Bibliometric analysis of ongoing projects

8th report
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1 EXECUTIVE SUMMARY

This report presents a bibliometric analysis of Innovative Medicine Initiative Joint Undertaking (IMI) project research published between 2009 and 2016, using citations as an index of research quality and co-authorship as an index of collaboration. This is the eighth report commissioned by IMI. The data show that IMI continues to perform well and to rapidly expand its research effort.

The overall volume of IMI project research has increased rapidly since 2009, 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 rises and as the projects funded early in the history of the program begin to publish. To date, IMI projects have produced 2,686 publications which have been matched to the Clarivate Web of Science™. This represents a 60% increase from the 1,678 publications matched to the Web of Science in Report 7, which included IMI project research published between 2009 and 2015.

Around three quarters of IMI project research (69.7%) 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 6.16. IMI project research was wide-ranging – the research portfolio from IMI projects covers diverse research fields from basic biological research to clinical practice. IMI project research has been published most frequently in Neurosciences, Pharmacology & Pharmacy and Rheumatology journals.

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 (2.03) was twice the world average (1.00), which indicates the research was internationally influential. Between 2009 and 2016, the citation impact for IMI project papers was approaching twice the European Union's (EU) average citation impact (1.18) 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 461 publications as of this report. This is a 60.6% increase from the 287 publications attributed to BTCURE in Report 7.

Projects funded by IMI were highly collaborative. Nearly two-thirds (62.8%) of all IMI project papers were published by researchers affiliated with different sectors, more than three-quarters (80.7%) of involved collaboration between institutions and more than half (57.1%) of all IMI project papers were internationally collaborative. Collaborative IMI project research was internationally influential with a citation impact well over twice the world average (1.0).

Since it was founded in 2009, IMI's research output has grown substantially while it has maintained its performance. Its field-normalised citation impact (2.03) is on par with the well-established funding bodies such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Medical Research Council (MRC) and the Wellcome Trust (WT) (2.02, 2.01 and 2.05 respectively). Its journal-normalised citation impact (1.25) 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 diversity of organisations across multiple sectors and countries. It is also clear from the data that there is significant collaboration with organisations that were not formal participants in the IMI-supported projects and that the involvement of such partners has grown with time.

The clusters in both Europe and North America tend to focus on 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 benchmark. 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 a total of 86 projects from a total of 23 funding calls. Of the calls, 11 were from IMI's first phase, which ran from 2008 to 2013, and 12 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 2,686 unique Web of Science publications (Figure 4.1.1). IMI project research continues to show substantial growth, with research publication count increasing every year since its inception to 796 publication in 2016 (Figure 4.3.1).
- More IMI project publications appeared in *PLOS ONE* than in other journals (122 publications), followed by *Annals of the Rheumatic Diseases* (84 publications). Of the publications in *Annals of the Rheumatic Diseases* all but one were from the Call 2 project BTCURE (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 five publications in *Nature*, which has a Journal Impact Factor of 38.138 (Table 4.4.2).
- IMI project research was most frequently published in Pharmacology & Pharmacy journals (Figure 4.5.1). Of the 373 papers published in this field, 21.7% were highly-cited, 4.7% appeared in open access journals, and the average citation impact of these papers was 1.7-times the world average for the field to which they relate (Tables 4.5.2 and 4.5.3).
- IMI project research had a higher citation impact than the European (EU-28) average across all 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 papers of most highly-cited papers in the relevant field and year of publication suggesting very strong performance (Table 4.7.1).
- The citation impact for IMI project papers was twice the world average (2.03) between 2009 and 2016. 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 every year between 2009 and 2013, peaking at 168 publications, before falling to 123 publications in 2016. Since the first year of project publication, the number of publications for Calls 2, 3 and 4 has increased annually (Figure 5.1.1).
- Research associated with four of the projects in Call 1 (EUROPAIN, NEWMEDS, U-BIOPRED, PRO-Active) 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 (62.8%) of IMI project papers were published by co-authors affiliated with more than one sector. More than three-quarters (80.7%) of IMI project papers involved collaboration between institutions. And more than half (57.1%) of all IMI project papers were internationally collaborative (Table 6.1.1). The metrics for all types of collaboration have increased since the previous report.

- BTCURE had the most cross-sector collaborative papers, 262 out of 457 (57.3%), as well as the most internationally collaborative papers (366 out of 457) (Table 6.2.1-6.2.3).
- IMI's research output grew faster (2918.2%) between 2010 and 2016 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 (2.01), CSIRO (2.02) and the WT (2.05) (Table 7.2.2.1).
- Of the five project analysed BTCURE and EU-AIMS had the largest increases with 2009 in the number of co-authoring organisations that were not formally part of the IMI-supported project; +82 and +53 respectively (Figure 8.1.1).
- The largest geographic clusters of research supported by IMI in European are London (522 publications), Amsterdam (456), Stockholm (287), Copenhagen (220) and Paris (214). The largest clusters in North America are Boston (111), Toronto (99), Montreal (53), New York (48) and Bethesda (41) (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 57.9% (Madrid). In addition, around two thirds of the European clusters have rates of international co-authorship of at least 75% (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 and intellectual property indicators.

The commissioned evaluation comprises a series of reports focusing on research publications and patents produced by IMI funded researchers. This report is the eighth evaluation in the series. Since the number of patent applications and awards specifically generated by IMI projects to date is small, IMI personnel have advised that patent analyses are not required for this eighth evaluation.

2.2 INNOVATIVE MEDICINES INITIATIVE (IMI) JOINT UNDERTAKING

The IMI is working 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 12 Calls for proposals under its second phase. The first Funding Call was announced in 2008 and the latest, was launched in July 2017. This report covers the research output (publications and papers) of a total of 60 projects from Calls 1 to 10 of the first IMI phase and ten projects from Calls 1 to 4 of the second IMI phase.

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 organisations 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

[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 references cited in the article. The selection procedures for the journals included in the citation databases are documented here http://scientific.thomsonreuters.com/mjl/.[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 2016. The census point for inclusion of publications into the seventh report was December 2015. 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 2016.

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

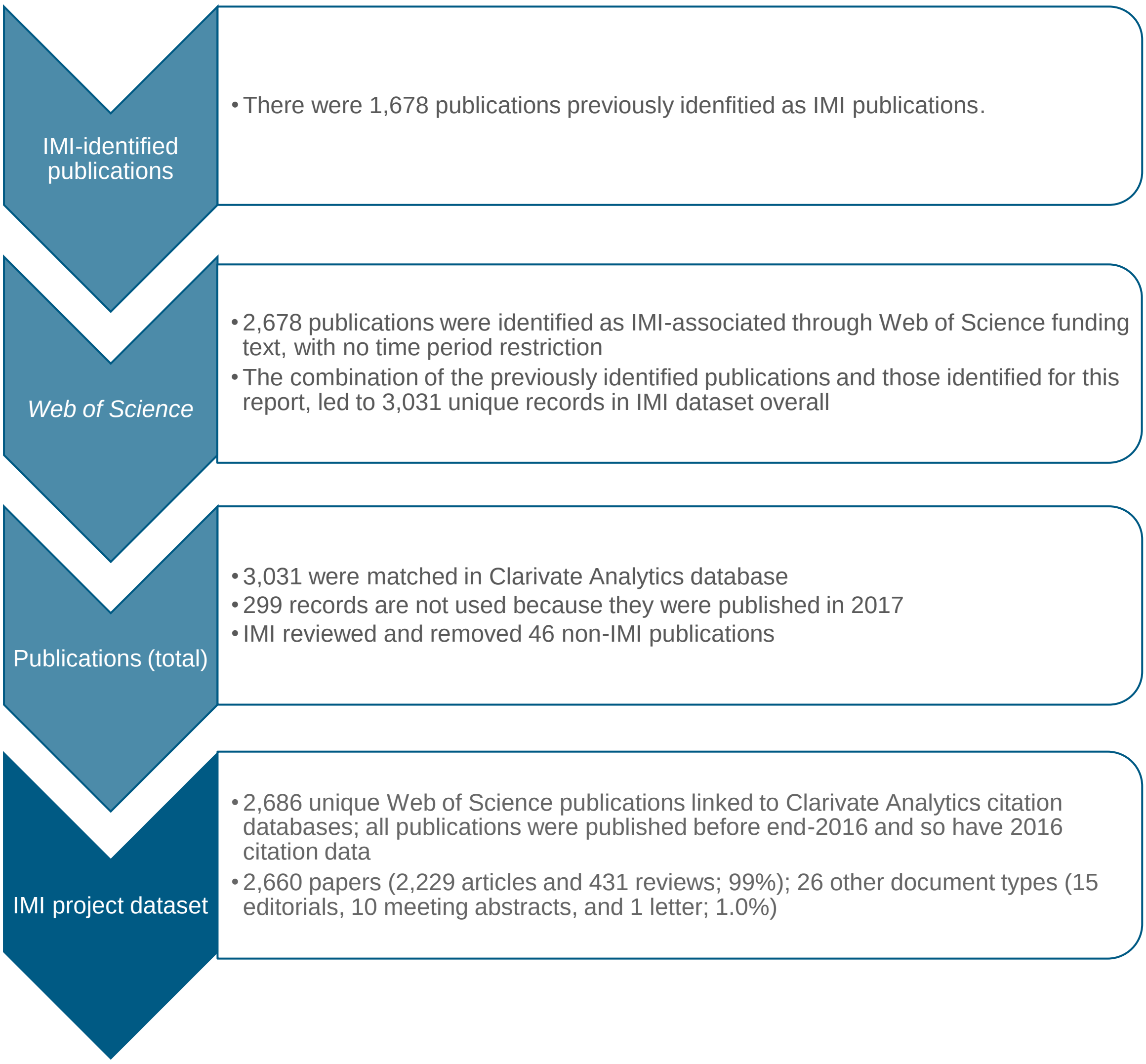
Publications from IMI-supported projects were identified using bibliographic data supplied by IMI, and through specific keyword searches using funding acknowledgment data in Web of Science. The process of identifying publications from IMI-supported projects that have Clarivate Analytics citation data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

The IMI project dataset started with 1,678 publications which were previously identified as IMI publications. Separately, 2,678 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 3,031 unique publication records associated with IMI-supported projects. Of these 3,031 publications that were matched to the databases underlying the Clarivate Analytics Web of Science, 299 were eliminated since they were published in 2017 and 46 were excluded by IMI because they were not IMI publications. Therefore, 2,686 Web of Science publications remained.

The aggregated list of publications was reviewed by Clarivate Analytics and supplied to IMI for validation prior to inclusion in the analyses. Of the identified records, 23 publications could not be assigned to specific projects despite review by IMI personnel.

The citation counts for this report were sourced from the citation databases which underlie Clarivate Analytics Web of Science and were extracted at the end of 2016. Normalised bibliometric indicators were calculated using standard methodology and the Clarivate Analytics National Science Indicators (NSI) database for 2016.

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

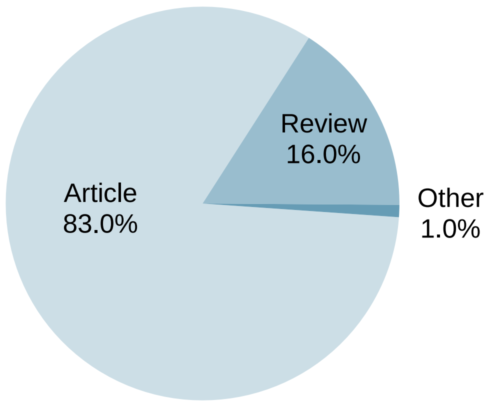


4.2 SHARE OF PAPERS RELATIVE TO OTHER PUBLICATION TYPES

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.

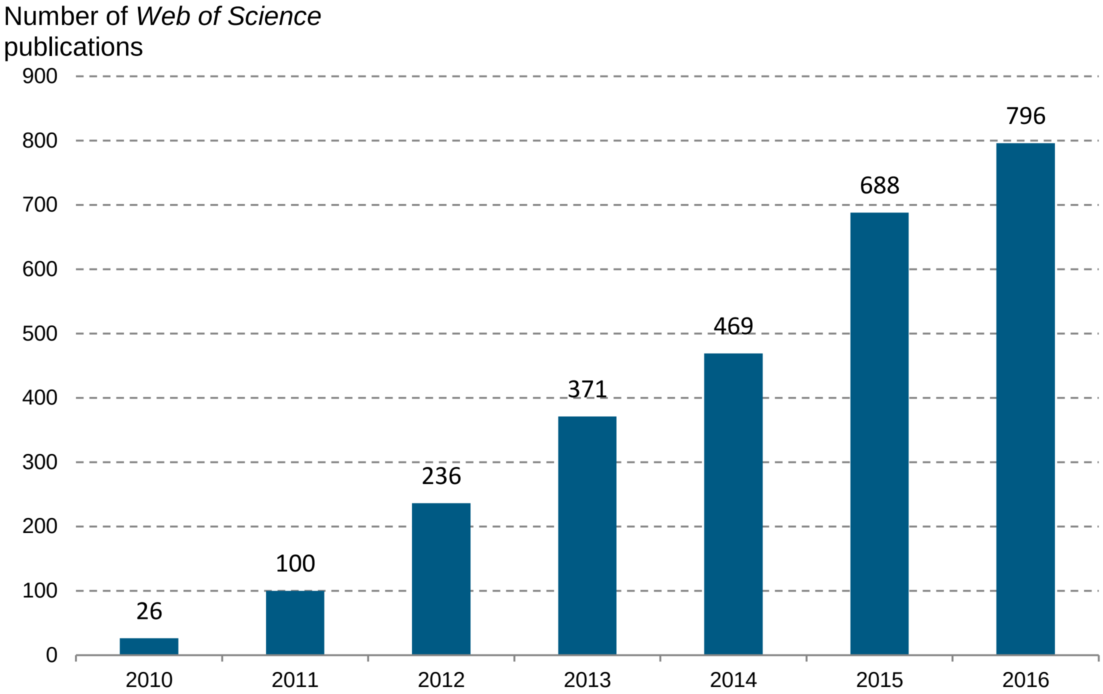
IMI project research resulted in 2,686 unique Web of Science publications. Of these publications 99% were substantive articles or reviews with only 26 documents not falling into these document types. These documents (classified as 'Other') comprised 15 editorials, ten meeting abstracts, and one letter.



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 2016.

FIGURE 4.3.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS FOR IMI PROJECTS BY YEAR, 2010-2016

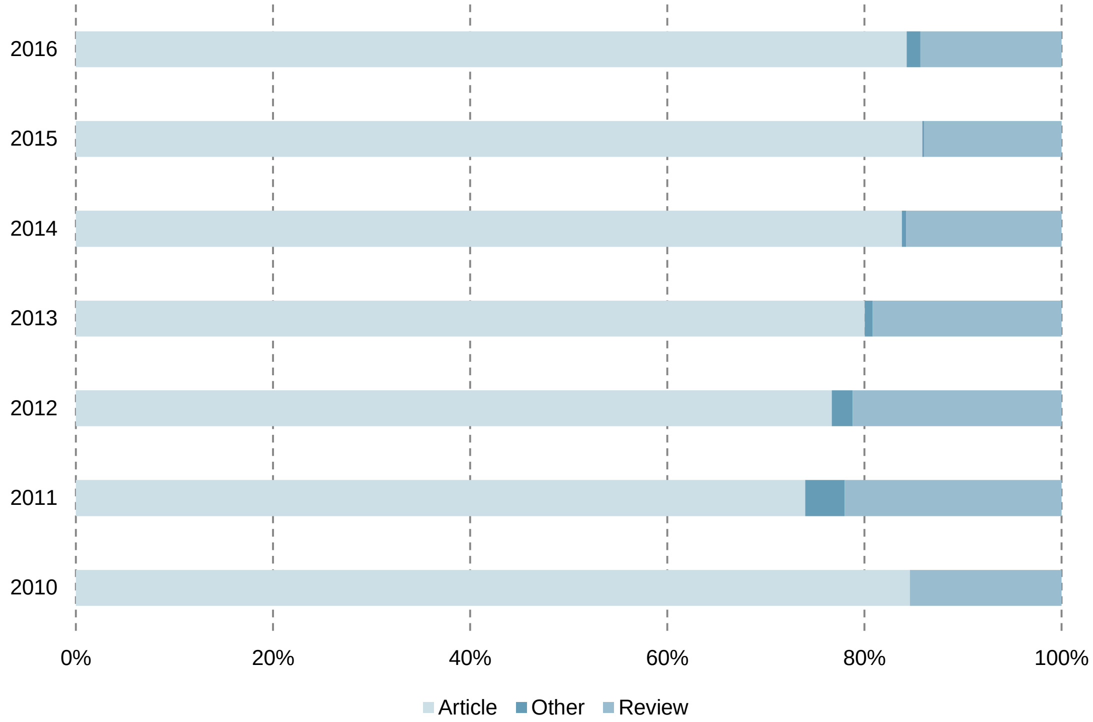


IMI project research continued to show substantial growth with publication count increasing every year between 2010 and 2016:

- The percentage change in the output of IMI project-supported publications between 2015 and 2016 was 15.7% compared with a growth of 46.7% between 2014 and 2015.
- While the percentage growth has decreased over time the number of publications continues to grow roughly linearly by an average of 128 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 2016.

FIGURE 4.3.2 CATEGORISATION OF WEB OF SCIENCE PUBLICATIONS FOR IMI PROJECTS BY YEAR AND DOCUMENT TYPE, 2010-2016



- IMI project research continued to generate a high proportion of papers relative to other document types. Articles accounted for around 80% of all publications, rising to 84.3% in 2016. Review papers accounted for approximately 20% of publications between 2010 and 2013, but fell after this point to 14.3% in 2016.

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 2016, are listed in Table 4.4.1. Together, the 20 most frequently used journals cover 664 Web of Science publications - almost one-quarter (24.7%) of the total number of publications in the dataset.

IMI project publications appeared most frequently in *PLOS ONE* (122 publications), followed by *Annals of the Rheumatic Diseases* (84 publications). All but one of the publications from *Annals of the Rheumatic Diseases* were from the Call 2 project BTCURE.

There was a strong focus on Rheumatology, as three of the top ten journals fall into that category. However, the top 20 journals for IMI projects highlight the diversity of IMI-supported research. There are multidisciplinary titles (such as *PLOS ONE*, *Scientific Reports, PNAS* and *Nature Communications*), as well as specialised titles in other disease areas such as *Diabetologia*, *Diabetes* and *Journal of Alzheimer's Disease*.

Of the 20 journals in Table 4.4.1, 14 were in the top quartile when ranked by Journal Impact Factor, five were in the second quartile, and one in the third quartile.

IMI project publications were published in a total of 796 journals, of which 471 were ranked in the top quartile (by Journal Impact Factor) of journals in their specific journal category. A total of 1,874 publications (69.7% of IMI project publications) were published in these well regarded journals. The average Journal Impact Factor of all IMI project publications is 6.16.

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 published seven publications in *Nature*, which had a Journal Impact Factor of 38.138 and six 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, 2010-2016, are listed in Table 4.4.3. Of the top 20 open access journals in which IMI project research published most frequently, *Nature Communications* had the highest impact factor (11.329). *PLOS ONE* is the open access journal with the highest number of IMI publications (122).

