical
Literature	Nuclear science & technology	Psychology, multidisciplinary
Literature, African, Australian, Canadian	Nursing	Psychology, psychoanalysis
Literature, American	Nutrition & dietetics	Psychology, social
Literature, British Isles	Obstetrics & gynecology	Public administration
Literature, German, Dutch, Scandinavian	Oceanography	Public, environmental & occupational health
Literature, romance	Oncology	Radiology, nuclear medicine & medical imaging
Literature, Slavic	Operations research & management science	Rehabilitation
Management	Ophthalmology	Religion
Marine & freshwater biology	Optics	Remote sensing
Materials science, biomaterials	Ornithology	Reproductive biology
Materials science, ceramics	Orthopedics	Respiratory system
Materials science, characterization & testing	Otorhinolaryngology	Rheumatology
Materials science, coatings & films	Paleontology	Robotics
Materials science, composites	Parasitology	Social issues
Materials science, multidisciplinary	Pathology	Social sciences, biomedical
Materials science, paper & wood	Pediatrics	Social sci, interdisciplinary
Materials science, textiles	Peripheral vascular disease	Social sci, mathematical methods
Math & computational biology	Pharmacology & pharmacy	Social work
Mathematics	Philosophy	Sociology
Mathematics, applied	Physics, applied	Soil science
Mathematics, interdisciplinary applications	Physics, atomic, molecular & chemical	Spectroscopy
Mechanics	Physics, condensed matter	Sport sciences
Medical ethics	Physics, fluids & plasmas	Statistics & probability
Medical informatics	Physics, mathematical	Substance abuse
Medical laboratory technology	Physics, multidisciplinary	Surgery
Medicine, general & internal	Physics, nuclear	Telecommunications
Medicine, legal	Physics, particles & fields	Theater
Medicine, research & experimental	Physiology	Thermodynamics
Medieval & renaissance studies	Planning & development	Toxicology

Metallurgy & metallurgical engineering	Plant sciences	Transplantation
Meteorology & atmospheric sci	Poetry	Transportation
Microbiology	Political science	Transportation science & technology
Microscopy	Polymer science	Tropical medicine
Mineralogy	Psychiatry	
Urban studies		
Urology & nephrology		
Veterinary		
Veterinary sciences		
Virology		
Water resources		
Women's studies		
Zoology		

ESSENTIAL SCIENCE INDICATORS

Agricultural Sciences	Geosciences	Pharmacology
Biology & Biochemistry	Immunology	Physics
Chemistry	Law	Plant & Animal Science
Clinical Medicine	Materials Science	Psychology/Psychiatry
Computer Science	Mathematics	Social Sciences, general
Ecology/Environment	Microbiology	Space Science
Economics & Business	Molecular Biology & Genetics	
Education	Multidisciplinary	
Engineering	Neurosciences & Behaviour	

ANNEX 2: MEDICALLY RELATED JOURNAL CATEGORIES

This Annex lists the Web of Science journal categories which capture medically related publications.

Allergy
Anatomy & Morphology
Andrology
Anaesthesiology
Psychology, Biological
Audiology & Speech-Language Pathology
Behavioural Sciences
Cell & Tissue Engineering
Oncology
Cardiac & Cardiovascular Systems
Critical Care Medicine
Emergency Medicine
Cytology & Histology
Dentistry, Oral Surgery & Medicine
Dermatology
Substance Abuse
Psychology, Educational
Health Care Sciences & Services
Endocrinology & Metabolism
Ergonomics
Gastroenterology & Hepatology
Geriatrics & Gerontology
Gerontology
Health Policy & Services
Haematology
Primary Health Care
Psychology, Developmental
Public, Environmental & Occupational Health
Immunology
Infectious Diseases
Psychology, Applied
Integrative & Complementary Medicine
Medical Ethics
Medicine, Legal
Medical Informatics
Medical Laboratory Technology
Medicine, General & Internal
Medicine, Research & Experimental
Med, Miscellaneous
Clinical Neurology
Neurosciences
Neuroimaging
Nursing
Nutrition & Dietetics
Obstetrics & Gynaecology
Ophthalmology
Orthopaedics
Otorhinolaryngology
Pathology
Paediatrics
Pharmacology & Pharmacy
Psychiatry
Psychology
Psychology, Psychoanalysis
Psychology, Mathematical
Psychology, Experimental
Radiology, Nuclear Medicine & Medical Imaging
Rehabilitation
Respiratory System
Reproductive Biology
Rheumatology
Psychology, Social
Surgery
Transplantation
Tropical Medicine
Urology & Nephrology
Peripheral Vascular Disease
Virology

ANNEX 3: COLLABORATION INDEX FOR ALL IMI SUPPORTED RESEARCH PROJECTS

This Annex provides the calculation of the collaboration index for all IMI supported research projects.