TABLE 4.4.1 JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 20 RANKED BY NUMBER OF WEB OF SCIENCE PUBLICATIONS, 2010-2016

Journal	Number of Web of Science Publications	Number of Papers	Journal Impact Factor (2016)	Web of Science Journal Categories
PLOS One	122	122	3.057	Multidisciplinary Sciences
Annals of the Rheumatic Diseases	84	83	12.384	Rheumatology
Arthritis Research & Therapy	41	41	3.979	Rheumatology
Pain	41	41	5.557	Anesthesiology; Clinical Neurology; Neurosciences
Psychopharmacology	40	40	3.54	Neurosciences; Pharmacology & Pharmacy; Psychiatry
Scientific Reports	33	33	5.228	Multidisciplinary Sciences
Arthritis & Rheumatology	32	32	6.009	Rheumatology
Diabetologia	29	29	6.206	Endocrinology & Metabolism
Drug Safety	26	26	3.206	Pharmacology & Pharmacy; Public, Environmental & Occupational Health; Toxicology
Proceedings of the National Academy of Sciences of the United States of America	26	26	9.423	Multidisciplinary Sciences
Journal of Alzheimer's Disease	23	23	3.92	Neurosciences
European Journal of Pharmaceutical Sciences	21	20	3.773	Pharmacology & Pharmacy
Diabetes	21	21	8.784	Endocrinology & Metabolism
Arthritis and Rheumatism	20	19	8.955	Rheumatology
Nature Communications	20	20	11.329	Multidisciplinary Sciences
Journal of Biological Chemistry	19	19	4.258	Biochemistry & Molecular Biology
Journal of Immunology	19	19	4.985	Immunology
Toxicological Sciences	16	16	3.880	Toxicology
European Journal of Immunology	16	15	4.179	Immunology
European Neuropsychopharmacology	15	14	4.409	Clinical Neurology; Neurosciences; Pharmacology & Pharmacy; Psychiatry

TABLE 4.4.2 JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 20 RANKED BY JOURNAL IMPACT FACTOR, 2010-2016

Journal	Number of Web of Science Publications	Number of Papers	Journal Impact Factor (2014)	Web Of Science Journal Categories
New England Journal of Medicine	1	1	59.558	Clinical Neurology
Nature Reviews Drug Discovery	1	0	47.12	Biotechnology & Applied Microbiology; Pharmacology & Pharmacy
Lancet	2	2	44.002	Medicine, General & Internal; Psychiatry
Nature Biotechnology	1	0	43.113	Biotechnology & Applied Microbiology
Nature Reviews Immunology	1	1	39.416	Immunology
Nature	7	7	38.138	Multidisciplinary Sciences
JAMA-Journal of the American Medical Association	5	5	37.684	Clinical Neurology; Medicine, General & Internal; Rheumatology
Chemical Reviews	1	1	37.369	Chemistry, Multidisciplinary
Nature Reviews Genetics	2	2	35.898	Genetics & Heredity
Science	6	6	34.661	Genetics & Heredity; Immunology; Infectious Diseases; Neurosciences
Nature Reviews Cancer	1	1	34.244	Oncology
Chemical Society Reviews	1	1	34.09	Chemistry, Multidisciplinary
Nature Genetics	6	4	31.616	Genetics & Heredity
Physiological Reviews	1	1	30.924	Physiology
Nature Medicine	4	4	30.357	Biochemistry & Molecular Biology; Cell Biology; Medicine, Research & Experimental
Nature Reviews Neuroscience	2	2	29.298	Neurosciences
Lancet Oncology	1	1	26.509	Oncology
Nature Methods	1	1	25.328	Biochemical Research Methods
Immunity	6	6	24.082	Immunology
Lancet Neurology	10	10	23.468	Clinical Neurology

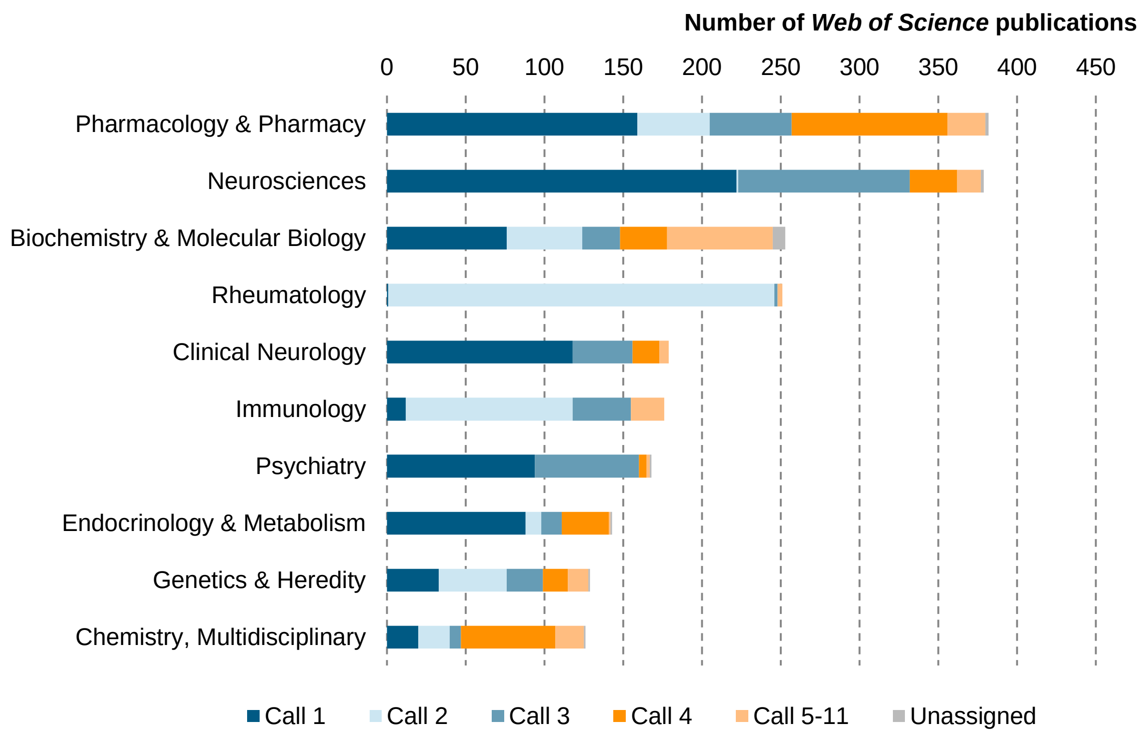
TABLE 4.4.3 OPEN ACCESS JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 20 RANKED BY NUMBER OF WEB OF SCIENCE PUBLICATIONS, 2010-2016

Open Access Journal	Number of Web of Science Publications	Number of Papers	Journal Impact Factor (2014)	Web of Science Journal Categories
PLOS One	122	122	3.057	Multidisciplinary Sciences
Arthritis Research & Therapy	41	41	3.979	Rheumatology
Scientific Reports	33	33	5.228	Multidisciplinary Sciences
Nature Communications	20	20	11.329	Multidisciplinary Sciences
Nucleic Acids Research	13	13	9.202	Biochemistry & Molecular Biology
International Journal of Molecular Sciences	13	13	3.257	Biochemistry & Molecular Biology; Chemistry, Multidisciplinary
BMC Bioinformatics	13	13	2.435	Biochemical Research Methods; Biotechnology & Applied Microbiology; Mathematical & Computational Biology
BMJ Open	10	10	2.562	Geriatrics & Gerontology; Infectious Diseases; Medicine, General & Internal; Oncology; Pharmacology & Pharmacy; Respiratory System; Statistics & Probability
Genome Biology	10	9	11.313	Biotechnology & Applied Microbiology; Genetics & Heredity
Genome Medicine	10	8	5.846	Genetics & Heredity
Cell Reports	9	9	7.87	Cell Biology
Translational Psychiatry	9	9	5.538	Psychiatry
Molecular Autism	7	7	4.961	Genetics & Heredity; Neurosciences
Journal of Biomedical Semantics	7	7	1.62	Mathematical & Computational Biology
Database-The Journal of Biological Databases and Curation	7	7	2.627	Mathematical & Computational Biology
Biomed Research International	7	7	2.134	Biotechnology & Applied Microbiology; Medicine, Research & Experimental
Frontiers In Immunology	6	6	5.695	Immunology
Journal of Diabetes Research	6	6	2.431	Endocrinology & Metabolism; Medicine, Research & Experimental
PLOS Computational Biology	6	6	4.587	Biochemical Research Methods; Mathematical & Computational Biology
Frontiers In Microbiology	5	5	4.165	Microbiology

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] by rank associated with IMI project research[5]. 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.

FIGURE 4.5.1 TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WERE PUBLISHED, 2010-2016



- IMI projects generated more publications in Pharmacology and Pharmacy than in other journal categories, followed by Neurosciences and Biochemistry & Molecular Biology. This has changed from Report 6 in which Neurosciences had the highest number of publications.
- The majority of publications (97.6%) in Rheumatology were from Call 2, and from the 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 70 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 CALL FOR THE TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED, 2010-2016

	Number of publications by IMI Call											
Journal Category	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Unassigned**
Pharmacology & Pharmacy	159	46	52	99	5	10	2	0	5	0	3	2
Neurosciences	222	1	109	30	0	0	0	9	3	0	3	2
Biochemistry & Molecular Biology	76	48	24	30	15	22	0	8	0	0	22	8
Rheumatology	1	245	2	0	0	0	0	3	0	0	0	0
Clinical Neurology	118	0	38	17	0	0	0	3	0	0	3	0
Immunology	12	106	37	0	0	1	1	11	1	7	2	0
Psychiatry	94	0	66	5	0	0	0	1	0	0	1	1
Endocrinology & Metabolism	88	10	13	30	0	0	0	0	0	0	1	1
Genetics & Heredity	33	43	23	16	0	2	0	4	1	0	9	1
Chemistry, Multidisciplinary	20	20	7	60	13	1	0	1	0	0	3	1

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, 2010-2016

		Citation Impact		
Journal category	**Number of Papers**	**Normalised at field level (nci_F)**	**Normalised at journal level (nci_J)**	**Raw citation impact**
Pharmacology & Pharmacy	373	1.70	1.24	8.61
Neurosciences	368	2.08	1.27	17.13
Rheumatology	248	2.25	1.12	12.40
Biochemistry & Molecular Biology	239	1.98	1.45	12.58
Immunology	175	1.65	1.10	11.87
Clinical Neurology	173	2.93	1.31	21.76
Psychiatry	162	2.16	1.06	14.99
Endocrinology & Metabolism	141	1.44	0.98	10.98
Chemistry, Multidisciplinary	125	2.21	1.51	12.80
Genetics & Heredity	118	2.93	1.34	23.39

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, 2010-2016

Journal Category	Number of Web of Science publications	% of Open Access publications	Number of papers	% of Highly Cited Papers
Pharmacology & Pharmacy	377	4.7%	373	21.7%
Neurosciences	374	14.7%	368	28.2%
Rheumatology	250	24.4%	248	30.2%
Biochemistry & Molecular Biology	239	20.9%	239	22.5%
Clinical Neurology	179	9.4%	173	36.4%
Immunology	176	17.6%	175	24.0%
Psychiatry	164	13.4%	162	23.4%
Endocrinology & Metabolism	141	17.7%	141	14.8%
Chemistry, Multidisciplinary	125	12.8%	125	24.0%
Genetics & Heredity	124	41.1%	118	34.7%

- IMI project research was most frequently published in Pharmacology & Pharmacy journals. Of the 373 papers published in this field, 21.7% were highly-cited and the average citation impact of these papers was 1.70. In addition, 4.7% of publications in this field (18) appeared in open access journals.
- There were 179 publications (173 papers) in the journal category of Clinical Neurology. This category has the highest percentage of highly cited papers (36.4%)
- The percentage of publications in open access journals was highest in Genetics & Heredity (41.1%).
- The highest average citation impact (2.93) was the same for both Genetics & Heredity and Clinical Neurology.

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, 2010-2016

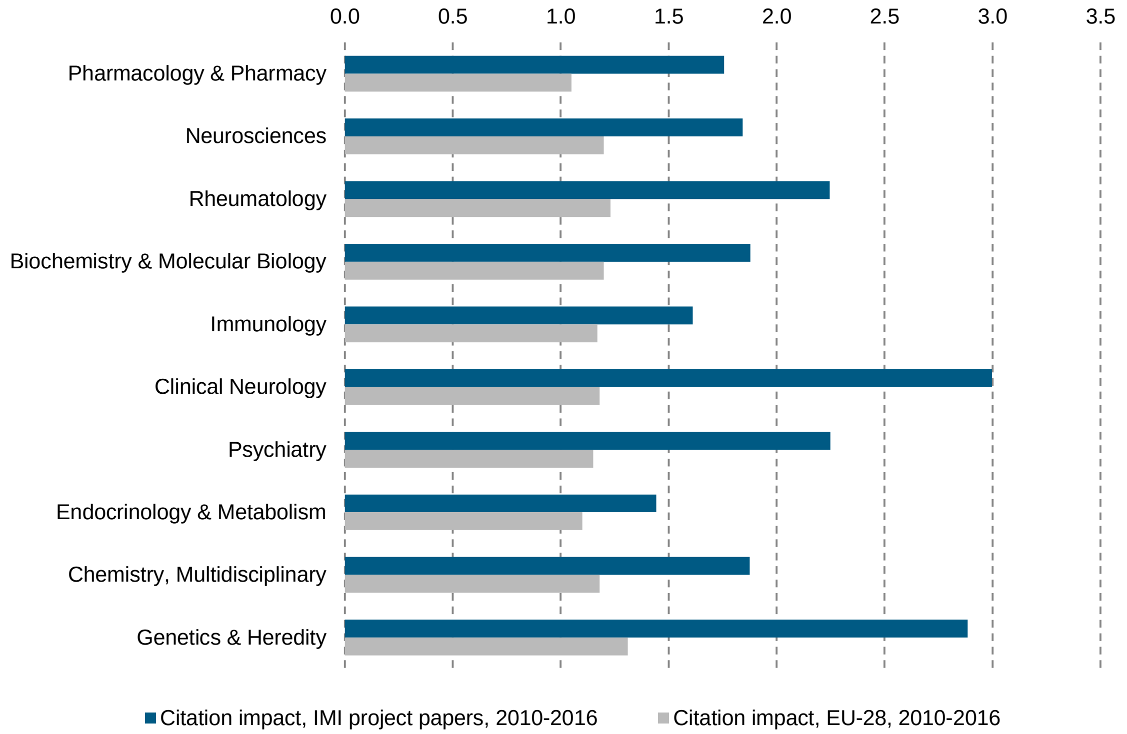


TABLE 4.6.1 CITATION IMPACT AND PERCENTAGE OF PAPERS IN TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED, BENCHMARKED AGAINST EU-28 PAPERS IN THE SAME JOURNAL CATEGORIES, 2010-2016

Journal category	% of IMI papers	% of EU-28 papers	Citation impact normalised at field level	
			IMI papers	EU-28
Pharmacology & Pharmacy	13.9%	2.4%	1.76	1.05
Neurosciences	13.7%	3.1%	1.84	1.20
Rheumatology	9.2%	0.5%	2.25	1.23
Biochemistry & Molecular Biology	8.9%	4.0%	1.88	1.20
Immunology	6.5%	1.7%	1.61	1.17
Clinical Neurology	6.4%	2.1%	3.00	1.18
Psychiatry	6.0%	1.5%	2.25	1.15
Endocrinology & Metabolism	5.2%	1.5%	1.44	1.10
Chemistry, Multidisciplinary	4.7%	2.9%	1.88	1.18
Genetics & Heredity	4.4%	1.6%	2.88	1.31

- IMI project research had a higher citation impact for 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).
- The journal category in which IMI-supported papers had the highest citation impact was Clinical Neurology (3.00).
- The journal category with the highest citation impact for EU-28 paper was Genetics & Heredity (1.31).

4.7 IS IMI PROJECT RESEARCH WELL-CITED?

Citation impact of research, an indicator linked to the accumulation of citations, is subject specific. Typically, papers published in areas 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, 2010-2016

		Citation Impact			
	Number of Papers	Normalised at field level (nci_F)	Normalised at journal level (nci_J)	Average Percentile	% Highly cited papers
IMI projects	2 660	2.03	1.25	40.01	25.0%

TABLE 4.7.2 SUMMARY OF IMI SUPPORTED RESEARCH PUBLICATIONS, 2010-2016

	Number of Publications	% Publications in Open access journals	Number of papers	Citations	Raw citation impact
IMI Projects	2 686	20.1%	2,660	33,162	12.47

SUMMARY OF KEY FINDINGS

- The citation impact of IMI project papers was 2.03 (world average is 1.0) for the 6-year period, 2010-2016. This indicates that 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 nearly twice the EU's average citation impact (1.18)[6,7] relative to the world baseline (1.00) for 2010-2016, in the same group of journal categories.
- A quarter (25.0%) 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.

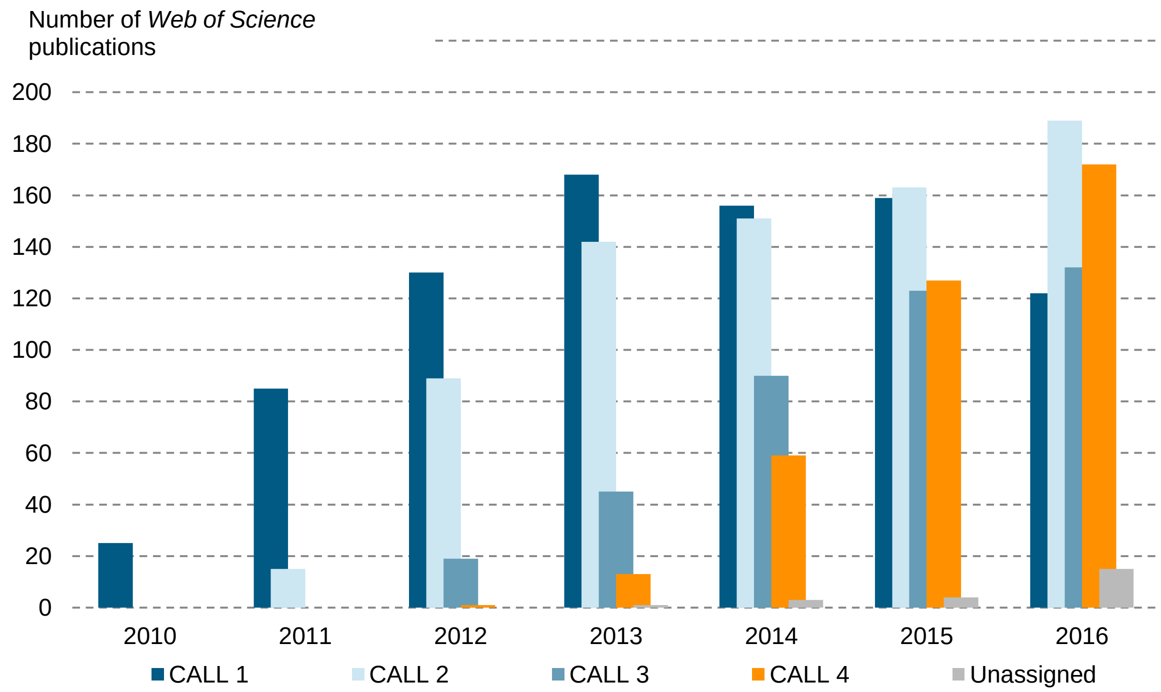
[6] EU-28 grouping of countries: Clarivate Analytics National Science Indicators 2016 database; similar research has been defined as including the same journal categories as in the IMI project dataset.
[7] For this analysis, only papers are considered since only these publication types have normalised citation impact data (see Section 3).

5 CITATION ANLYSIS – 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 2016 for IMI Calls 1-4. Calls 5-11 were more recently introduced and have a smaller number of publications relative to Calls 1-4. For clarity, the publications from Calls 5-10 are shown separately in Figure 5.1.2. Table 5.1.1 presents summary bibliometric data for IMI calls 1-11, including number of publications, papers, and citation impact.

FIGURE 5.1.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL 2010-2016



- The number of publications from Call 1 increased from 2010 to a peak of 168 in 2013. In 2015 and 2016, Call 2 had the highest number of publications (163 and 189, respectively).
- The number of publications from Calls 2, 3 and 4 increased every year after the initial set of publications for that call.