Project	X-sector Score	International score	Metric 3	Collaboration Index	Total Papers publications	Citation impact (field normalised)
BTCure	0.61	0.49	1.00	2.10	573	1.86
EU-AIMS	0.66	0.64	1.00	2.30	262	2.32
NEWMEDS	0.63	0.57	1.00	2.20	173	2.25
EMIF	0.79	0.63	1.00	2.42	160	2.72
EUROPAIN	0.51	0.35	1.00	1.86	154	2.39
IMIDIA	0.52	0.48	0.65	1.65	127	1.66
ULTRA-DD	0.58	0.65	0.94	2.17	110	2.10
ORBITO	0.54	0.48	0.56	1.58	107	1.59
CHEM21	0.22	0.27	0.05	0.54	105	1.69
SUMMIT	0.71	0.60	1.00	2.31	99	1.27
PROTECT	0.97	0.64	0.58	2.19	95	1.06
eTOX	0.29	0.37	0.24	0.90	86	1.72
TRANSLOCATION	0.36	0.49	0.40	1.25	84	1.50
MIP-DILI	0.68	0.42	1.00	2.10	82	1.70
Quic-Concept	0.70	0.58	1.00	2.28	80	2.74
U-BIOPRED	0.81	0.63	1.00	2.44	79	1.72
ELF	0.36	0.50	0.10	0.96	75	1.33
Open PHACTS	0.62	0.58	1.00	2.20	71	2.68
STEMBANCC	0.54	0.45	1.00	1.99	71	1.73
PreDiCT-TB	0.56	0.48	0.74	1.78	70	1.31
CANCER-ID	0.74	0.37	1.00	2.11	69	3.27
Pharma-Cog	0.84	0.73	1.00	2.57	69	1.46
DDMoRe	0.57	0.52	0.53	1.62	61	0.69
ABIRISK	0.63	0.37	0.95	1.95	57	1.26
COMPACT	0.15	0.39	0.49	1.03	54	1.89
Onco Track	0.55	0.41	1.00	1.96	53	2.51
DIRECT	0.73	0.65	1.00	2.38	49	2.23
MARCAR	0.43	0.40	0.18	1.01	49	1.18
BioVacSafe	0.46	0.42	1.00	1.88	48	1.49
SPRINTT	0.52	0.56	0.38	1.46	45	2.99
COMBACTE	0.61	0.35	0.67	1.63	41	1.52
Predect	0.69	0.63	0.82	2.14	36	1.87
RAPP-ID	0.31	0.38	0.15	0.84	36	1.01
K4DD	0.46	0.49	1.00	1.95	35	2.01
AETIONOMY	0.64	0.44	1.00	2.08	33	1.02
GETREAL	0.80	0.80	0.21	1.81	31	3.36
PRECISESADS	0.66	0.68	1.00	2.34	29	1.08
PRO-active	0.96	0.76	0.41	2.13	26	2.00
ND4BB	0.48	0.46	0.46	1.40	24	1.15

Project	X-sector Score	International score	Metric 3	Collaboration Index	Total Papers publications	Citation impact (field normalised)
COMBACTE-MAGNET	0.67	0.70	0.81	2.18	22	1.87
eTRIKS	0.68	0.85	1.00	2.53	22	2.71
ZAPI	0.59	0.65	1.00	2.24	22	2.31

ANNEX 4: BIBLIOGRAPHY OF HOT PAPERS AND HIGHLY-CITED PAPERS

This Annex provides bibliographic data for hot and highly-cited papers. Hot papers are papers that receive citations soon after publication, relative to other papers of the same field and age. For the purpose of this report, highly-cited papers have been defined as those articles and reviews which belong to the world's top decile of papers in that journal category and year of publication, when ranked by number of citations received. A percentage that is above 10 indicates above-average performance.

Papers are listed in ascending alphabetical order (project, first author) and unassigned papers, of which there are three, are listed at the end of each section.

This section lists papers that have been identified as current hot papers or that have been identified as highly-cited in the IMI project publication dataset.

HOT PAPERS ASSOCIATED WITH IMI PROJECTS

- CANCER-ID: SIRAVEGNA, G et al. (2017) Integrating liquid biopsies into the management of cancer, NAT REV CLIN ONCOL 14: 531-548
- IMPRiND: FITZPATRICK, AWP et al. (2017) Cryo-EM structures of tau filaments from Alzheimers disease, NATURE 547: 185-+
- Quic-Concept: OCONNOR, JPB et al. (2017) Imaging biomarker roadmap for cancer studies, NAT REV CLIN ONCOL 14: 169-186
- Unassigned project: VISSCHER, PM et al. (2017) 10 Years of GWAS Discovery: Biology, Function, and Translation, AM J HUM GENET 101: 5-22

This section lists papers that perform above average as defined by citation counts in the 10th percentile.

HIGHLY-CITED PAPERS ASSOCIATED WITH IMI PROJECTS

- ABIRISK: HEMMER, B et al. (2015) Role of the innate and adaptive immune responses in the course of multiple sclerosis, LANCET NEUROL 14: 406-419
- ABIRISK: KIESEIER, BC et al. (2013) Disease Amelioration With Tocilizumab in a Treatment-Resistant Patient With Neuromyelitis Optica Implication for Cellular Immune Responses, JAMA NEUROL 70: 390-393
- ABIRISK: RINGELSTEIN, M et al. (2015) Long-term Therapy With Interleukin 6 Receptor Blockade in Highly Active Neuromyelitis Optica Spectrum Disorder, JAMA NEUROL 72: 756-763
- ABIRISK: SHANKAR, G et al. (2014) Assessment and Reporting of the Clinical Immunogenicity of Therapeutic Proteins and Peptides-Harmonized Terminology and Tactical Recommendations, AAPS J 16: 658-673
- ABIRISK: UNGAR, B et al. (2014) The temporal evolution of antidrug antibodies in patients with inflammatory bowel disease treated with infliximab, GUT 63: 1258-1264
- ABIRISK: WARNKE, C et al. (2015) Natalizumab exerts a suppressive effect on surrogates of B cell function in blood and CSF, MULT SCLER J 21: 1036-1044
- ABIRISK: WARNKE, C et al. (2013) Changes to anti-JCV antibody levels in a Swedish national MS cohort, J NEUROL NEUROSUR PS 84: 1199-1205
- ABIRISK: WARNKE, C et al. (2014) Cerebrospinal Fluid JC Virus Antibody Index for Diagnosis of Natalizumab-Associated Progressive Multifocal Leukoencephalopathy, ANN NEUROL 76: 792-801