FIGURE 5.1.2 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL 2010-2016

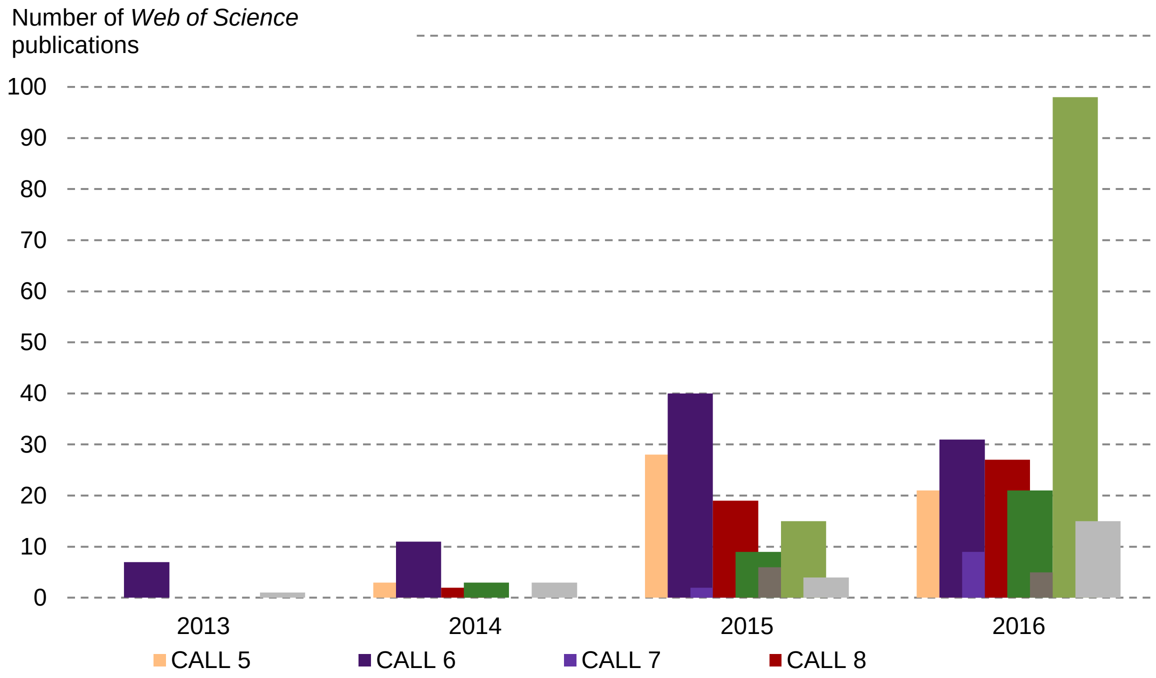


TABLE 5.1.1 SUMMARY BIBLIOMETRIC ANALYSES OF IMI PROJECTS AGGREGATED BY FUNDING CALL, 2010-2016

IMI Call	Number of Publications[8]	% Publications in Open access journals	Number of Papers	Citation Impact Raw citation impact	Citation Impact Normalised at field level (nci_F)	Citation Impact Normalised at journal level (nci_J)
1	845	17.6%	841	17.57	1.85	1.24
2	749	24.8%	740	13.29	1.99	1.22
3	409	22.9%	400	12.22	2.14	1.25
4	372	15.3%	370	7.50	2.43	1.49
5	52	0.0%	52	3.42	1.32	1.04
6	89	24.7%	89	5.35	1.43	1.11
7	11	27.2%	11	1.82	1.29	0.60
8	48	22.9%	48	3.73	1.52	0.97
9	33	33.3%	33	3.52	1.66	1.64
10	11	36.3%	11	1.27	0.71	0.68
11	113	17.6%	111	2.98	3.01	1.29
Unassigned	23	17.3%	23	4.26	1.51	0.89

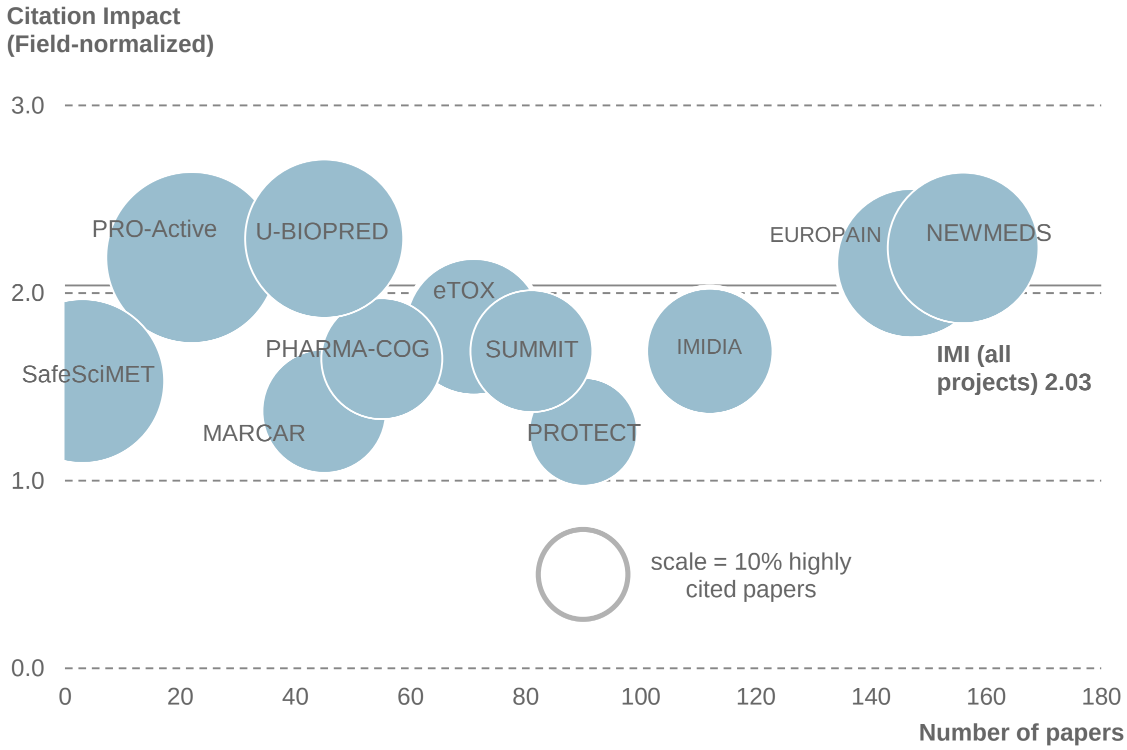
- IMI Call 1 generated the highest number of Web of Science publications (845), and papers (841). Of the 845 publications in Call 1, 17.6% were published in open access journals. The publications generated by IMI Call 1 also had the highest raw citation impact (17.57).
- The papers which were assigned to Call 11 had the highest field normalised citation impact (3.01).

[8] Publications can be associated with more than one Call.

5.2 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 1

Figure 5.2.1 presents an analysis of IMI-supported research published by Call 1 projects. Only projects with at least 10 papers and one highly-cited paper over the time period (2010-2016) 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, 2010-2016



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 four of the projects that had at least 10 publications (NEWMEDS, EUROPAIN, PRO-Active, U-BIOPRED) in Call 1 was cited over twice the world average.
- Of the 15 projects in Call 1, five (NEWMEDS, EUROPAIN, PRO-Active, U-BIOPRED, Eu2P) had papers with an average citation impact greater than the average citation impact of all IMI project papers (2.03).

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 raw citation impact and the percentage of publications in open access journals by project for Call 1 publications.

TABLE 5.2.1 SUMMARY CITATION INDICATORS FOR IMI PROJECTS IN CALL 1, 2010-2016

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level (nci_F)**	**Normalised at journal level (nci_J)**	**Average Percentile**	**% Highly cited papers**
eTOX	71	1.82	1.56	31.59	23.94%
Eu2P	1	4.17	1.47	4.44	100.00%
EUROPAIN	147	2.16	1.36	32.37	28.57%
IMIDIA	112	1.69	1.11	33.24	20.54%
MARCAR	45	1.37	1.02	39.30	20.00%
NEWMEDS	156	2.24	1.15	35.29	28.21%
PHARMA-COG	55	1.65	0.97	45.32	18.18%
PHARMATRAIN	1	0.00	0.00	100.00	0.00%
PRO-Active	22	2.19	2.42	33.15	36.36%
PROTECT	90	1.26	1.21	37.33	14.44%
SAFE-T	12	1.38	1.36	34.74	25.00%
SafeSciMET	3	1.53	1.24	33.03	33.33%
SUMMIT	81	1.69	1.16	43.99	18.52%
U-BIOPRED	45	2.29	1.25	30.28	31.11%
OVERALL (IMI PROJECTS)	**2660**	**2.03**	**1.25**	**40.01**	**25.04%**

TABLE 5.2.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 1, 2010-2016

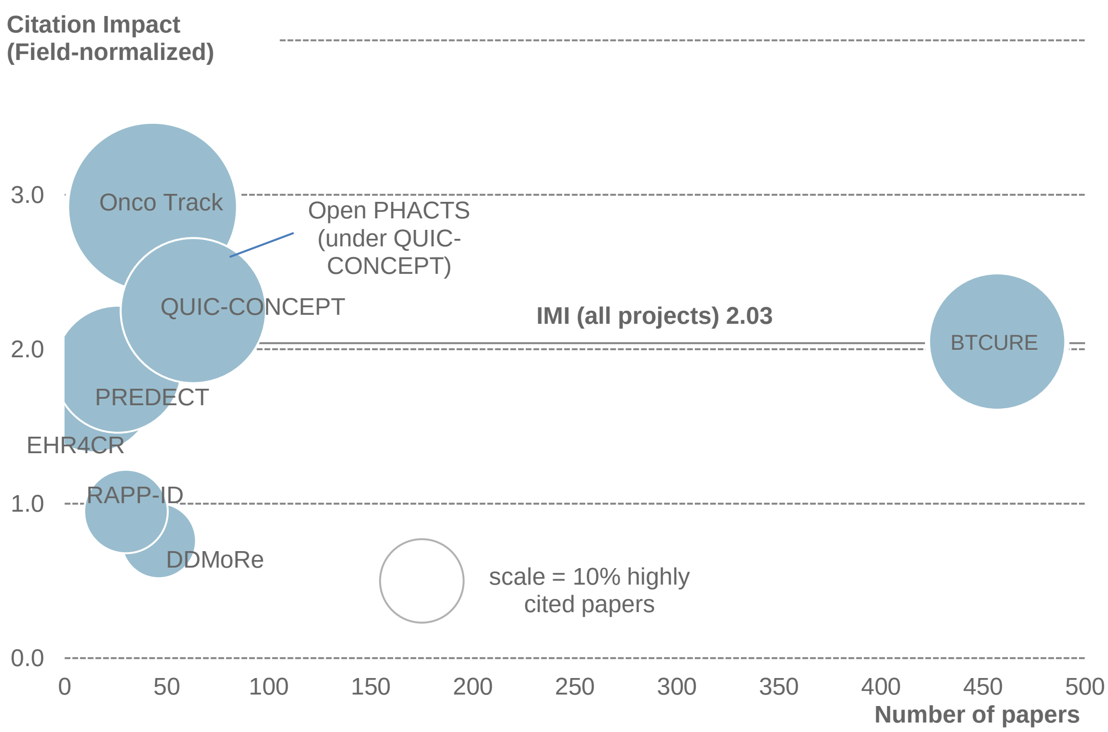
Project	**Number of Publications**	**Number of Papers**	**% Publications in Open access journals**	**Citations**	**Raw citation impact**
eTOX	72	71	34.7%	1281	17.79
Eu2P	1	1	0.0%	12	12.00
EUROPAIN	147	147	8.8%	3019	20.53
IMIDIA	112	112	14.2%	1984	17.71
MARCAR	46	45	43.4%	517	11.23
NEWMEDS	157	156	8.2%	3789	24.13
PHARMA-COG	55	55	14.5%	994	18.07
PHARMATRAIN	1	1	100.0%	0	0.00
PRO-active	22	22	50.0%	349	15.86
PROTECT	90	90	11.1%	784	8.71
SafeSciMET	4	3	0.0%	31	7.75
SAFE-T	12	12	25.0%	121	10.08
SUMMIT	81	81	27.1%	1017	12.55
U-BIOPRED	45	45	15.5%	947	21.04

- Of the projects in call 1, eTOX had the highest number of publications in open access journals (25). PharmaTrain had the highest percentage of publications in open access journals (100%) but only published one publication over the time period analysed.

5.3 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 2

Figure 5.3.1 presents an analysis of IMI-supported research published by Call 2 projects. Only projects with at least 10 papers and one highly-cited paper over the time period (2010-2016) 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, 2010-2016



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 (0.95).
- BTCURE was by far the most prolific IMI Call 2 project with 457 papers at the end of 2016. The citation impact of this research was more than twice the world average (2.05).
- Research associated with OncoTrack was very well-cited with a citation impact of nearly three times (2.92) the world average.
- QUIC-CONCEPT and Open PHACTS were also very well-cited with a citation impact of more than twice the world average at 2.25, and 2.27 respectively.
- Five of the eleven projects in this Call had papers with an average citation impact greater than the citation impact of all IMI project papers.

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 journals by project for Call 2 publications.

TABLE 5.3.1 SUMMARY CITATION INDICATORS FOR IMI PROJECTS IN CALL 2, 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
BTCURE	457	2.05	1.10	37.61	27.79%
DDMoRe	46	0.76	0.70	64.29	8.70%
EHR4CR	14	1.72	1.80	46.14	21.43%
Onco Track	43	2.92	1.43	24.92	41.86%
Open PHACTS	61	2.27	1.66	45.14	21.31%
PREDECT	26	1.87	1.18	44.94	23.08%
QUIC-CONCEPT	63	2.25	1.72	36.16	30.16%
RAPP-ID	30	0.95	0.83	45.79	10.00%
OVERALL (IMI PROJECTS)	**2660**	**2.03**	**1.25**	**40.01**	**25.04%**

TABLE 5.3.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 2, 2010-2016

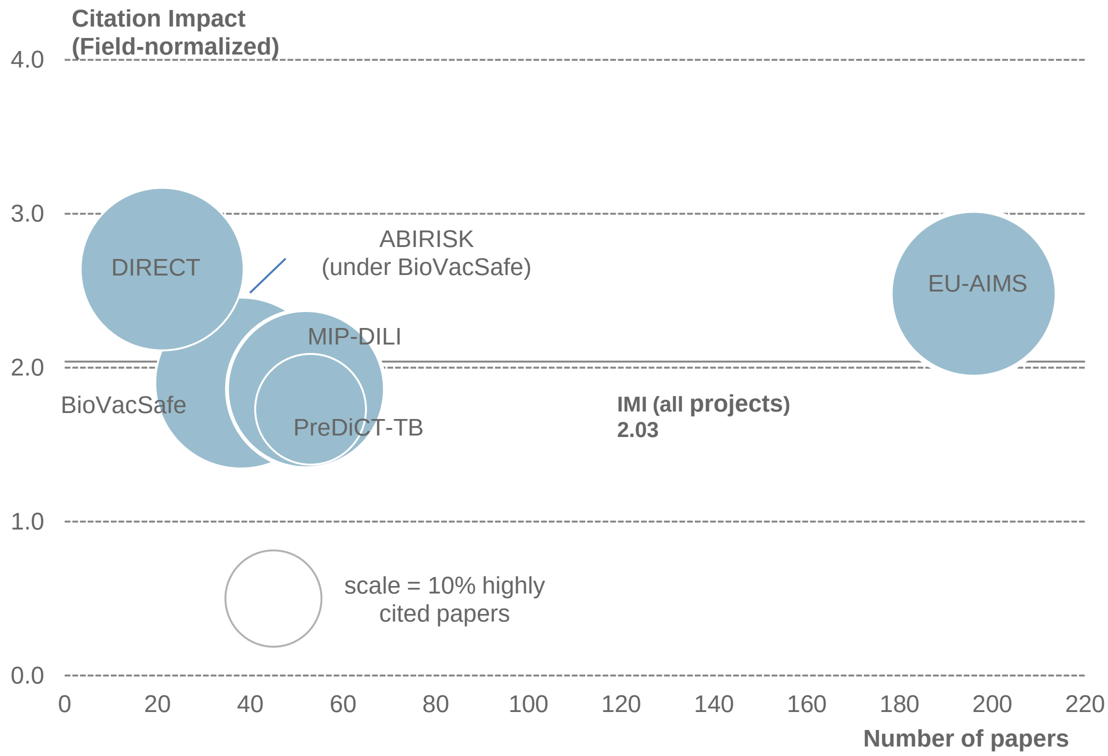
Project	Number of Publications	Number of papers	% Publications in Open access journals	Citations	Raw citation impact
BTCURE	461	457	23.6%	5942	12.88
DDMoRe	47	46	10.6%	204	4.34
EHR4CR	14	14	42.8%	85	6.07
Onco Track	44	43	29.5%	1198	27.22
Open PHACTS	64	61	39.0%	995	15.54
PREDECT	26	26	26.9%	204	7.84
QUIC-CONCEPT	63	63	20.6%	1049	16.65
RAPP-ID	30	30	26.6%	280	9.33

- Among the projects with at least 10 publications, BTCURE was the project with the highest number of open access publications (109), but EHR4CR had the highest percentage of publications in open access journals (42.8%).

5.4 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 3

Figure 5.4.1 presents an analysis of IMI-supported research published by Call 3 projects. Only projects with at least ten papers and one highly-cited paper over the time period (2010-2016) 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, 2010-2016



The data in Figure 5.4.1 shows that:

- The average citation impact of seven of the nine projects in this call was above world average.
- EU-AIMS was by far the most prolific Call 3 project with 196 papers by the end of 2016. The citation impact of this research was more than twice the world average (2.48).
- Research associated with DIRECT was also very well-cited with a citation impact that was well over two times the world average.
- Two of the nine 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 percentage of open access journals by project for Call 3 publications.

TABLE 5.4.1 SUMMARY CITATION INDICATORS FOR IMI PROJECTS IN CALL 3, 2010-2016

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level (nci_F)**	**Normalised at journal level (nci_J)**	**Average Percentile**	**% Highly cited papers**
ABIRISK	38	1.91	1.11	45.97	28.95%
BioVacSafe	38	1.90	1.26	34.97	31.58%
DIRECT	21	2.64	1.39	42.99	28.57%
EU-AIMS	196	2.48	1.20	36.89	30.10%
EUPATI	2	1.42	3.84	42.56	0.00%
MIP-DILI	52	1.86	1.55	45.76	26.92%
PreDiCT-TB	53	1.73	1.10	45.74	13.21%
RADAR-CNS	1	0.00	0.00	100.00	0.00%
OVERALL (IMI PROJECTS)	**2660**	**2.03**	**1.25**	**40.01**	**25.04%**

TABLE 5.4.2 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 3, 2010-2016

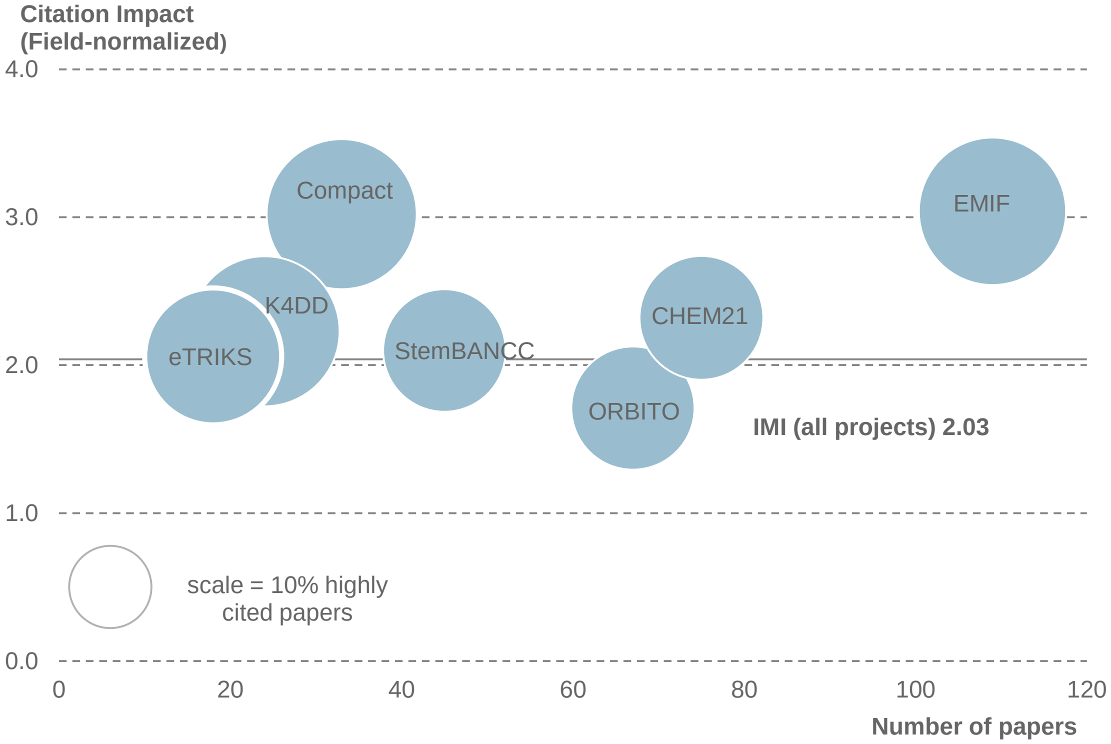
Project	Number of Publications	Number of papers	% Publications in Open access journals	Citations	Raw citation impact
ABIRISK	43	38	18.6%	412	9.58
BioVacSafe	39	38	20.5%	507	13.00
DIRECT	21	21	19.0%	305	14.52
EU-AIMS	199	196	22.1%	3117	15.66
EUPATI	2	2	100.0%	3	1.50
MIP-DILI	52	52	25.0%	319	6.13
PreDiCT-TB	53	53	26.4%	342	6.45
RADAR-CNS	1	1	100.0%	0	0.00

- 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 IMI-supported research published by Call 4 projects. Only projects with at least ten papers and one highly-cited paper over the time period (2010-2016) 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, 2010-2016



The data in Figure 5.5.1 shows that:

- The average citation impact of all but one of these projects was above world average.
- EMIF and CHEM21 produced the highest number of papers in Call 4, with 109 and 75 respectively.
- Research associated with EMIF and Compact was very well-cited with a citation impact of more than three times the world average (3.04 and 3.02, respectively).
- Six of the eight 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 shows raw citation impact and percentage of open access journals by project for Call 4 publications.