- ABIRISK: WENNIGER, LJMD et al. (2013) Immunoglobulin G4+clones identified by next-generation sequencing dominate the B cell receptor repertoire in immunoglobulin G4 associated cholangitis, HEPATOLOGY 57: 2390-2398
- ADVANCE: PEBODY, R et al. (2016) Effectiveness of seasonal influenza vaccine for adults and children in preventing laboratory-confirmed influenza in primary care in the United Kingdom: 2015/16 end-of-season results, EUROSURVEILLANCE 21: 41-51
- ADVANCE: STURKENBOOM, MCJM et al. (2015) The narcolepsy-pandemic influenza story: Can the truth ever be unraveled?, VACCINE 33: B6-B13
- AETIONOMY: AUFFRAY, C et al. (2016) Making sense of big data in health research: Towards an EU action plan, GENOME MED 8:
- AETIONOMY: BEDARF, JR et al. (2017) Functional implications of microbial and viral gut metagenome changes in early stage L-DOPA-naive Parkinsons disease patients, GENOME MED 9:
- AETIONOMY: ERPAPAZOGLOU, Z et al. (2017) From dysfunctional endoplasmic reticulum-mitochondria coupling to neurodegeneration, NEUROCHEM INT 109: 171-183
- AETIONOMY: GAUTIER, CA et al. (2016) The endoplasmic reticulum-mitochondria interface is perturbed in PARK2 knockout mice and patients with PARK2 mutations, HUM MOL GENET 25: 2972-2984
- AETIONOMY: GISPERT, JD et al. (2016) CSF YKL-40 and pTau181 are related to different cerebral morphometric patterns in early AD, NEUROBIOL AGING 38: 47-55
- AETIONOMY: MOLINUEVO, JL et al. (2014) White matter changes in preclinical Alzheimers disease: a magnetic resonance imaging-diffusion tensor imaging study on cognitively normal older people with positive amyloid beta protein 42 levels, NEUROBIOL AGING 35: 2671-2680
- APPROACH: MOBASHERI, A et al. (2017) Osteoarthritis Year in Review 2016: biomarkers (biochemical markers), OSTEOARTHR CARTILAGE 25: 199-208
- APPROACH: MOBASHERI, A et al. (2017) The role of metabolism in the pathogenesis of osteoarthritis, NAT REV RHEUMATOL 13: 302-311
- APPROACH: RAHMATI, M et al. (2016) Inflammatory mediators in osteoarthritis: A critical review of the state-of-the-art, current prospects, and future challenges, BONE 85: 81-90
- APPROACH: RICHARDSON, SM et al. (2016) Mesenchymal stem cells in regenerative medicine: Focus on articular cartilage and intervertebral disc regeneration, METHODS 99: 69-80
- BEAT-DKD: RINSCHEN, MM et al. (2017) YAP-mediated mechanotransduction determines the podocytes response to damage, SCI SIGNAL 10:
- BioVacSafe: ANDERSEN, P et al. (2014) Novel Vaccination Strategies against Tuberculosis, CSH PERSPECT MED 4:
- BioVacSafe: ANDERSEN, P et al. (2014) Tuberculosis vaccines - rethinking the current paradigm, TRENDS IMMUNOL 35: 387-395
- BioVacSafe: CLIFF, JM et al. (2015) The human immune response to tuberculosis and its treatment: a view from the blood, IMMUNOL REV 264: 88-102
- BioVacSafe: KAUFMANN, SHE et al. (2013) Tuberculosis vaccines: Time to think about the next generation, SEMIN IMMUNOL 25: 172-181
- BioVacSafe: KAUFMANN, SHE et al. (2014) Progress in tuberculosis vaccine development and host-directed therapies-a state of the art review, LANCET RESP MED 2: 301-320
- BioVacSafe: KAUFMANN, SHE et al. (2013) Inflammation in tuberculosis: interactions, imbalances and interventions, CURR OPIN IMMUNOL 25: 441-449
- BioVacSafe: KAUFMANN, SHE et al. (2012) Tuberculosis vaccine development: strength lies in tenacity, TRENDS IMMUNOL 33: 373-379
- BioVacSafe: KAUFMANN, SHE et al. (2016) Molecular Determinants in Phagocyte-Bacteria Interactions, IMMUNITY 44: 476-491

- BioVacSafe: MAERTZDORF, J et al. (2012) Enabling biomarkers for tuberculosis control, INT J TUBERC LUNG D 16: 1140-1148
- BioVacSafe: PERSSON, J et al. (2016) Nasal Immunization Confers High Avidity Neutralizing Antibody Response and Immunity to Primary and Recurrent Genital Herpes in Guinea Pigs, FRONT IMMUNOL 7:
- BioVacSafe: RAPPUOLI, R et al. (2014) Vaccines, new opportunities for a new society, P NATL ACAD SCI USA 111: 12288-12293
- BioVacSafe: TRICOT, S et al. (2015) Evaluating the Efficiency of Isotope Transmission for Improved Panel Design and a Comparison of the Detection Sensitivities of Mass Cytometer Instruments, CYTOM PART A 87A: 357-368
- BioVacSafe: VAN AALST, S et al. (2017) Dynamics of APC recruitment at the site of injection following injection of vaccine adjuvants, VACCINE 35: 1622-1629
- BioVacSafe: WEINER, J et al. (2014) Recent advances towards tuberculosis control: vaccines and biomarkers, J INTERN MED 275: 467-480
- BTCure: AJEGANOVA, S et al. (2016) Anticitrullinated protein antibodies and rheumatoid factor are associated with increased mortality but with different causes of death in patients with rheumatoid arthritis: a longitudinal study in three European cohorts, ANN RHEUM DIS 75: 1924-1932
- BTCure: AJEGANOVA, S et al. (2017) The association between anti-carbamylated protein (anti-CarP) antibodies and radiographic progression in early rheumatoid arthritis: a study exploring replication and the added value to ACPA and rheumatoid factor, ANN RHEUM DIS 76: 112-118
- BTCure: AKHMETSHINA, A et al. (2012) Activation of canonical Wnt signalling is required for TGF-beta-mediated fibrosis, NAT COMMUN 3:
- BTCure: AMARA, K et al. (2013) Monoclonal IgG antibodies generated from joint-derived B cells of RA patients have a strong bias toward citrullinated autoantigen recognition, J EXP MED 210: 445-455
- BTCure: AMMARI, M et al. (2013) Impact of microRNAs on the understanding and treatment of rheumatoid arthritis, CURR OPIN RHEUMATOL 25: 225-233
- BTCure: ARBOREA, G et al. (2017) Intracellular complement - the complosome - in immune cell regulation, MOL IMMUNOL 89: 2-9
- BTCure: ARBORE, G et al. (2016) A novel complement-metabolism-inflammasome axis as a key regulator of immune cell effector function, EUR J IMMUNOL 46: 1563-1573
- BTCure: ARNTZ, OJ et al. (2015) Oral administration of bovine milk derived extracellular vesicles attenuates arthritis in two mouse models, MOL NUTR FOOD RES 59: 1701-1712
- BTCure: BECKER, C et al. (2013) Complex Roles of Caspases in the Pathogenesis of Inflammatory Bowel Disease, GASTROENTEROLOGY 144: 283-293
- BTCure: BOSSINI-CASTILLO, L et al. (2015) A genome-wide association study of rheumatoid arthritis without antibodies against citrullinated peptides, ANN RHEUM DIS 74:
- BTCure: BOZEC, A et al. (2014) T Cell Costimulation Molecules CD80/86 Inhibit Osteoclast Differentiation by Inducing the IDO/Tryptophan Pathway, SCI TRANSL MED 6:
- BTCure: BRINK, M et al. (2013) Multiplex Analyses of Antibodies Against Citrullinated Peptides in Individuals Prior to Development of Rheumatoid Arthritis, ARTHRITIS RHEUM-US 65: 899-910
- BTCure: BUDIN-LJOSNE, I et al. (2017) Dynamic Consent: a potential solution to some of the challenges of modern biomedical research, BMC MED ETHICS 18:
- BTCure: BURSKA, AN et al. (2014) Gene expression analysis in RA: towards personalized medicine, PHARMACOGENOMICS J 14: 93-106
- BTCure: CAMPBELL, TM et al. (2016) Mesenchymal Stem Cell Alterations in Bone Marrow Lesions in Patients With Hip Osteoarthritis, ARTHRITIS RHEUMATOL 68: 1648-1659