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

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level (nci_F)**	**Normalised at journal level (nci_J)**	**Average Percentile**	**% Highly cited papers**
CHEM21	75	2.32	1.63	39.79	22.67%
Compact	33	3.02	2.54	28.79	33.33%
EMIF	109	3.04	1.29	39.69	32.11%
eTRIKS	18	2.06	1.10	51.58	27.78%
K4DD	24	2.23	1.73	49.81	33.33%
ORBITO	67	1.71	1.23	52.87	22.39%
StemBANCC	45	2.10	1.41	48.00	22.22%
OVERALL (IMI PROJECTS)	**2660**	**2.03**	**1.25**	**40.01**	**25.04%**

TABLE 5.5.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 4, 2010-2016

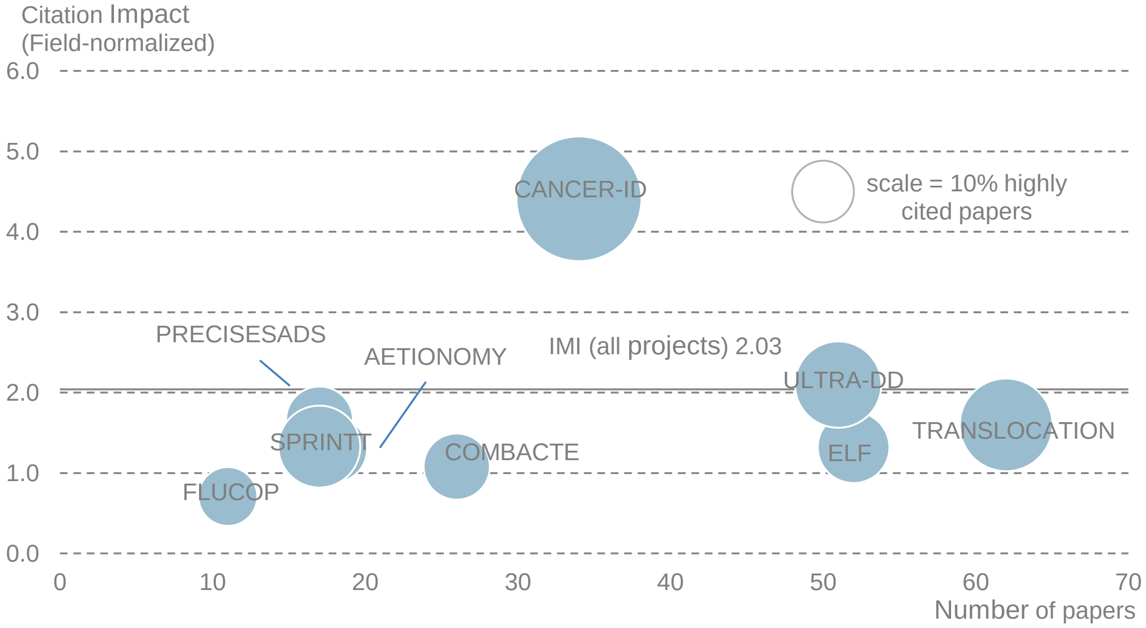
Project	Number of Publications	Number of Papers	% Publications in Open access journals	Citations	Raw citation impact
CHEM21	77	75	5.1%	691	8.97
Compact	33	33	9.0%	276	8.36
EMIF	109	109	28.4%	933	8.55
eTRIKS	18	18	38.8%	90	5.00
K4DD	24	24	4.1%	87	3.62
ORBITO	67	67	0.0%	451	6.73
StemBANCC	45	45	26.6%	265	5.88

- Two out of the seven projects in Call 4 had no publications in open access journals.
- EMIF is the project with both the highest number and highest percentage of publications in open access journals (31 and 28.4%).

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

Figure 5.6.1 presents an analysis of IMI-supported research published by Call 5-11 projects. Only projects with at least ten papers and one highly-cited paper over the time period (2010-2016) 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, 2010-2016



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 four times the world average (4.41), and 41.18% 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 percentage of open access journals by project for Call 5-11 publications.

TABLE 5.6.1 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 5-11, 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
ADVANCE	2	3.44	1.83	6.53	100.00%
AETIONOMY	18	1.29	0.95	44.29	11.11%
APPROACH	4	5.48	2.30	31.42	50.00%
CANCER-ID	34	4.41	1.74	27.87	41.18%
COMBACTE	26	1.08	0.86	46.87	11.54%
COMBACTE-CARE	5	0.26	0.24	86.61	0.00%
COMBACTE-MAGNET	3	0.00	0.00	100.00	0.00%
COMBACTE-NET	1	0.00	0.00	100.00	0.00%
DRIVE-AB	9	2.78	1.83	24.76	33.33%
EBiSC	4	1.29	0.93	55.53	25.00%
ELF	52	1.32	1.04	44.83	13.46%
ENABLE	9	1.81	0.92	47.12	33.33%
EPAD	3	0.89	0.45	54.11	0.00%
FLUCOP	11	0.71	0.68	66.02	9.09%
GetReal	9	0.82	0.33	67.68	0.00%
iABC	3	1.14	0.46	53.33	0.00%
iPiE	5	1.14	0.73	67.53	20.00%
PRECISESADS	17	1.66	1.01	43.96	11.76%
SPRINTT	17	1.33	1.89	54.83	17.65%
TRANSLOCATION	62	1.60	1.24	38.46	22.58%
ULTRA-DD	51	2.10	1.01	62.31	19.61%
WEB-RADR	2	3.06	2.13	28.64	50.00%
ZAPI	8	4.98	1.03	45.79	25.00%
OVERALL (IMI PROJECTS)	**2660**	**2.03**	**1.25**	**40.01**	**25.04%**

TABLE 5.6.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 5-11, 2010-2016

Project	Number of Publications	Number of Papers	% Open access journals	Citations	Raw citation impact
ADVANCE	2	2	50.0%	13	6.50
AETIONOMY	18	18	22.2%	49	2.72
APPROACH	4	4	50.0%	22	5.50
CANCER-ID	35	34	25.7%	131	3.74
COMBACTE	26	26	26.9%	144	5.53
COMBACTE-CARE	5	5	20.0%	1	0.20
COMBACTE-MAGNET	3	3	33.3%	0	0.00
COMBACTE-NET	1	1	100.0%	0	0.00
DRIVE-AB	9	9	22.2%	54	6.00

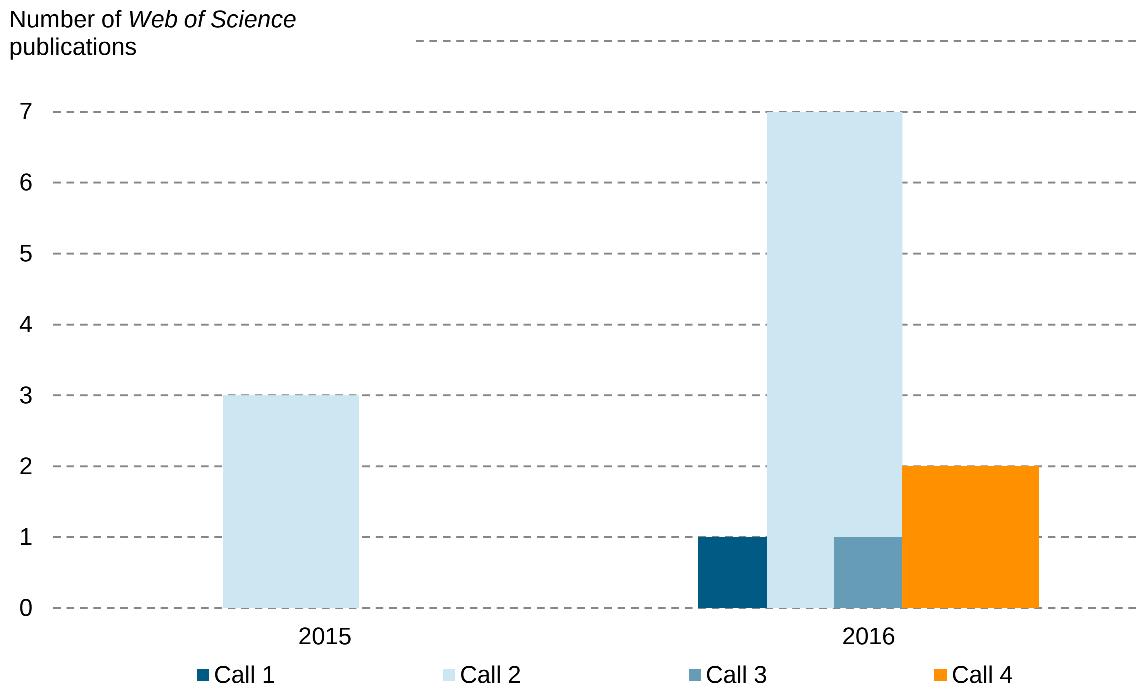
Project	Number of Publications	Number of Papers	% Open access journals	Citations	Raw citation impact
EBiSC	4	4	25.0%	16	4.00
ELF	52	52	0.0%	178	3.42
ENABLE	9	9	22.2%	39	4.33
EPAD	4	3	25.0%	11	2.75
FLUCOP	11	11	36.3%	14	1.27
GetReal	9	9	22.2%	7	0.77
iABC	3	3	0.0%	5	1.66
iPiE	5	5	40.0%	3	0.60
PRECISESADS	17	17	23.5%	75	4.41
SPRINTT	17	17	47.0%	56	3.29
TRANSLOCATION	62	62	22.5%	332	5.35
ULTRA-DD	51	51	7.8%	129	2.52
WEB-RADR	2	2	0.0%	5	2.50
ZAPI	8	8	12.5%	36	4.50

- Nine of twenty-three projects in Call 5-11 had more than 10 publications between 2009 and 2016.

5.7 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI 2 PROJECTS

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

FIGURE 5.7.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL 2015-2016 FOR IMI 2 PROJECTS



- IMI projects of Call 2 generated the greatest number of publications from 2015-2016 among IMI 2 projects (10).

TABLE 5.7.1 SUMMARY BIBLIOMETRIC ANALYSES OF IMI 2 PROJECTS AGGREGATED BY FUNDING CALL, 2015-2016

				Citation Impact		
IMI Call	**Number of Publications[9]**	**% Publications in Open access journals**	**Number of Papers**	**Raw citation impact**	**Normalised at field level (nci_F)**	**Normalised at journal level (nci_J)**
1	1	0.0%	1	0.00	0.00	0.00
2	10	50.0%	10	1.30	1.32	0.56
3	1	0.0%	1	0.00	0.00	0.00
4	2	0.0%	2	0.50	0.84	0.35

- The seven IMI 2 projects have just started generated publications.
- The field normalized citation impact of the ten publications from IMI Call 2 exceeded the world average.

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.

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

TABLE 5.7.2 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI 2 PROJECTS, 2015-2016

Project	Number of Papers	Citation Impact Normalised at field level (nci_F)	Normalised at journal level (nci_J)	Average Percentile	% Highly cited papers
INNODIA	1	0	0	100	0.00%
EbolaMoDRAD	1	0.00	0.00	100.00	0.00%
EBOVAC1	7	1.28	0.58	69.66	28.57%
VSV-EBOVAC	2	2.10	0.78	25.93	50.00%
RHAPSODY	1	0.00	0.00	100.00	0.00%
ADAPT-SMART	2	0.84	0.35	65.45	0.00%
OVERALL (IMI PROJECTS)	**2660**	**2.03**	**1.25**	**40.01**	**25.04%**

TABLE 5.7.3 BIBLIOMETRIC INDICATORS FOR IMI 2 PROJECTS, 2015-2016

Project	Number of Publications	Number of Papers	% Open access journals	Citations	Raw citation impact
INNODIA	1	1	0.00%	0	0
EbolaMoDRAD	1	1	0.0%	0	0.00
EBOVAC1	7	7	71.4%	8	1.14
VSV-EBOVAC	2	2	0.0%	5	2.50
RHAPSODY	1	1	0.0%	0	0.00
ADAPT-SMART	2	2	0.0%	1	0.50

- Only one of the IMI 2 projects (EBOVAC1) has more than 5 papers.
- Very low paper counts make it difficult to draw firm conclusions from average citation impact indicators. However, the VSV-EBOVAC project had the highest field normalised citation impact (2.10) followed by EBOVAC1 (1.28).

6 COLLABORATION ANALYSIS FOR IMI RESEARCH

6.1 COLLABORATION ANALYSIS FOR IMI RESEARCH

International research collaboration is a rapidly growing element of research activity.[10] 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.[11] 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. Sectors are academic, corporate, government, medical, or other[12]. A paper is defined as cross-sector if the listed addresses are from more than one sector. For example, if a paper has addresses corresponding to the University of Copenhagen and 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	1671	62.8%	2.17
Single-sector	989	37.1%	1.80
Cross-institution	2149	80.7%	2.13
Single-institution	511	19.2%	1.65
International	1521	57.1%	2.24
Domestic	1139	42.8%	1.75

- Nearly two-thirds (62.8%) of all IMI project papers were published by researchers affiliated with different sectors.
- More than three-quarters (80.7%) of IMI project papers involved collaboration between institutions.
- More than half (57.1%) of all IMI project papers were internationally collaborative.
- 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.

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

[11] 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.

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

6.2 COLLABORATION ANALYSIS BY IMI PROJECT

In this section, collaboration analysis 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 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 these 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, China, and Taiwan (Figure 6.2.2), and NEWMEDS had substantial collaborations also with Canada (Figure 6.2.3).

TABLE 6.2.1 NUMBER, PERCENTAGE AND CITATION IMPACT[13] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE COUNTRY, 2010-2016.

Project	Number of papers	Number of internationally collaborative papers	Percentage of internationally collaborative papers	Citation impact (normalised at field level)
BTCURE	457	262	57.3%	2.17
EU-AIMS	196	137	69.9%	2.63
NEWMEDS	156	97	62.2%	2.27
EUROPAIN	147	57	38.8%	2.46
IMIDIA	112	59	52.7%	1.98
EMIF	109	78	71.6%	3.34
PROTECT	90	66	73.3%	1.35
SUMMIT	81	50	61.7%	2.03
CHEM21	75	24	32.0%	3.37
eTOX	71	29	40.8%	1.47
ORBITO	67	40	59.7%	1.94
QUIC-CONCEPT	63	44	69.8%	2.51
TRANSLOCATION	62	37	59.7%	1.68
Open PHACTS	61	40	65.6%	2.26
PHARMA-COG	55	44	80.0%	1.87
PreDiCT-TB	53	31	58.5%	2.18
ELF	52	29	55.8%	1.09
MIP-DILI	52	26	50.0%	2.07
ULTRA-DD	51	34	66.7%	2.32
DDMoRe	46	27	58.7%	0.77
MARCAR	45	20	44.4%	1.94
StemBANCC	45	23	51.1%	2.40
U-BIOPRED	45	27	60.0%	3.10
Onco Track	43	15	34.9%	3.60
ABIRISK	38	16	42.1%	2.23
BioVacSafe	38	18	47.4%	1.54
CANCER-ID	34	19	55.9%	6.20
Compact	33	14	42.4%	2.90
RAPP-ID	30	15	50.0%	0.96
COMBACTE	26	11	42.3%	0.69
PREDECT	26	16	61.5%	1.95
K4DD	24	12	50.0%	2.60
PRO-active	22	18	81.8%	2.57
DIRECT	21	14	66.7%	2.73
AETIONOMY	18	9	50.0%	1.09
eTRIKS	18	18	100.0%	2.06
PRECISESADS	17	13	76.5%	1.72
SPRINTT	17	8	47.1%	1.96
ND4BB	16	11	68.8%	2.05
EHR4CR	14	9	64.3%	2.15
SAFE-T	12	6	50.0%	1.54
FLUCOP	11	7	63.6%	0.59

[13] 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)
DRIVE-AB	9	6	66.7%	3.01
ENABLE	9	2	22.2%	0.00
GetReal	9	8	88.9%	0.75
ZAPI	8	7	87.5%	5.69
EBOVAC1	7	3	42.9%	1.25
COMBACTE-CARE	5	3	60.0%	0.00
iPiE	5	3	60.0%	0.00
APPROACH	4	4	100.0%	5.48
EBiSC	4	3	75.0%	0.88
EMI	4	3	75.0%	1.53
COMBACTE-MAGNET	3	3	100.0%	0.00
EPAD	3	3	100.0%	0.89
EUCLID	3	3	100.0%	0.48
iABC	3	2	66.7%	1.71
SafeSciMET	3	3	100.0%	1.53
ADAPT-SMART	2	1	50.0%	1.68
ADVANCE	2	0	0.0%	0.00
EUPATI	2	2	100.0%	1.42
INNODIA	2	1	50.0%	0.00
VSV-EBOVAC	2	1	50.0%	0.57
WEB-RADR	2	2	100.0%	3.06
COMBACTE-NET	1	0	0.0%	0.00
EbolaMoDRAD	1	1	100.0%	0.00
Eu2P	1	0	0.0%	0.00
PHARMATRAIN	1	1	100.0%	0.00
RADAR-CNS	1	1	100.0%	0.00
RHAPSODY	1	1	100.0%	0.00

TABLE 6.2.2 NUMBER, PERCENTAGE AND CITATION IMPACT[14] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE INSTITUTION, 2010-2016

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	457	366	80.1%	2.14
EU-AIMS	196	174	88.8%	2.54
NEWMEDS	156	131	84.0%	2.32
EUROPAIN	147	91	61.9%	2.41
IMIDIA	112	88	78.6%	1.77
EMIF	109	102	93.6%	3.17
PROTECT	90	88	97.8%	1.27
SUMMIT	81	64	79.0%	1.86
CHEM21	75	36	48.0%	2.77
eTOX	71	48	67.6%	2.15
ORBITO	67	54	80.6%	1.71
QUIC-CONCEPT	63	52	82.5%	2.48
TRANSLOCATION	62	48	77.4%	1.58
Open PHACTS	61	53	86.9%	2.47
PHARMA-COG	55	53	96.4%	1.68
PreDiCT-TB	53	48	90.6%	1.76
ELF	52	36	69.2%	1.09
MIP-DILI	52	40	76.9%	1.89
ULTRA-DD	51	38	74.5%	2.13
DDMoRe	46	36	78.3%	0.72
MARCAR	45	32	71.1%	1.58
StemBANCC	45	35	77.8%	2.32
U-BIOPRED	45	36	80.0%	2.59
Onco Track	43	33	76.7%	2.82
ABIRISK	38	33	86.8%	2.06
BioVacSafe	38	30	78.9%	1.67
CANCER-ID	34	29	85.3%	4.71
Compact	33	25	75.8%	2.62
RAPP-ID	30	23	76.7%	0.96
COMBACTE	26	21	80.8%	1.10
PREDECT	26	20	76.9%	1.81
K4DD	24	20	83.3%	2.40
PRO-active	22	22	100.0%	2.19
DIRECT	21	20	95.2%	2.74
AETIONOMY	18	18	100.0%	1.29
eTRIKS	18	18	100.0%	2.06
PRECISESADS	17	17	100.0%	1.66
SPRINTT	17	11	64.7%	1.84
ND4BB	16	15	93.8%	1.91
EHR4CR	14	13	92.9%	1.80
SAFE-T	12	12	100.0%	1.38
FLUCOP	11	10	90.9%	0.79

[14] 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)
DRIVE-AB	9	8	88.9%	2.95
ENABLE	9	8	88.9%	1.51
GetReal	9	9	100.0%	0.82
ZAPI	8	8	100.0%	4.98
EBOVAC1	7	4	57.1%	0.94
COMBACTE-CARE	5	5	100.0%	0.26
iPiE	5	5	100.0%	1.14
APPROACH	4	4	100.0%	5.48
EBiSC	4	4	100.0%	1.29
EMI	4	4	100.0%	1.15
COMBACTE-MAGNET	3	3	100.0%	0.00
EPAD	3	3	100.0%	0.89
EUCLID	3	3	100.0%	0.48
iABC	3	3	100.0%	1.14
SafeSciMET	3	3	100.0%	1.53
ADAPT-SMART	2	2	100.0%	0.84
ADVANCE	2	1	50.0%	3.75
EUPATI	2	2	100.0%	1.42
INNODIA	2	2	100.0%	0.24
VSV-EBOVAC	2	1	50.0%	0.57
WEB-RADR	2	2	100.0%	3.06
COMBACTE-NET	1	1	100.0%	0.00
EbolaMoDRAD	1	1	100.0%	0.00
Eu2P	1	1	100.0%	4.17
PHARMATRAIN	1	1	100.0%	0.00
RADAR-CNS	1	1	100.0%	0.00
RHAPSODY	1	1	100.0%	0.00

TABLE 6.2.3 NUMBER, PERCENTAGE AND CITATION IMPACT[15] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE SECTOR, 2010-2016

Project	Number of papers	Number of cross sector papers	Percentage of cross sector papers	Citation impact (normalised at field level)
BTCURE	457	294	64.3%	2.24
EU-AIMS	196	129	65.8%	2.51
NEWMEDS	156	102	65.4%	2.36
EUROPAIN	147	56	38.1%	2.85
IMIDIA	112	60	53.6%	1.91
EMIF	109	87	79.8%	2.60
PROTECT	90	88	97.8%	1.27
SUMMIT	81	52	64.2%	1.79
CHEM21	75	15	20.0%	4.31
eTOX	71	35	49.3%	1.78
ORBITO	67	39	58.2%	1.83
QUIC-CONCEPT	63	43	68.3%	2.69
TRANSLOCATION	62	27	43.5%	1.85
Open PHACTS	61	44	72.1%	2.28
PHARMA-COG	55	48	87.3%	1.76
PreDiCT-TB	53	34	64.2%	1.75
ELF	52	25	48.1%	1.27
MIP-DILI	52	36	69.2%	1.97
ULTRA-DD	51	25	49.0%	2.13
DDMoRe	46	33	71.7%	0.72
MARCAR	45	21	46.7%	1.77
StemBANCC	45	28	62.2%	2.36
U-BIOPRED	45	29	64.4%	2.76
Onco Track	43	30	69.8%	3.04
ABIRISK	38	26	68.4%	2.37
BioVacSafe	38	28	73.7%	1.70
CANCER-ID	34	25	73.5%	4.65
Compact	33	8	24.2%	3.85
RAPP-ID	30	16	53.3%	1.01
COMBACTE	26	19	73.1%	1.03
PREDECT	26	17	65.4%	2.04
K4DD	24	12	50.0%	1.66
PRO-active	22	22	100.0%	2.19
DIRECT	21	16	76.2%	3.36
AETIONOMY	18	14	77.8%	1.31
eTRIKS	18	12	66.7%	2.82
PRECISESADS	17	16	94.1%	1.68
SPRINTT	17	7	41.2%	2.08
ND4BB	16	10	62.5%	2.46
EHR4CR	14	12	85.7%	1.75
SAFE-T	12	12	100.0%	1.38
FLUCOP	11	10	90.9%	0.79

15 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)
DRIVE-AB	9	6	66.7%	3.25
ENABLE	9	4	44.4%	1.53
GetReal	9	8	88.9%	0.92
ZAPI	8	8	100.0%	4.98
EBOVAC1	7	3	42.9%	1.25
COMBACTE-CARE	5	5	100.0%	0.26
iPiE	5	5	100.0%	1.14
APPROACH	4	1	25.0%	1.20
EBiSC	4	3	75.0%	0.84
EMI	4	3	75.0%	0.00
COMBACTE-MAGNET	3	2	66.7%	0.00
EPAD	3	2	66.7%	1.34
EUCLID	3	2	66.7%	0.73
iABC	3	2	66.7%	1.71
SafeSciMET	3	3	100.0%	1.53
ADAPT-SMART	2	2	100.0%	0.84
ADVANCE	2	1	50.0%	3.75
EUPATI	2	2	100.0%	1.42
INNODIA	2	1	50.0%	0.48
VSV-EBOVAC	2	1	50.0%	0.57
WEB-RADR	2	1	50.0%	0.68
COMBACTE-NET	1	1	100.0%	0.00
EbolaMoDRAD	1	1	100.0%	0.00
Eu2P	1	0	0.0%	0.00
PHARMATRAIN	1	1	100.0%	0.00
RADAR-CNS	1	1	100.0%	0.00
RHAPSODY	1	0	0.0%	0.00

FIGURE 6.2.1 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: BTCURE, 2010-2016

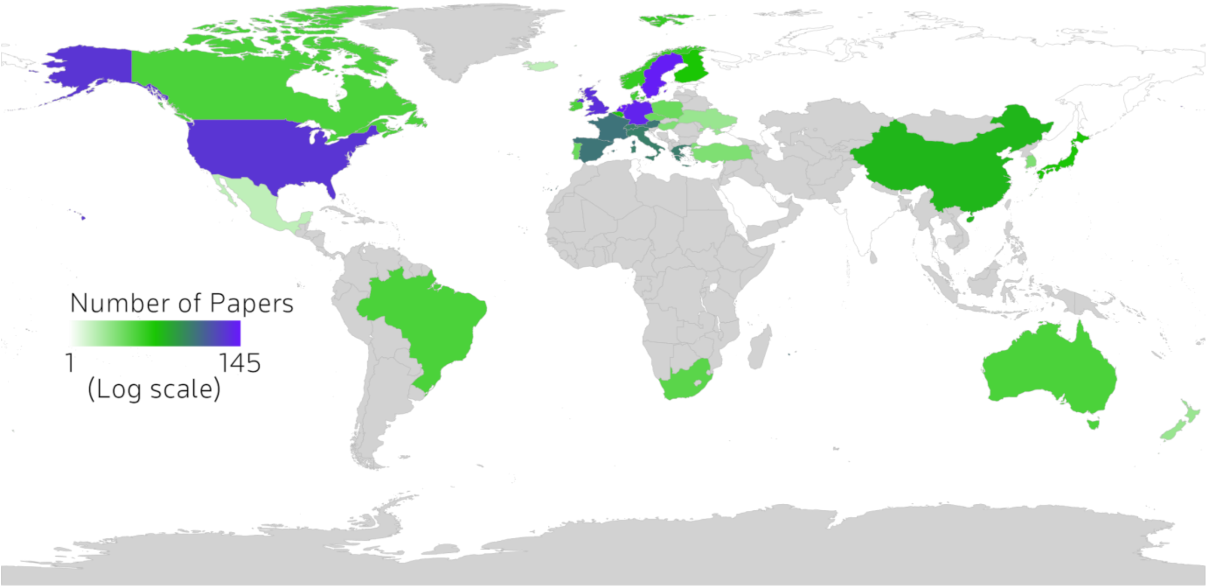


FIGURE 6.2.2 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: EU-AIMS, 2010-2016

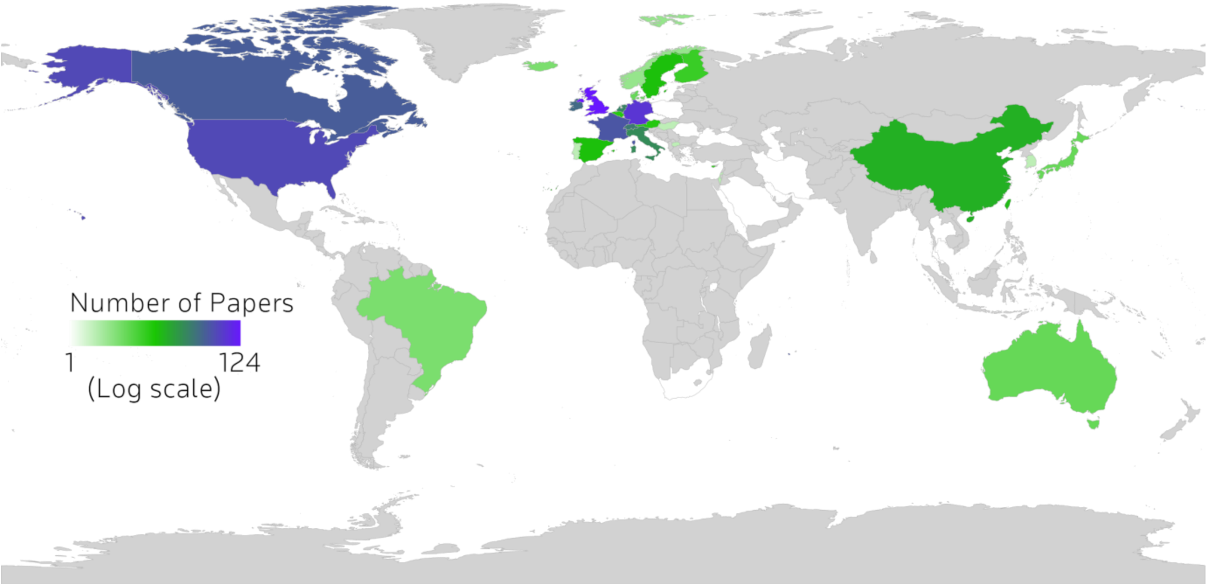


FIGURE 6.2.3 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: NEWMEDS, 2010-2016

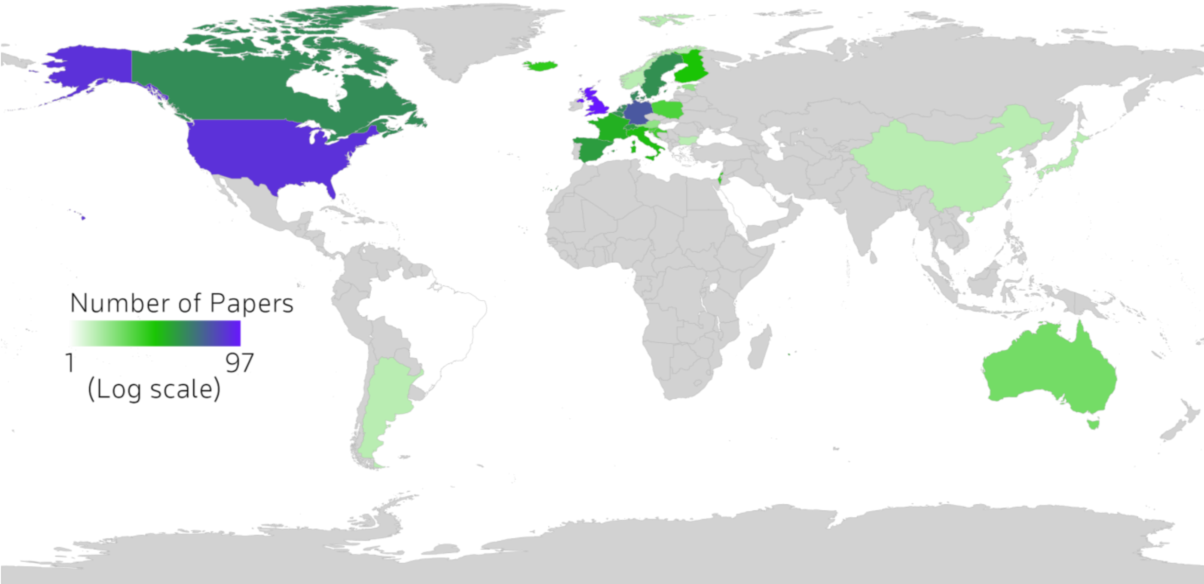


FIGURE 6.2.4 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: EUROPAIN, 2010-2016

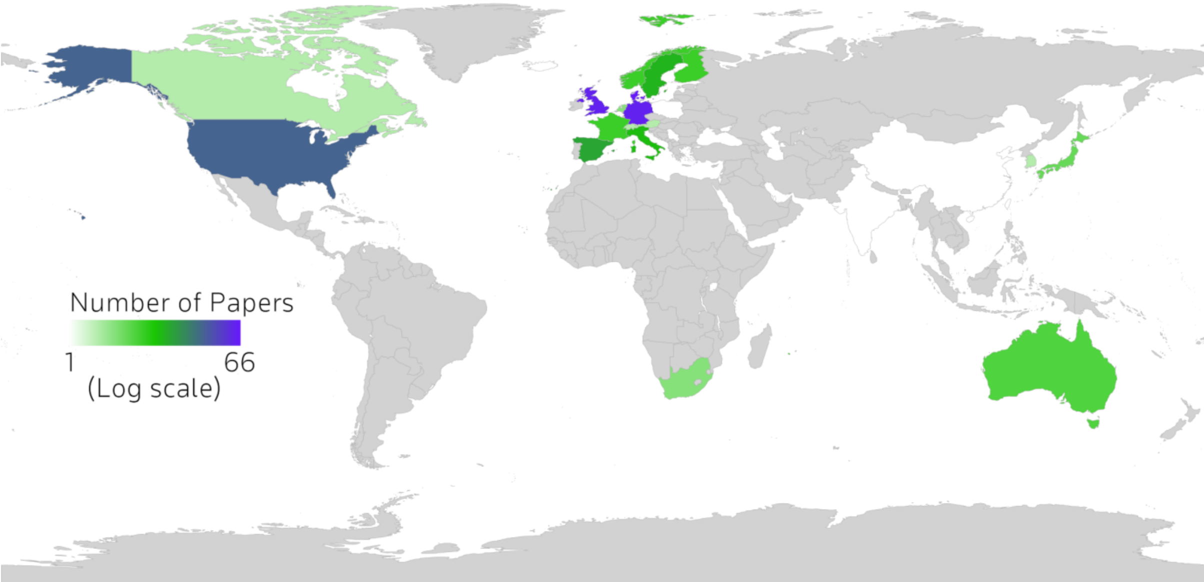
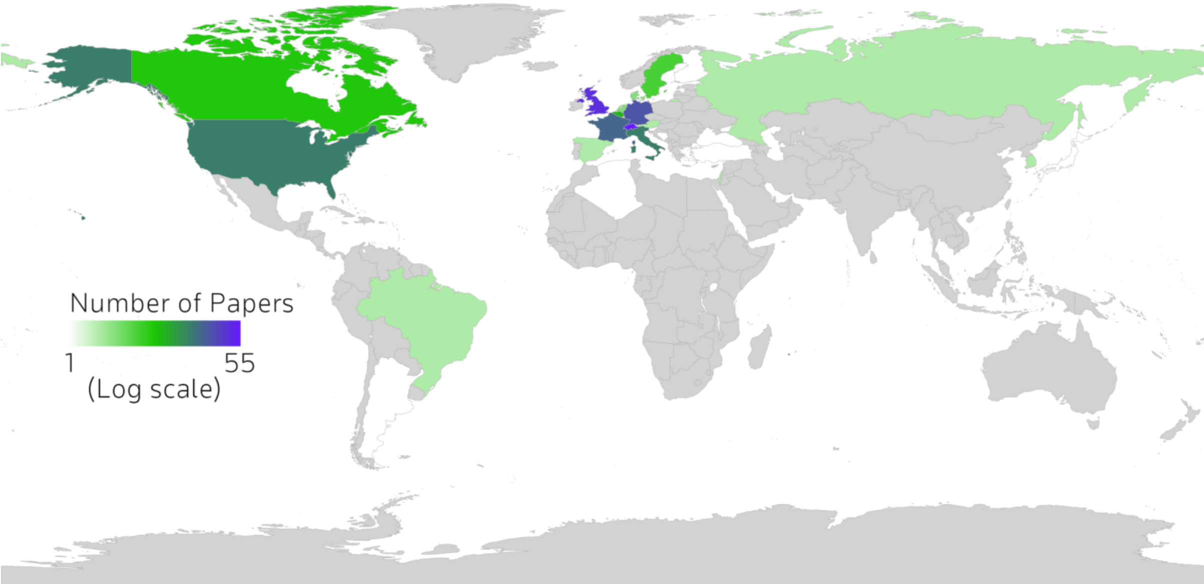


FIGURE 6.2.5 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: IMIDIA, 2010-2016



6.3 COLLABORATION METRICS FOR IMI RESEARCH

This section of the report analyses the types of collaboration that occurred within each IMI project publications, 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 therefore 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 2016. The results for all projects are shown in Annex 3.

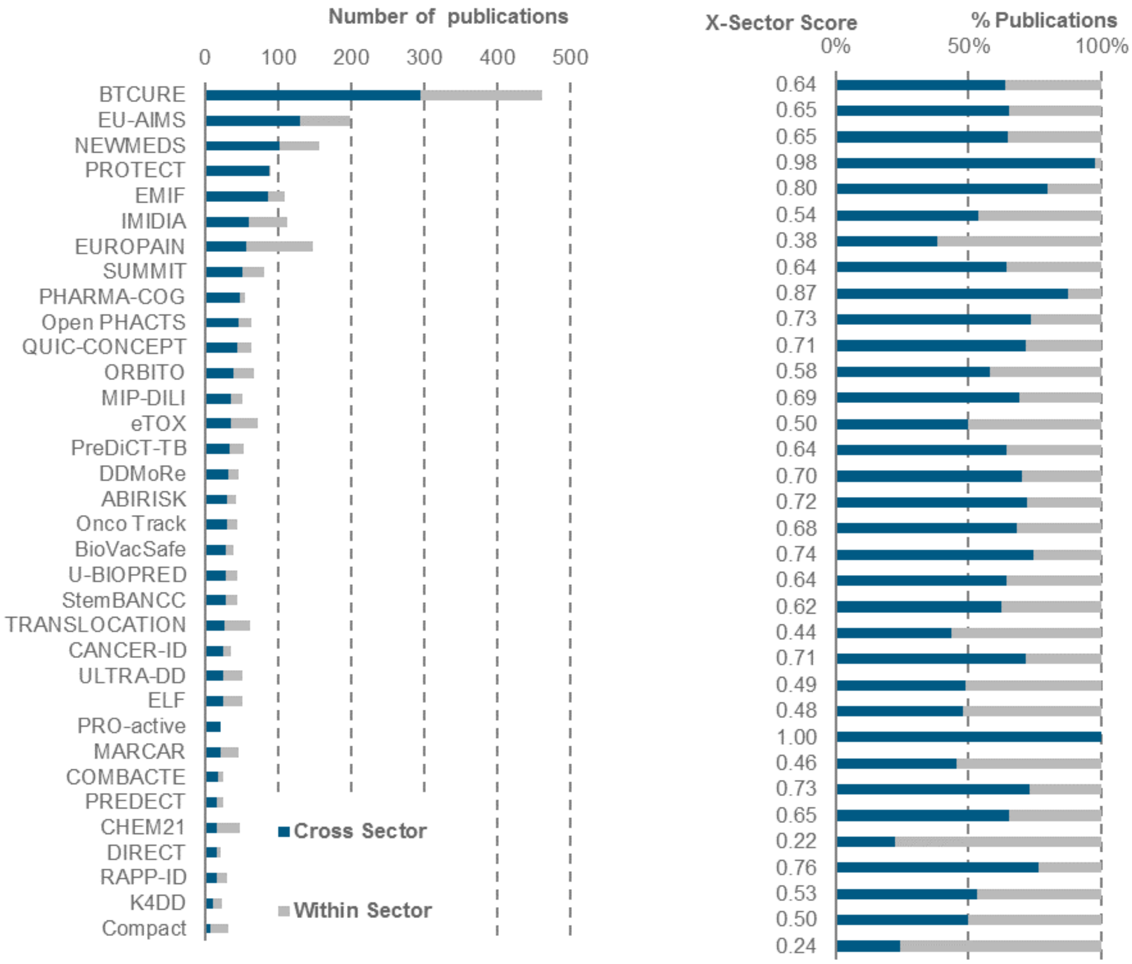
Three metrics were chosen to evaluate the collaborative nature of IMI projects:

- Metric 1 – Fraction of publications with co-authors affiliated to organisations in different sectors. The organisations 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 organisations were identified for each IMI project publication and the intensity of each pair was assessed. The collaboration intensities of the pairs of organisations 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 beginning with the project that has the largest 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, 2010-2016



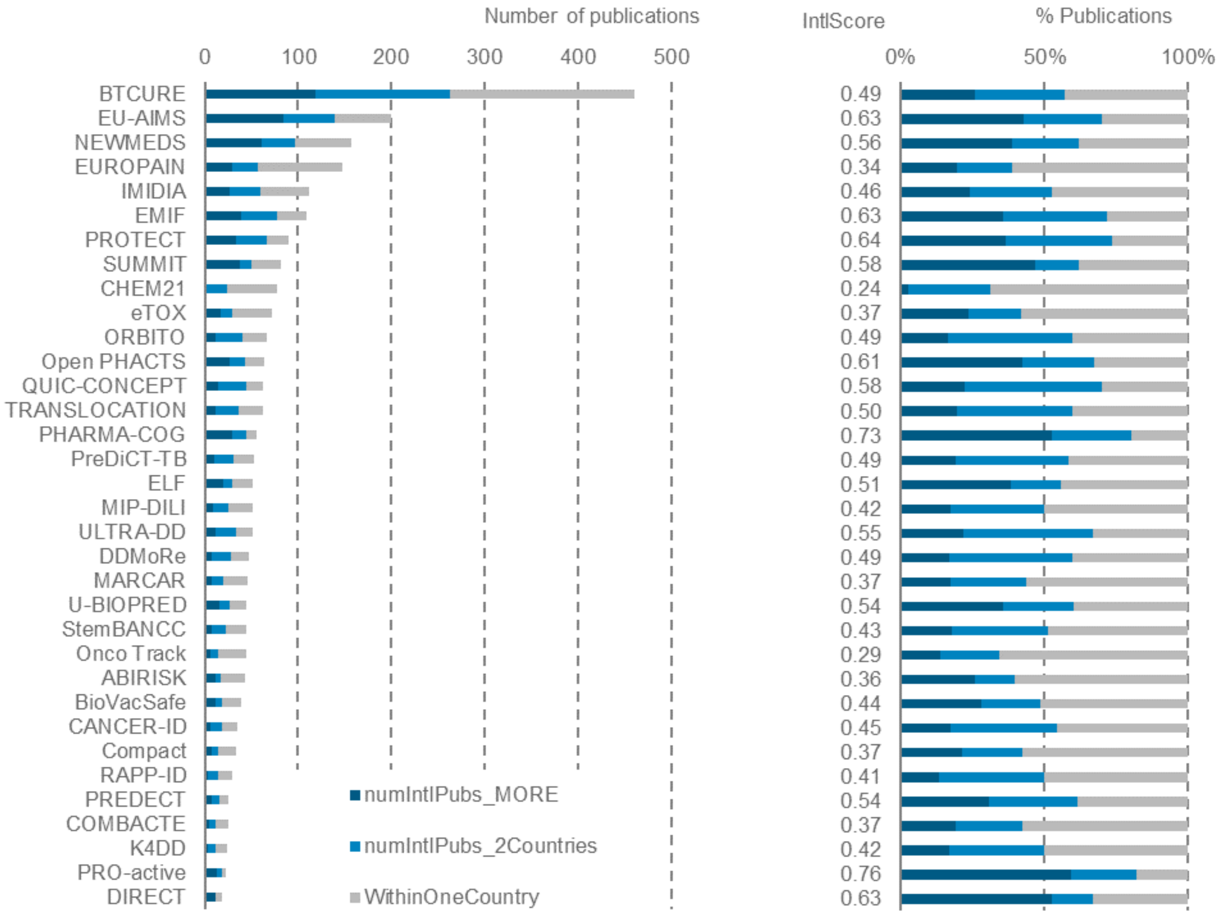
BTCURE had the greatest number of cross-sector collaborative publications, 295 out of 461. PRO-active, Protect and PHARMA-COG had the highest percentage of cross-sector collaborative publications (100.0%, 97.8% and 87.3% respectively).