- BTCure: CATRINA, AI et al. (2016) Mechanisms involved in triggering rheumatoid arthritis, IMMUNOL REV 269: 162-174
- BTCure: CATRINA, AI et al. (2014) Lungs, joints and immunity against citrullinated proteins in rheumatoid arthritis, NAT REV RHEUMATOL 10: 645-653
- BTCure: CATRINA, AI et al. (2017) Mechanisms leading from systemic autoimmunity to joint-specific disease in rheumatoid arthritis, NAT REV RHEUMATOL 13: 79-86
- BTCure: CHATZIDIONISYOU, A et al. (2016) The lung in rheumatoid arthritis, cause or consequence?, CURR OPIN RHEUMATOL 28: 76-82
- BTCure: CHOI, IY et al. (2015) MRP8/14 serum levels as a strong predictor of response to biological treatments in patients with rheumatoid arthritis, ANN RHEUM DIS 74: 499-505
- BTCure: COPE, A et al. (2011) The Th1 life cycle: molecular control of IFN-gamma to IL-10 switching, TRENDS IMMUNOL 32: 278-286
- BTCure: CUI, J et al. (2013) Genome-Wide Association Study and Gene Expression Analysis Identifies CD84 as a Predictor of Response to Etanercept Therapy in Rheumatoid Arthritis, PLOS GENET 9:
- BTCure: DALESSIO, S et al. (2014) VEGF-C-dependent stimulation of lymphatic function ameliorates experimental inflammatory bowel disease, J CLIN INVEST 124: 3863-3878
- BTCure: DANKS, L et al. (2016) RANKL expressed on synovial fibroblasts is primarily responsible for bone erosions during joint inflammation, ANN RHEUM DIS 75: 1187-1195
- BTCure: DE AQUINO, SG et al. (2014) Periodontal Pathogens Directly Promote Autoimmune Experimental Arthritis by Inducing a TLR2-and IL-1-Driven Th17 Response, J IMMUNOL 192: 4103-4111
- BTCure: DE HAIR, MJH et al. (2014) Features of the Synovium of Individuals at Risk of Developing Rheumatoid Arthritis, ARTHRITIS RHEUMATOL 66: 513-522
- BTCure: DE HAIR, MJH et al. (2013) Smoking and overweight determine the likelihood of developing rheumatoid arthritis, ANN RHEUM DIS 72: 1654-1658
- BTCure: DEKKERS, JS et al. (2017) Possibilities for preventive treatment in rheumatoid arthritis? Lessons from experimental animal models of arthritis: a systematic literature review and meta-analysis, ANN RHEUM DIS 76: 458-467
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