6.3.2 METRIC 2: FRACTION OF INTERNATIONALLY COLLABORATIVE PUBLICATIONS

Authors and author 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 (abbreviated as "IntlScore" in the diagram) 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, 2010-2016

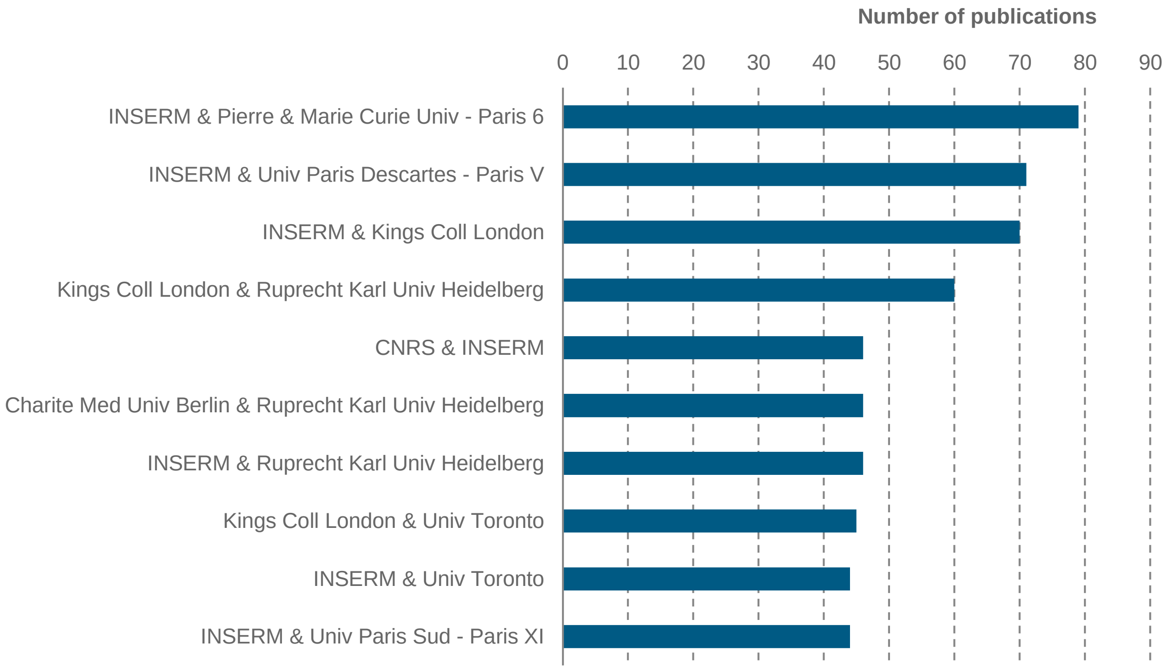


BTCURE had the most internationally collaborative publications involving two or more countries (263 out of 461), with an International Score of 0.49. PRO-active, PHARMA-COG and PROTECT, had the highest International Score (0.76, 0.73, and 0.64, respectively).

6.3.3 METRIC 3: TOP COLLABORATING ORGANISATIONS PER PUBLICATION

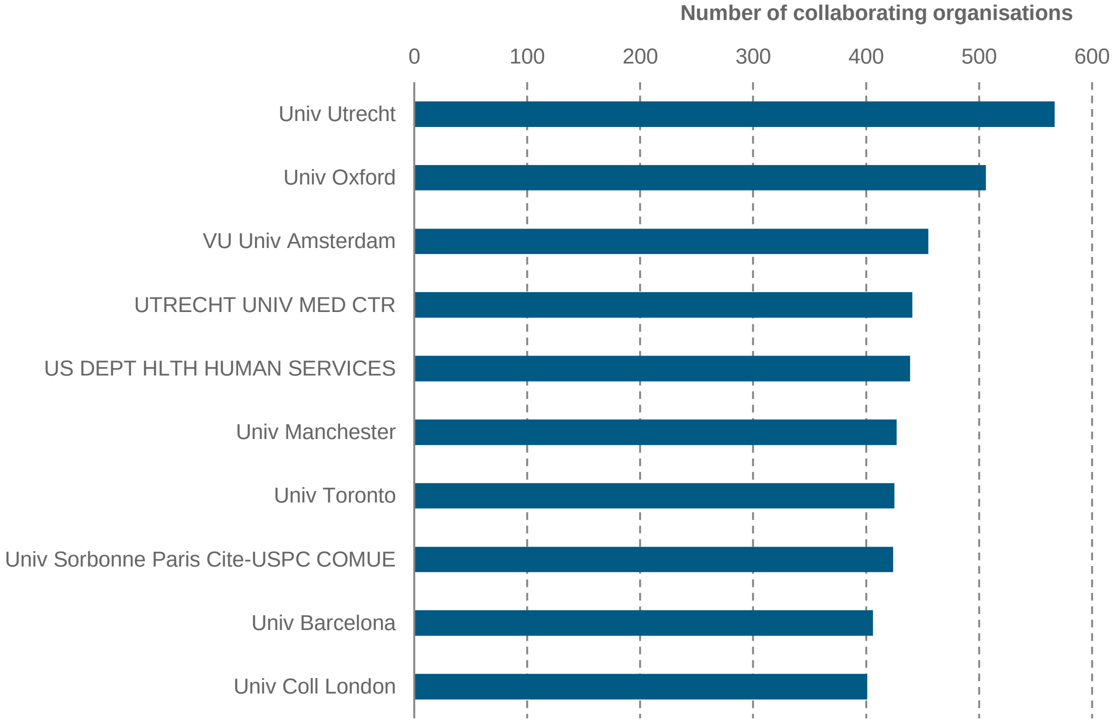
Metric 3 focuses on the top collaborating organisations and the number involved in publications associated with each project. Figure 6.3.3.1 shows the top ten 10 collaborating organisation pairs and the total number of collaborating publications for each pair. Figure 6.3.3.2 shows the number of collaborating organisations 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 ORGANISATIONS, 2010-2016



The organisations that collaborated together the most frequently in IMI project publications were the Pierre & Marie Curie University and Institut National de la Sante et de la Recherche Medicale (INSERM).

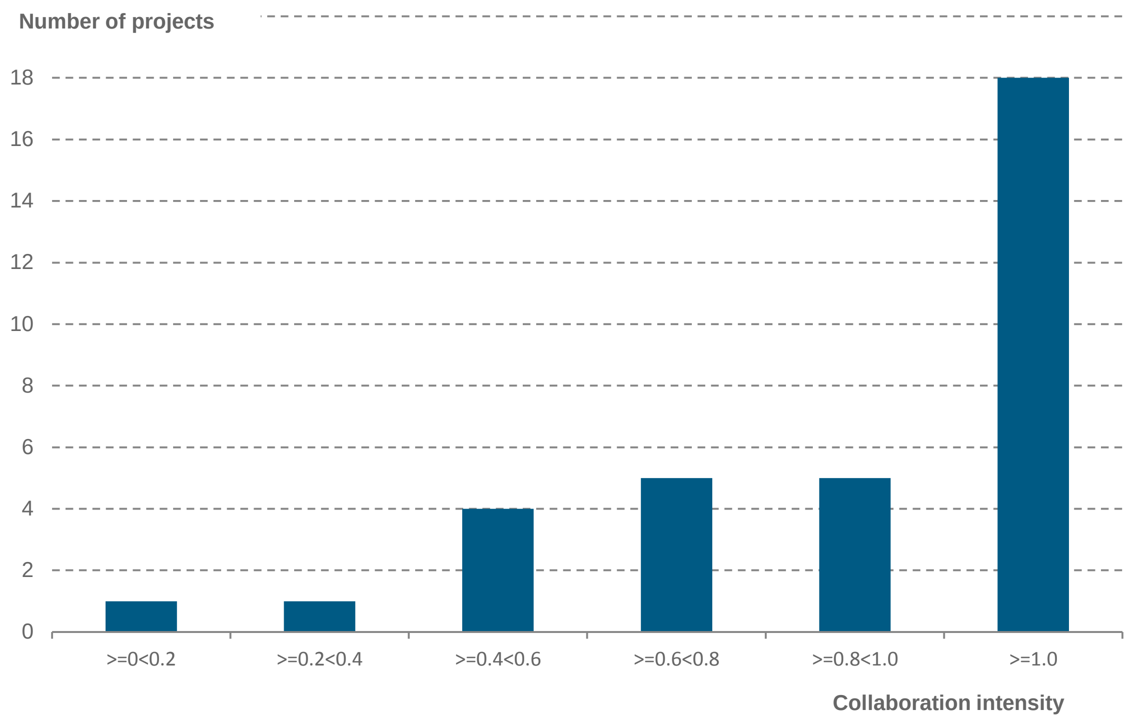
FIGURE 6.3.3.2 THE TEN MOST DIVERSE COLLABORATIVE ORGANISATIONS, 2010-2016



Utrecht University has collaborated with 567 different organisations within the IMI project publications.

The top 50 most diverse collaborating organisations were used to assign each project a score (metric 3). For each project, the number of non-distinct publications affiliated with the top 50 collaborating organisations was calculated. This total was then divided by the number of total 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 NEWMEDS the summed count of publications affiliated with the top 50 institutions was 260, and it published a total of 157 publications, so the result for metric 3 was 1.66 and this was consequently set to 1.0.

FIGURE 6.3.3.3 METRIC 3 SCORE DISTRIBUTION, 2010-2016



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 organisations 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). EU-AIMS had the highest overall collaboration index score (4.54), followed by SUMMIT, PRO-active and EMIF (3.73, 3.58, and 3.55, respectively).

TABLE 6.4.1 SUMMARY SCORE FOR COLLABORATION METRICS, TOTAL NUMBER PUBLICATIONS, AND CITATION IMPACT FOR IMI PROJECTS, 2010-2016

Project	X-sector Score	IntlScore	Metric 3	Collaboration Index	Total Project publications	Citation impact (field normalised)
BTCURE	0.64	0.49	1.02	2.15	461	2.24
EU-AIMS	0.65	0.63	3.26	4.54	199	2.51
NEWMEDS	0.65	0.56	1.66	2.87	157	2.36
EUROPAIN	0.38	0.34	1.06	1.78	147	2.85
IMIDIA	0.54	0.46	1.26	2.25	112	1.91
EMIF	0.80	0.63	2.13	3.55	109	2.60
PROTECT	0.98	0.64	1.46	3.08	90	1.27
SUMMIT	0.64	0.58	2.51	3.73	81	1.79
CHEM21	0.22	0.24	0.10	0.56	77	4.31
eTOX	0.50	0.37	0.67	1.54	72	1.78
ORBITO	0.58	0.49	0.40	1.47	67	1.83
Open PHACTS	0.73	0.61	1.11	2.45	64	2.28
QUIC-CONCEPT	0.71	0.58	1.13	2.42	63	2.69
TRANSLOCATION	0.44	0.50	0.48	1.42	62	1.85
PHARMA-COG	0.87	0.73	1.31	2.91	55	1.76
PreDiCT-TB	0.64	0.49	0.85	1.98	53	1.75
MIP-DILI	0.69	0.42	0.75	1.86	52	1.97
ELF	0.48	0.51	0.38	1.38	52	1.27
ULTRA-DD	0.49	0.55	0.98	2.02	51	2.13
DDMoRe	0.70	0.49	1.13	2.32	47	0.72
MARCAR	0.46	0.37	0.43	1.26	46	1.77
StemBANCC	0.62	0.43	0.71	1.76	45	2.36
U-BIOPRED	0.64	0.54	1.91	3.09	45	2.76
Onco Track	0.68	0.29	1.09	2.06	44	3.04
ABIRISK	0.72	0.36	1.72	2.80	43	2.37
BioVacSafe	0.74	0.44	0.92	2.10	39	1.70
CANCER-ID	0.71	0.45	0.83	1.99	35	4.65
Compact	0.24	0.37	0.82	1.43	33	3.85
RAPP-ID	0.53	0.41	0.40	1.34	30	1.01
COMBACTE	0.73	0.37	1.00	2.10	26	1.03
PREDECT	0.65	0.54	0.69	1.88	26	2.04
K4DD	0.50	0.42	0.75	1.67	24	1.66
PRO-active	1.00	0.76	1.82	3.58	22	2.19

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 (2016). Each of them had sufficient publications to allow a robust analysis.

TABLE 7.1.1 SUMMARY OF INFORMATION OF IMI-SELECTED COMPARATORS, 2010-2016

Comparator	Publications (2010-2016)	Papers (2010-2016)	Country	Region
Critical Path (C-Path)	273	273	USA	North America
Commonwealth Scientific and Industrial Research Organization (CSIRO) [16]	363	363	Australia	Australia
Foundation for the National Institutes of Health (FNIH)	1,896	1,895	USA	North America
Grand Challenges in Global Health (GCGH)	757	757	USA	North America
Indian Council of Medical Research (ICMR)	7,748	7,734	India	Asia
Medical Research Council (MRC)	34,526	34,524	UK	Europe
Wellcome Trust (WT)	42,121	41,957	UK	Europe

[16] The total publications for CSIRO between 2010 and 2016 was 6,103; 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. In order to provide a more easily interpretable comparison, Figure 7.2.1.1shows the percentage of the organisation's papers published each year to the total number of papers published between 2010 and 2016. Table 7.2.1.1shows 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, 2010-2016

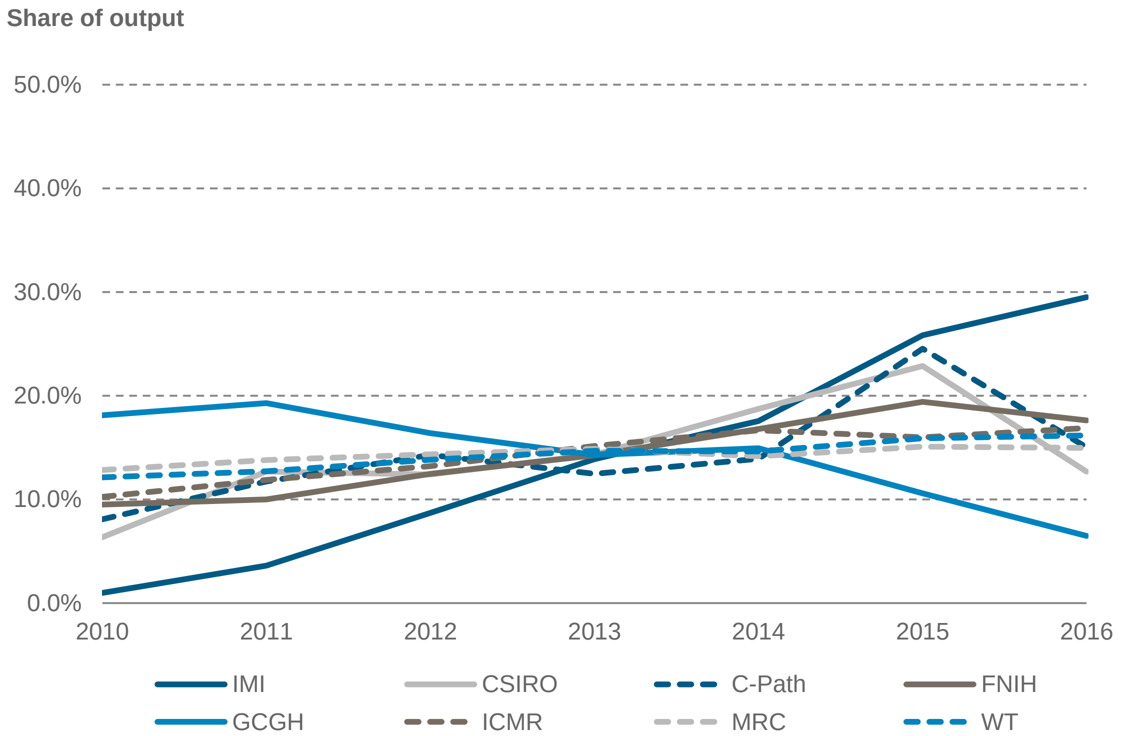


TABLE 7.2.1.1 SHARE OF OUPUT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	1.0%	6.3%	8.1%	9.5%	18.1%	10.2%	12.8%	12.1%
2011	3.6%	12.7%	11.7%	10.0%	19.3%	11.9%	13.8%	12.7%
2012	8.7%	12.4%	14.3%	12.5%	16.4%	13.2%	14.3%	13.8%
2013	13.9%	14.3%	12.5%	14.2%	14.3%	15.2%	14.9%	14.7%
2014	17.5%	18.7%	13.9%	16.8%	14.9%	16.7%	14.2%	14.6%
2015	25.8%	22.9%	24.5%	19.4%	10.6%	16.0%	15.1%	15.9%
2016	29.5%	12.7%	15.0%	17.6%	6.5%	16.9%	15.0%	16.2%

TABLE 7.2.1.2 NUMBER OF PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	26	23	22	180	137	792	4431	5090
2011	96	46	32	189	146	919	4757	5326
2012	231	45	39	236	124	1020	4947	5799
2013	368	52	34	270	108	1172	5128	6159
2014	467	68	38	318	113	1289	4888	6138
2015	687	83	67	368	80	1236	5205	6667
2016	785	46	41	334	49	1306	5168	6778
Total	**2660**	**363**	**273**	**1895**	**757**	**7734**	**34524**	**41957**

- Except GCGH, both IMI and the other comparators had a generally upward trend in papers published between 2010 and 2016.
- 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, 2015 and 2016, account for more than half of 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 2016. 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, 2010-2016

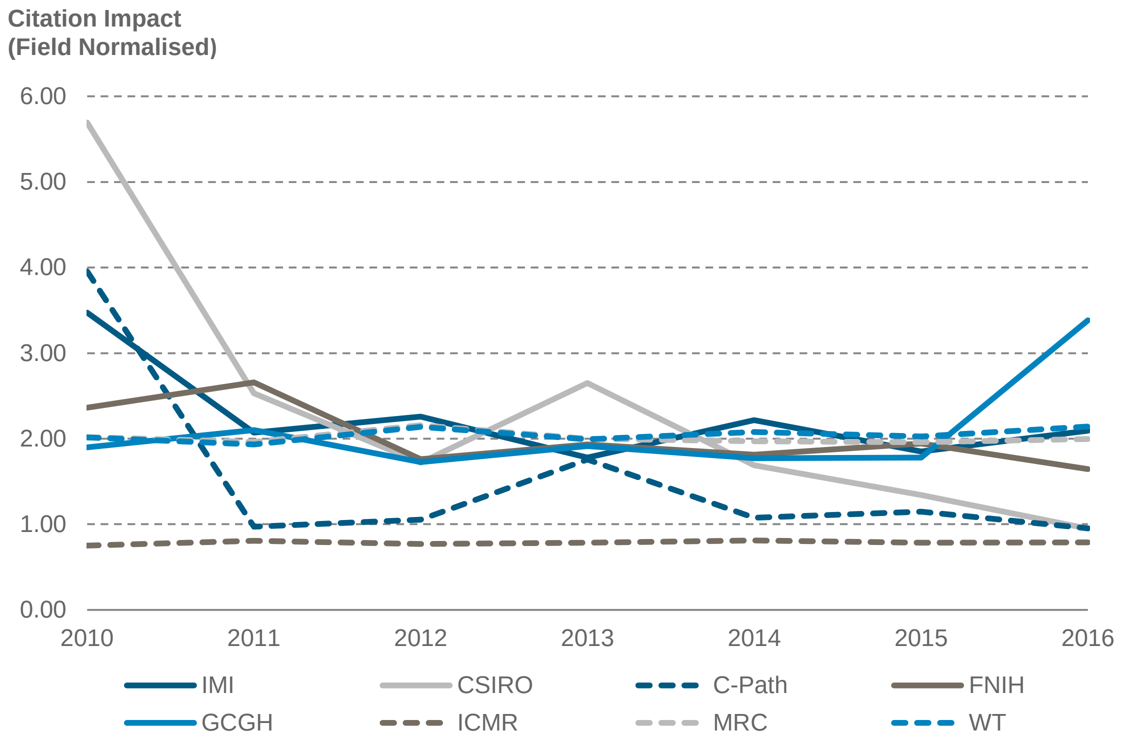


TABLE 7.2.2.1 NCI_F – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	3.47	5.69	3.96	2.36	1.90	0.75	2.02	2.01
2011	2.07	2.53	0.97	2.66	2.10	0.81	1.96	1.93
2012	2.26	1.72	1.06	1.76	1.73	0.77	2.16	2.14
2013	1.78	2.65	1.76	1.93	1.91	0.78	2.00	1.99
2014	2.22	1.69	1.08	1.81	1.77	0.81	1.97	2.08
2015	1.85	1.34	1.15	1.94	1.78	0.78	1.96	2.02
2016	2.09	0.95	0.95	1.65	3.38	0.79	2.00	2.14
AVG	**2.03**	**2.02**	**1.38**	**1.96**	**1.98**	**0.79**	**2.01**	**2.05**

- In 2012 and 2014, IMI had the highest citation impact (2.26 and 2.22 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 2016, 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.
- The papers published by GCGH in 2016 had high field normalised citation impact, above three times the world average.

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 2016. Table 7.2.3.1 shows the same data as in Figure7.2.3.1.

FIGURE 7.2.3.1 TRENDS IN NCI_J – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

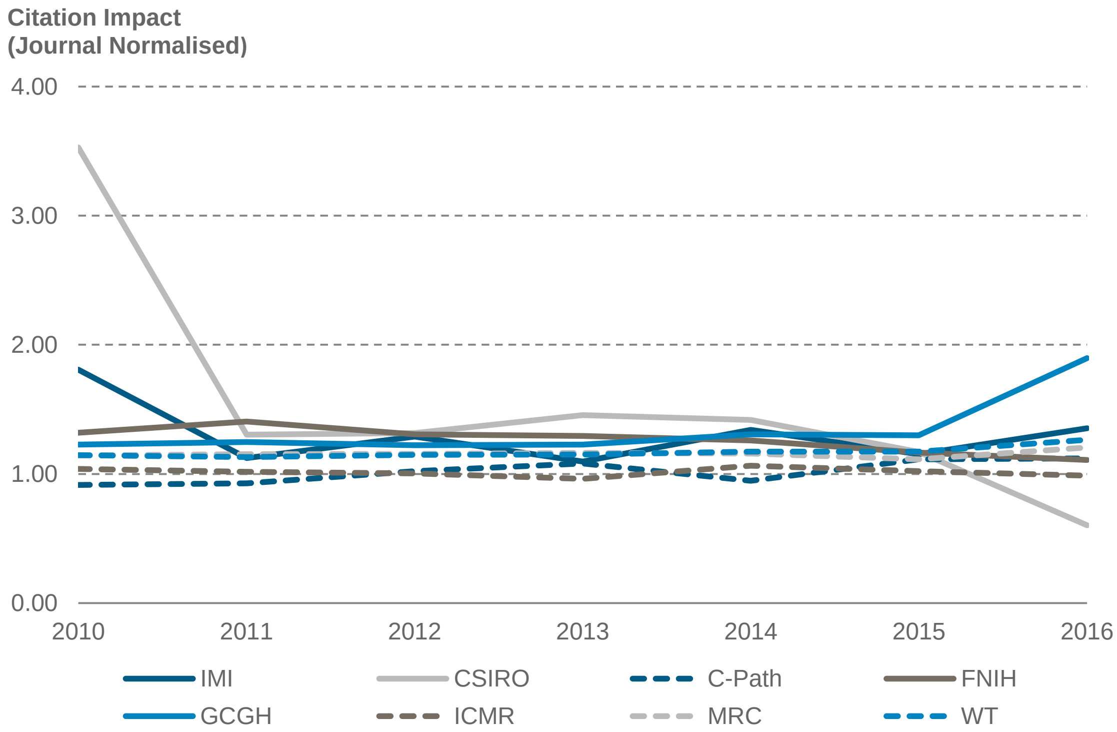


TABLE 7.2.3.1 NCI_J – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	1.81	3.53	0.91	1.32	1.23	1.04	1.14	1.14
2011	1.12	1.30	0.93	1.41	1.25	1.02	1.15	1.13
2012	1.29	1.32	1.02	1.31	1.22	1.00	1.16	1.15
2013	1.10	1.45	1.08	1.30	1.23	0.96	1.16	1.15
2014	1.34	1.42	0.95	1.26	1.31	1.06	1.16	1.17
2015	1.15	1.17	1.11	1.17	1.30	1.02	1.11	1.17
2016	1.35	0.60	1.12	1.11	1.90	0.99	1.21	1.26
AVG	**1.25**	**1.37**	**1.04**	**1.25**	**1.29**	**1.01**	**1.16**	**1.17**

- IMI had the joint third highest nci_J (1.25) overall and in 2016 had the second highest nci_J (1.35).
- The nci_J of the ICMR, MRC and WT remained relatively stable, while that of CSIRO showed greater variability. This is to be expected given the smaller number of papers funded by CSIRO, 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 2016. Table 7.2.4.1 has the same data as in Figure7.2.4.1.

FIGURE 7.2.4.1 TRENDS IN RAW CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

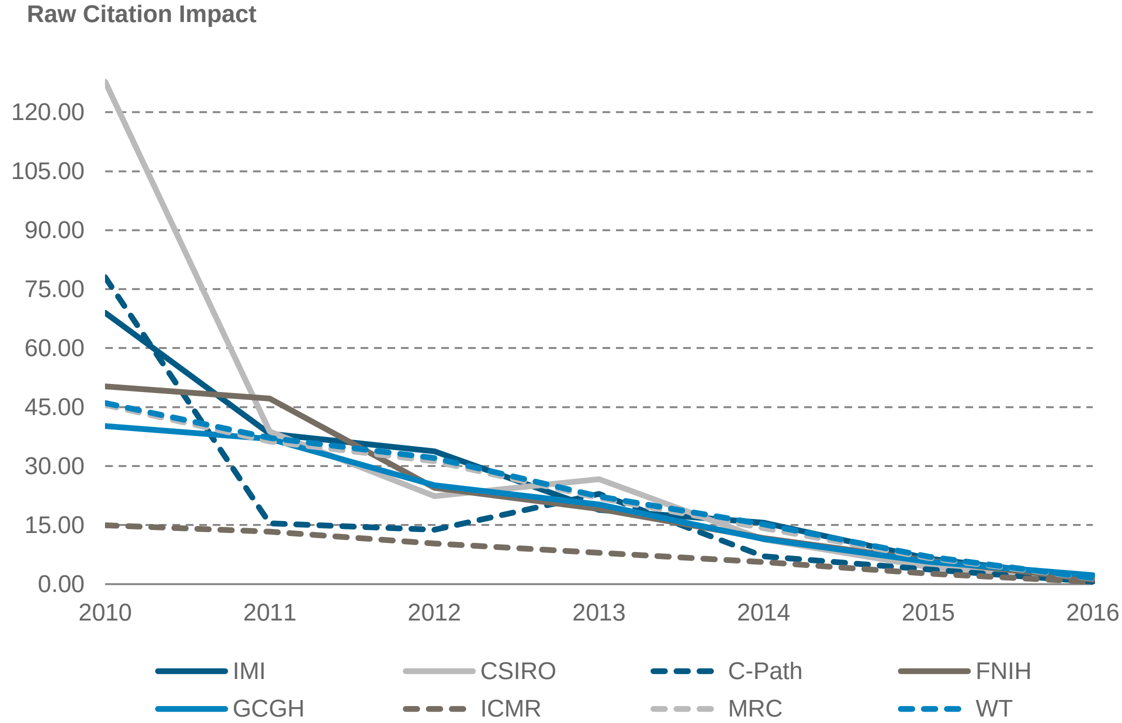


TABLE 7.2.4.1 RAW CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	69.00	127.74	78.05	50.27	40.22	14.95	45.59	46.07
2011	38.20	38.80	15.47	47.16	36.95	13.35	36.24	37.20
2012	33.75	22.38	13.79	24.44	25.16	10.29	31.24	32.01
2013	18.85	26.65	22.94	19.09	20.22	8.00	21.84	22.29
2014	15.63	11.38	7.11	11.70	11.43	5.63	14.24	15.23
2015	6.48	4.35	3.70	6.00	5.65	2.63	6.66	7.02
2016	1.55	0.65	0.63	1.10	2.24	0.54	1.43	1.55
AVG	**12.47**	**22.81**	**14.92**	**18.57**	**23.86**	**7.14**	**21.80**	**21.60**

- The raw citation impact of all organisations decreased from 2010 to 2016. This is expected as more recent publications have had less time to accumulate citations, and the raw citation impact is not normalised.
- In 2016 IMI's raw citation impact was second among the comparator group (1.55) the same as that of WT.

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 2016 for IMI and the selected comparators. Table 7.2.5.1 has the same data as in Figure7.2.5.1.

FIGURE 7.2.5.1 TRENDS IN UNCITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

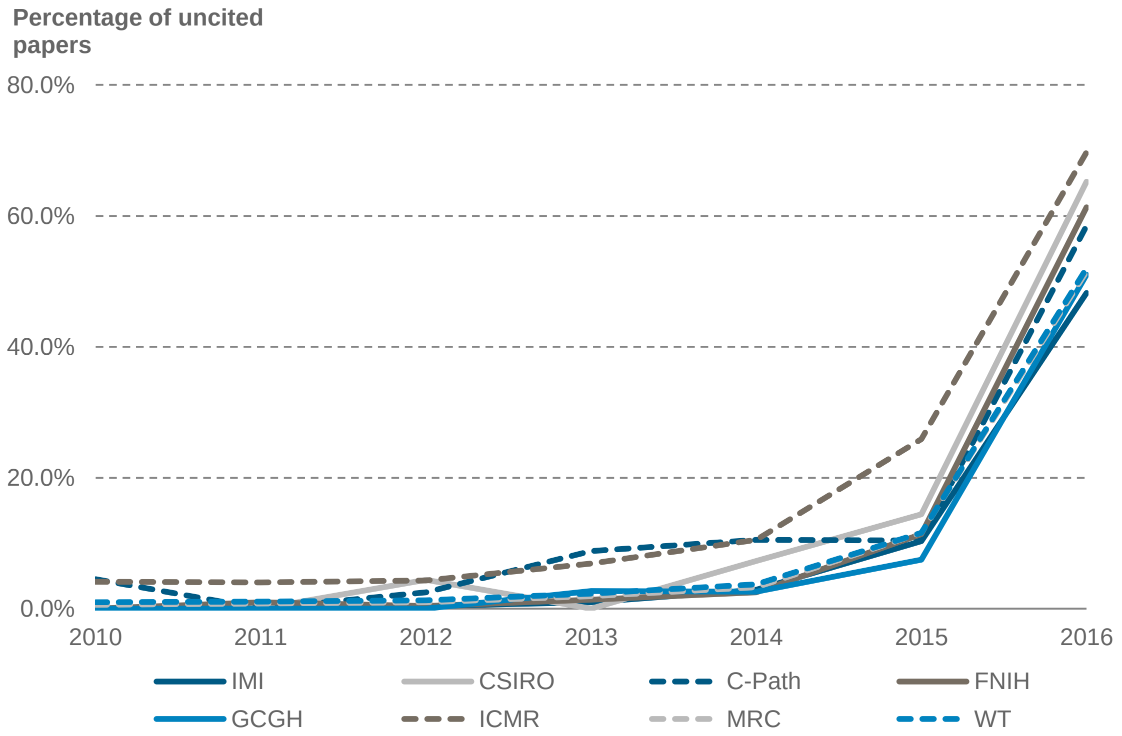


TABLE 7.2.5.1 PERCENTAGE OF UNCITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	0.0%	0.0%	4.5%	0.0%	0.0%	4.1%	0.6%	1.0%
2011	0.0%	0.0%	0.0%	1.0%	0.0%	4.0%	0.8%	1.1%
2012	0.4%	4.4%	2.5%	0.4%	0.0%	4.3%	1.0%	1.3%
2013	1.0%	0.0%	8.8%	1.4%	2.7%	6.9%	1.9%	2.3%
2014	2.9%	7.3%	10.5%	2.5%	2.6%	10.5%	3.3%	3.7%
2015	10.3%	14.4%	10.4%	11.4%	7.5%	25.9%	11.6%	11.6%
2016	48.2%	65.2%	58.5%	61.3%	51.0%	69.7%	51.5%	52.0%
Total	**17.6%**	**13.5%**	**14.7%**	**13.8%**	**4.9%**	**20.2%**	**10.6%**	**11.6%**

- A little over one sixth of papers published from IMI project research were uncited. The proportion of uncited research is in the similar range of its comparators, except GCGH, between 2010 and 2016. Only less than 5% of GCGH papers were uncited overall between 2010 and 2016.
- No IMI project papers published in 2010 and 2011 are uncited. Its share of uncited research in the most recent year, 2016, is also the lowest among 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 2016 for IMI and the selected comparators. Table 7.2.6.1 has the same data as in Figure7.2.6.1.

FIGURE 7.2.6.1 TRENDS IN HIGHLY CITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

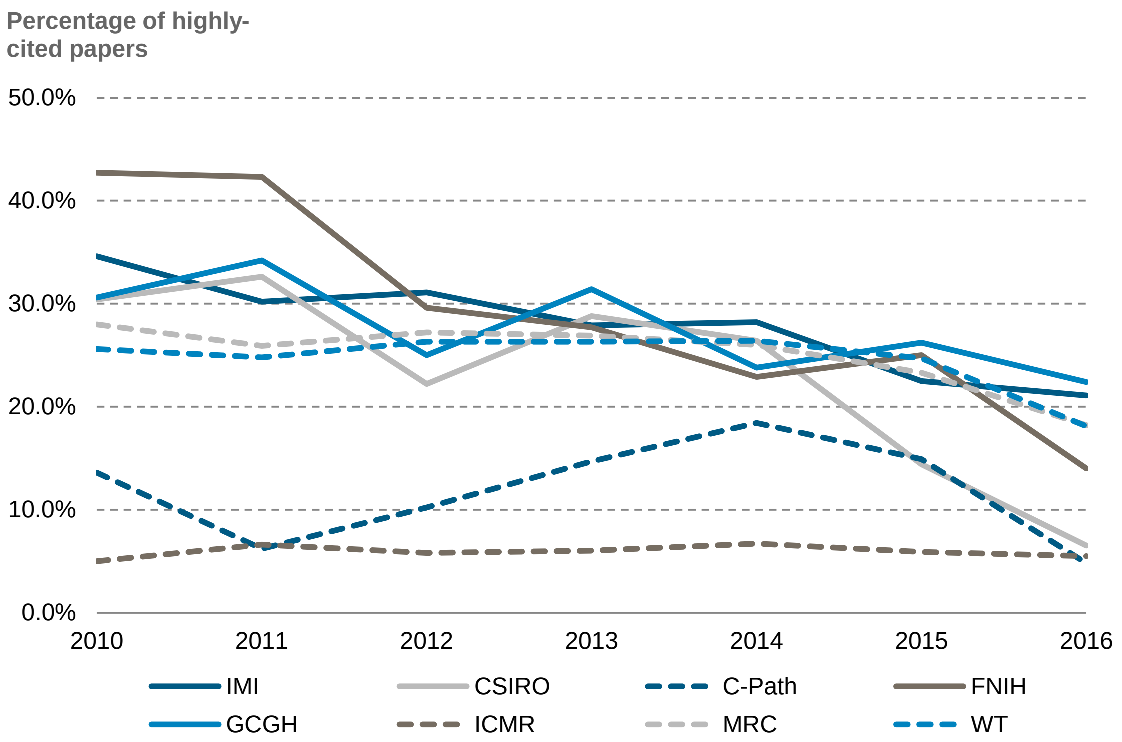


TABLE 7.2.6.1 PERCENTAGE OF HIGHLY CITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	34.6%	30.4%	13.6%	42.7%	30.6%	5.0%	28.0%	25.6%
2011	30.2%	32.6%	6.2%	42.3%	34.2%	6.6%	25.9%	24.8%
2012	31.1%	22.2%	10.2%	29.6%	25.0%	5.8%	27.2%	26.3%
2013	27.9%	28.8%	14.7%	27.7%	31.4%	6.0%	26.9%	26.3%
2014	28.2%	26.4%	18.4%	22.9%	23.8%	6.7%	26.0%	26.4%
2015	22.5%	14.4%	14.9%	25.0%	26.2%	5.9%	23.3%	24.7%
2016	21.1%	6.5%	4.8%	14.0%	22.4%	5.5%	18.2%	18.1%
Total	**25.0%**	**22.0%**	**12.1%**	**27.1%**	**28.5%**	**6.0%**	**25.0%**	**24.5%**

- Approximately one quarter of papers published by IMI and its comparators between 2010 and 2016 were highly cited. ICMR and C-Path were notable exceptions.
- In 2012 and 2014, IMI had the highest share of highly-cited papers in the group. In 2010 and 2016, it 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 publications that are published in open-access journals between 2010 and 2016 for IMI and the selected comparators. Table 7.2.7.1 shows the same data as in Figure7.2.7.1.

FIGURE 7.2.7.1 TRENDS IN OPEN-ACCESS PUBLICATIONS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

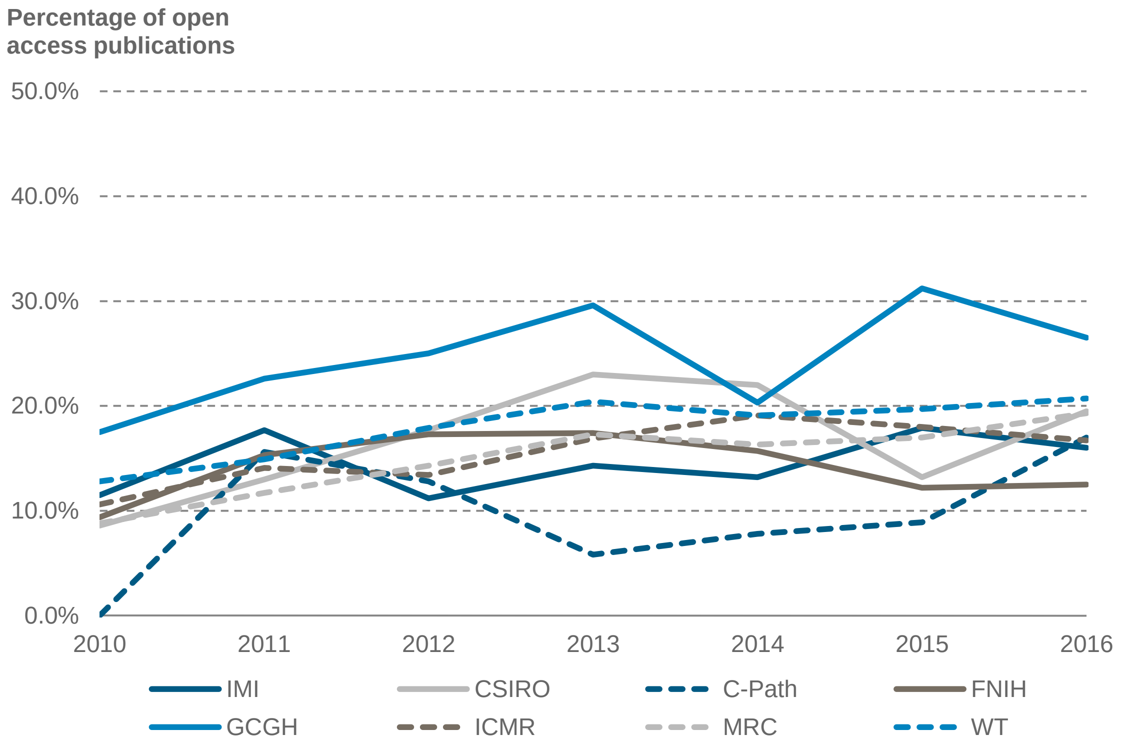


TABLE 7.2.7.1 PERCENTAGE OF OPEN-ACCESS PUBLICATIONS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2016

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	11.5%	8.6%	0.0%	9.4%	17.5%	10.6%	8.8%	12.8%
2011	17.7%	13.0%	15.6%	15.3%	22.6%	14.1%	11.7%	14.9%
2012	11.2%	17.7%	12.8%	17.3%	25.0%	13.4%	14.3%	17.9%
2013	14.3%	23.0%	5.8%	17.4%	29.6%	16.9%	17.3%	20.4%
2014	13.2%	22.0%	7.8%	15.7%	20.3%	19.1%	16.3%	19.1%
2015	17.9%	13.2%	8.9%	12.2%	31.2%	18.0%	17.0%	19.7%
2016	16.0%	19.5%	17.0%	12.5%	26.5%	16.7%	19.3%	20.7%
Total	**15.4%**	**17.4%**	**10.3%**	**14.3%**	**23.9%**	**16.0%**	**15.2%**	**18.2%**

- The majority of organisations, including IMI, had less than 20% of publications that were published in open-access journals, though there is a slight increasing share of open-access papers for all organisations.
- GCGH consistently has the highest percentage of open access papers in most of the years between 2010 and 2016 in the group. Overall, it had nearly a quarter of papers that were published in open-access journals between 2010 and 2016, while C-Path only had one tenth of such papers.

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 the 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, 2010-2016

	Number of papers	Citation impact (normalised at field level)	Percentage of uncited papers	Percentage of highly-cited papers
IMI	2,660	2.03	17.6%	25.0%
CSIRO	363	2.02	13.5%	22.0%
C-Path	72	1.38	14.7%	12.1%
FNIH	1,895	1.96	13.8%	27.1%
GCGH	757	1.98	4.9%	28.5%
ICMR	7,734	0.79	20.2%	6.0%
MRC	34,524	2.01	10.6%	25.0%
WT	41,957	2.05	11.6%	24.5%

8 COLLABORATION NETWORK ANALYSIS BY IMI PROJECT

This section of the report analyses changes in organisation collaborations since the projects were established. The projects included 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 organisations appear together in the author 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 2009 to 2016. Changes in collaborations are compared across two time periods, 2009-2012 and 2013-2016 – this is to enable 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 organisations appearing in the publications (including all the organisations that are participating in the project[17]). The number of papers co-authored between organisations is represented by the thickness of the line linking them. Graph nodes are colour coded according to the corresponding sector. As in the section 6 collaboration analysis, the sectors assigned to the organisations are academic, corporate, government, medical, or other[12]. Nodes displayed as labelled, filled spheres correspond to organisations that were IMI participants while unlabelled, unfilled circles correspond to those that were not IMI participants. The graphs show the amount of change in collaborations from period 1 to period 2. Collaborations with at least two co-authored publications are included in the graphs. Section 8.1 first summarises the data presented in the network graphs.

The numbers of publications co-published by organisations 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 diversity of organisations across multiple sectors and countries. It is also clear from the data that there is significant collaboration with organisations 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[17]

PROJECT	START DATE	END DATE	TOTAL FUNDING SUPPORT
BTCURE	1/4/2011	31/03/2017	$40,736,439.00
EU-AIMS	1/4/2012	30/03/2017	$37,631,993.00
EUROPAIN	1/10/2009	30/09/2015	$22,550,083.00
IMIDIA	1/4/2011	31/03/2017	$27,447,009.00
NEWMEDS	1/9/2009	28/02/2015	$24,849,675.00

[17] 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 (2009-2012) to period 2 (2013-2016) in the number and types of organisations 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 organisations that were IMI participants by sector.

- The BTCURE project had the largest number of academia and medical organisations (12 and 5, respectively) as IMI participants among these five projects.
- Both BTCURE and IMIDIA had the largest number of corporate organisations (9 each) as IMI participants.

TABLE 8.1.1 NUMBER OF IMI PARTICIPATING ORGANIZATIONS[17]

SECTOR	BTCURE	EU-AIMS	EUROPAIN	NEWMEDS	IMIDIA
ACADEMIA	12	9	10	5	8
CORPORATE	9	7	7	8	9
GOVERNMENT	1	1	0	0	1
MEDICAL	5	4	1	1	1
OTHER	3	2	0	1	2

Academia organisations include universities and other institutions that focus on a combination of education and research such as Kings College London and the Karolinska Institute. Corporate organisations are commercial organisations 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 organisations, 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 organisations include hospitals and patient-care organisations such as CHU Montpellier and the Central Institute of Mental Health Mannheim. Other organisations include organisations that either have reach across multiple sectors such as INSERM and 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 organisations co-authoring IMI publications, the academic and medical sectors had the greatest changes in the number of non-IMI participating organisations across the five projects.

Table 8.1.2 provides the change in the number of organisations by sector for all five projects. The unshaded and grey shaded rows provide the information for the IMI participating and non-IMI participating organisations respectively.

Table 8.1.2 CHANGE IN THE NUMBER OF ORGANIZATIONS BY SECTOR FROM PERIOD 1 (2009-2012) TO PERIOD 2 (2013-2016) FOR IMI PARTICIPATING AND NON PARTICIPATING ORGANISATIONS [NUMBER OF ORGANISATIONS FROM PERIOD 2]

SECTOR	BTCURE	EU-AIMS	EUROPAIN	NEWMEDS	IMIDIA
ACADEMIA	3 [11]	8 [9]	5 [9]	2 [5]	4 [8]
	82 [93]	53 [72]	18 [23]	20 [39]	11 [17]
CORPORATE	2 [2]	2 [2]	5 [5]	3 [6]	4 [4]
	7 [7]	2 [2]	3 [4]	2 [5]	0 [0]
GOVERNMENT	0 [1]	1 [1]	0 [0]	0 [0]	0 [0]
	6 [6]	4 [4]	1 [1]	1 [3]	0 [0]
MEDICAL	2 [4]	3 [3]	1 [1]	-1 [0]	1 [1]
	43 [52]	21 [22]	7 [8]	-6 [5]	6 [7]
OTHER	2 [3]	1 [1]	0 [0]	1 [1]	0 [1]
	9 [11]	7 [9]	0 [1]	3 [4]	2 [2]

Figure 8.1.1 graphs the number of collaborating organisations for period 1 and period 2 for the academic sector.

- For all five projects either all or nearly all of the IMI participating academic organisations contributed to publications during period 2.
- All five projects had an increase in the number of IMI participating and non-IMI participating academic organisations 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 organisations that contributed to IMI publications (+82 and +53, respectively or 8.5 and 3.8 times more of these collaborations in period 2 compared to period 1, respectively).
    - EUROPAIN had 4.6 times more non-IMI participating collaborations during period 2 while IMIDIA had 2.8 and NEWMEDS had 2.1 times more.

FIGURE 8.1.1 NUMBER OF COLLABORATING ORGANISATIONS FROM THE **ACADEMIC** SECTOR IN PERIOD 1 (2009-2012) AND IN PERIOD 2 (2013-2016)

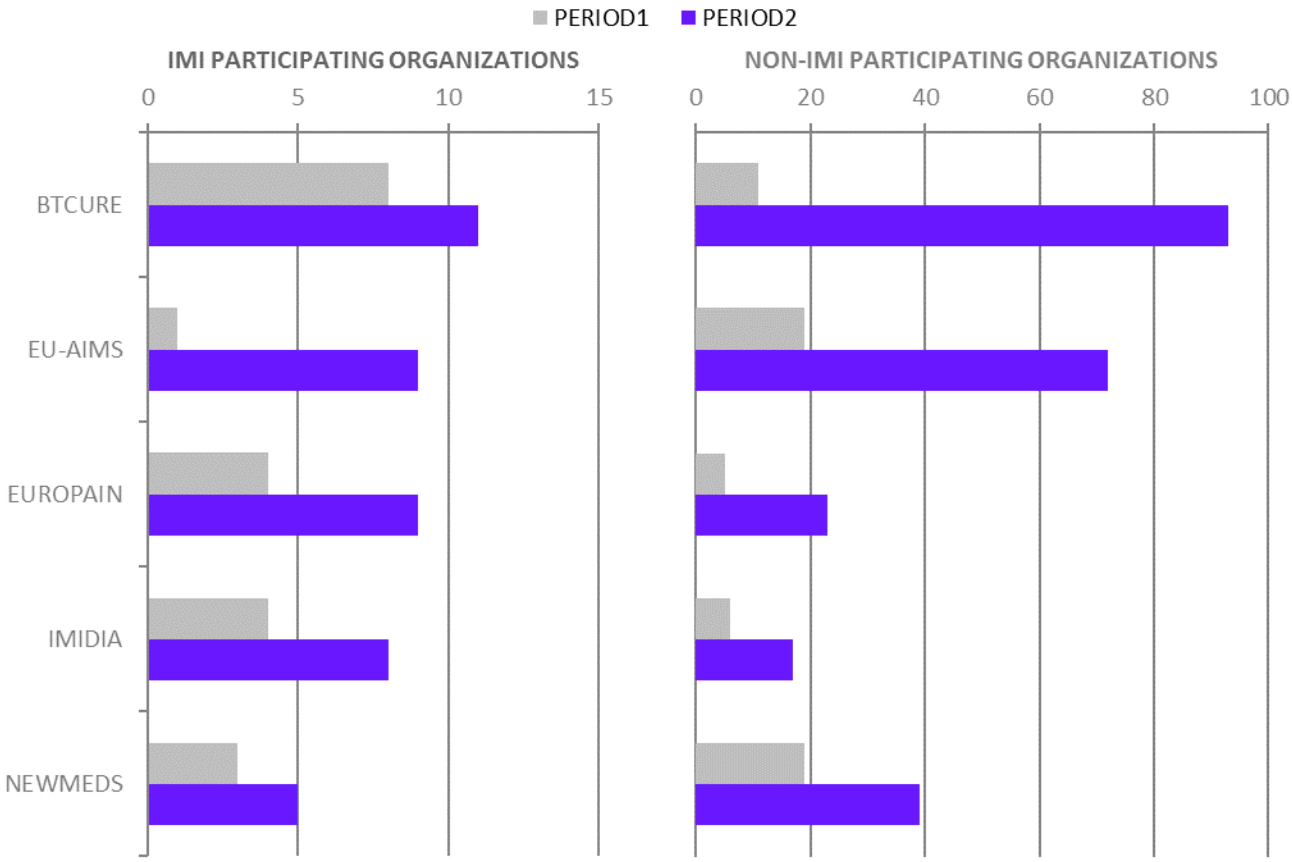


Figure 8.1.2 graphs the number of collaborating organisations for both periods for the medical sector.

- Only EU-AIMs had contributions from IMI supported medical organisations during period 1.
- All but one of the medical organisations directly funded by the BTCURE project contributed to IMI publications during period 2.
- All projects except NEWMEDS had an increase in the number of non-IMI participating medical organisations contributing to IMI publications.
- BTCURE and EU-AIMS had the largest increase in the number of non-IMI participating medical organisations from period 1 to period 2 (+43 and +21, respectively which corresponds to 5.8 and 22 times more collaborations in period 2).
- EUROPAIN and IMIDIA increased collaborations with non-IMI participating organisations by 8 and 7 times, respectively, during period 2.

FIGURE 8.1.2 NUMBER OF COLLABORATING ORGANISATIONS FROM THE MEDICAL SECTOR IN PERIOD 1 (2009-2012) AND IN PERIOD 2 (2013-2016)

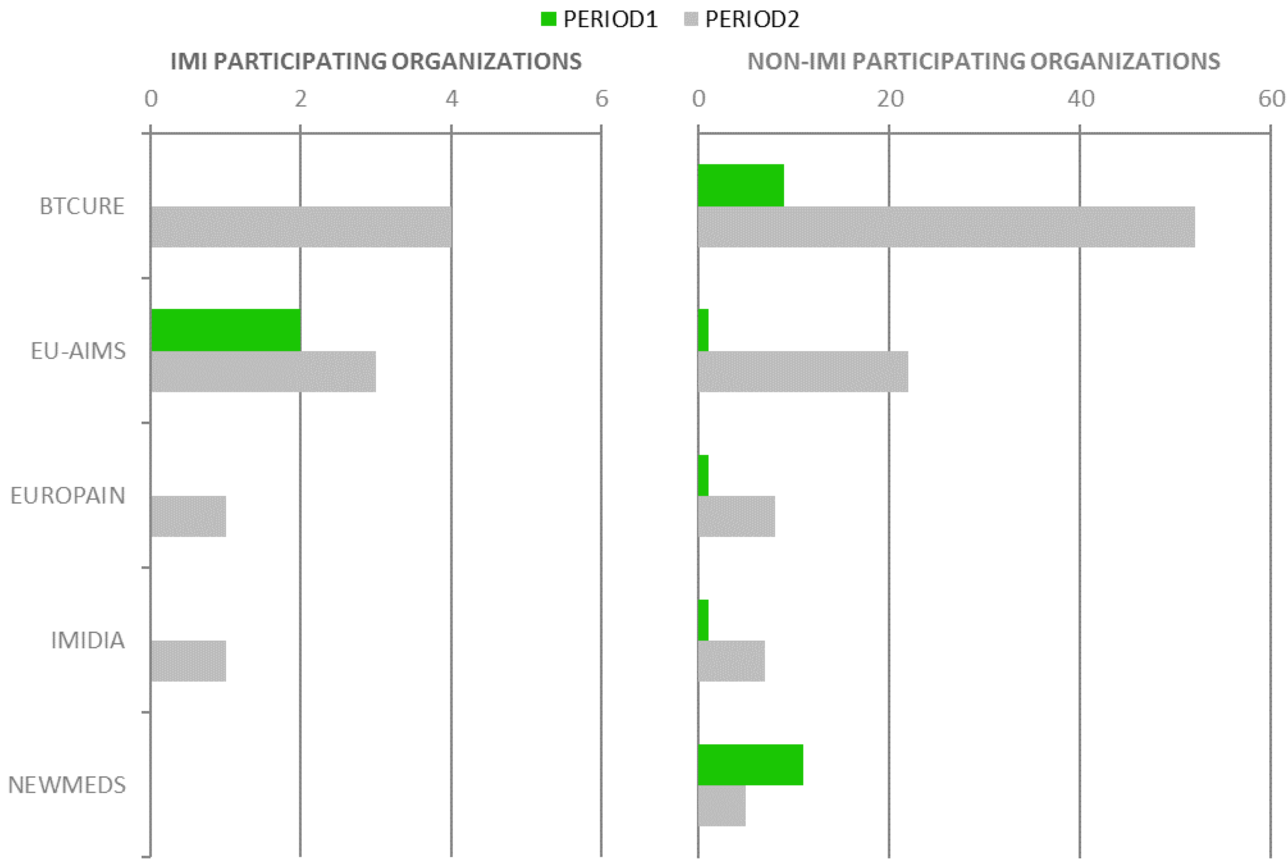


Table 8.1.3 provides this information for all sector publication collaborations.

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

TABLE 8.1.3 CHANGE IN THE NUMBER OF SECTOR PUBLICATION COLLABORATIONS FROM PERIOD 1 (2009-2012) TO PERIOD 2 (2013-2016) [NUMBER OF PUBLICATION COLLABORATIONS FROM PERIOD 2]

SECTOR 1	SECTOR 2	BTCURE	EU-AIMS	EUROPAIN	NEWMEDS	IMIDIA
ACADEMIA	ACADEMIA	792 [836]	4145 [4394]	357 [369]	127 [276]	119 [137]
	CORPORATE	57 [57]	16 [16]	121 [125]	139 [169]	17 [17]
	GOVERNMENT	64 [66]	418 [418]	0 [0]	26 [32]	0 [0]
	MEDICAL	552 [576]	1268 [1282]	148 [150]	-105 [10]	42 [48]
	OTHER	265 [273]	566 [612]	2 [4]	22 [24]	14 [18]
CORPORATE	CORPORATE	0 [0]	5 [5]	15 [15]	71 [75]	2 [2]
	GOVERNMENT	0 [0]	0 [0]	0 [0]	-4 [0]	0 [0]
	MEDICAL	2 [2]	6 [6]	14 [14]	-12 [4]	0 [0]
	OTHER	0 [0]	0 [0]	0 [0]	4 [4]	0 [0]
GOVERNMENT	GOVERNMENT	2 [2]	4 [4]	0 [0]	2 [2]	0 [0]
	MEDICAL	2 [2]	49 [49]	0 [0]	-4 [0]	0 [0]
	OTHER	0 [0]	18 [18]	0 [0]	0 [0]	0 [0]
MEDICAL	MEDICAL	192 [226]	90 [90]	7 [7]	2 [11]	5 [5]
	OTHER	28 [38]	74 [76]	0 [0]	0 [0]	6 [6]
OTHER	OTHER	15 [17]	10 [10]	0 [0]	0 [0]	0 [0]
ALL SECTORS	ALL SECTORS	1971	6669	664	268	205

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 organisations, academia and corporate organisations, academia and government organisations, academia and medical organisations, and academia and other organisations.

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

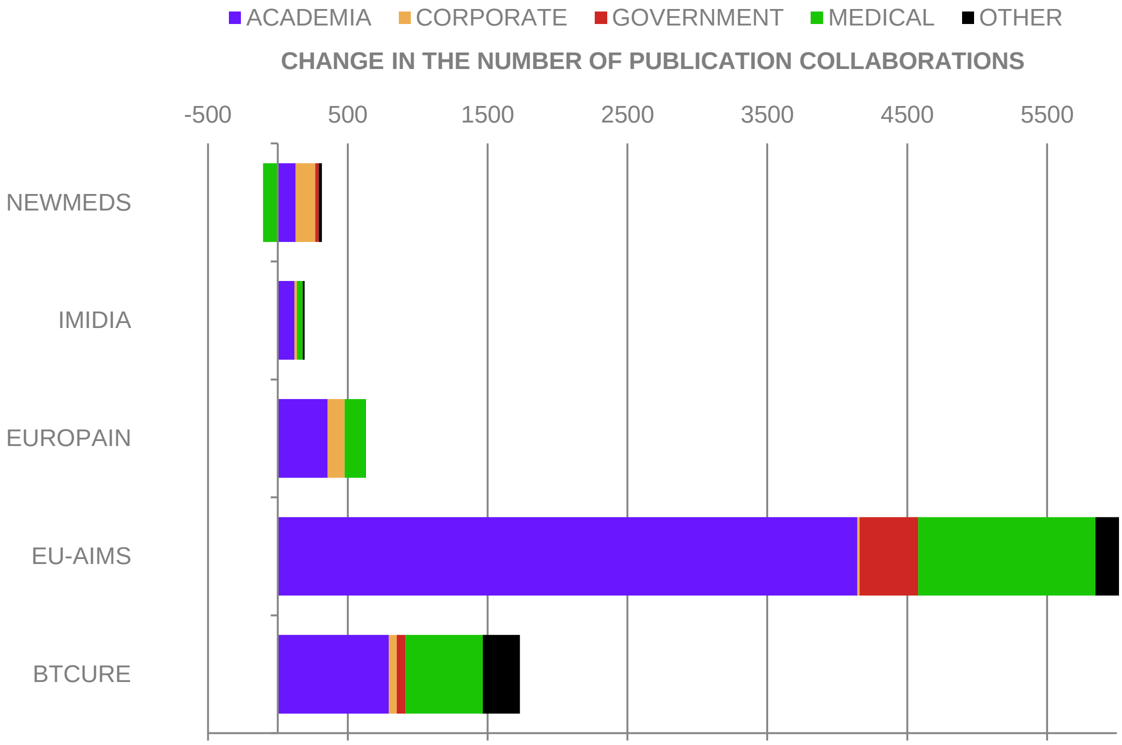


Figure 8.1.4 graphs the change in the number of publication collaborations from period 1 to period 2 for collaborations between corporate and academia organisations, corporate and corporate organisations, corporate and government organisations, corporate and medical organisations, and corporate and other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

- NEWMEDS had the largest increase in collaborations between corporate organisations (+71) and between corporate and academia organisations from period 1 to period 2 (+139).
- EUROPAIN had the second largest increase in collaborations between corporate and academia organisations (+121).
- NEWMEDS had a small decrease in the number of collaborations between corporate and medical organisations (-12) and between corporate and government organisations (-4).

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

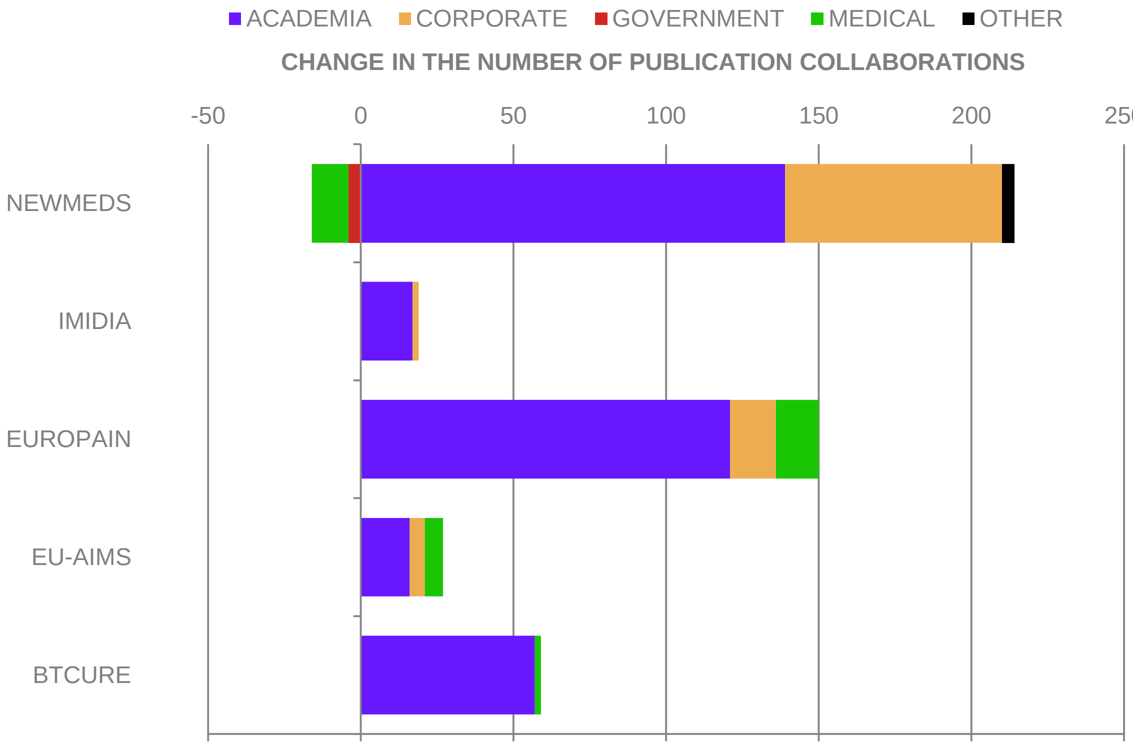


Figure 8.1.5 graphs the change in the number of publication collaborations from period 1 to period 2 for collaborations between government and academia organisations, government and corporate organisations, government and government organisations, government and medical organisations, and government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

- EU-AIMS had the largest increase in collaborations between government and academia organisations (+418).

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

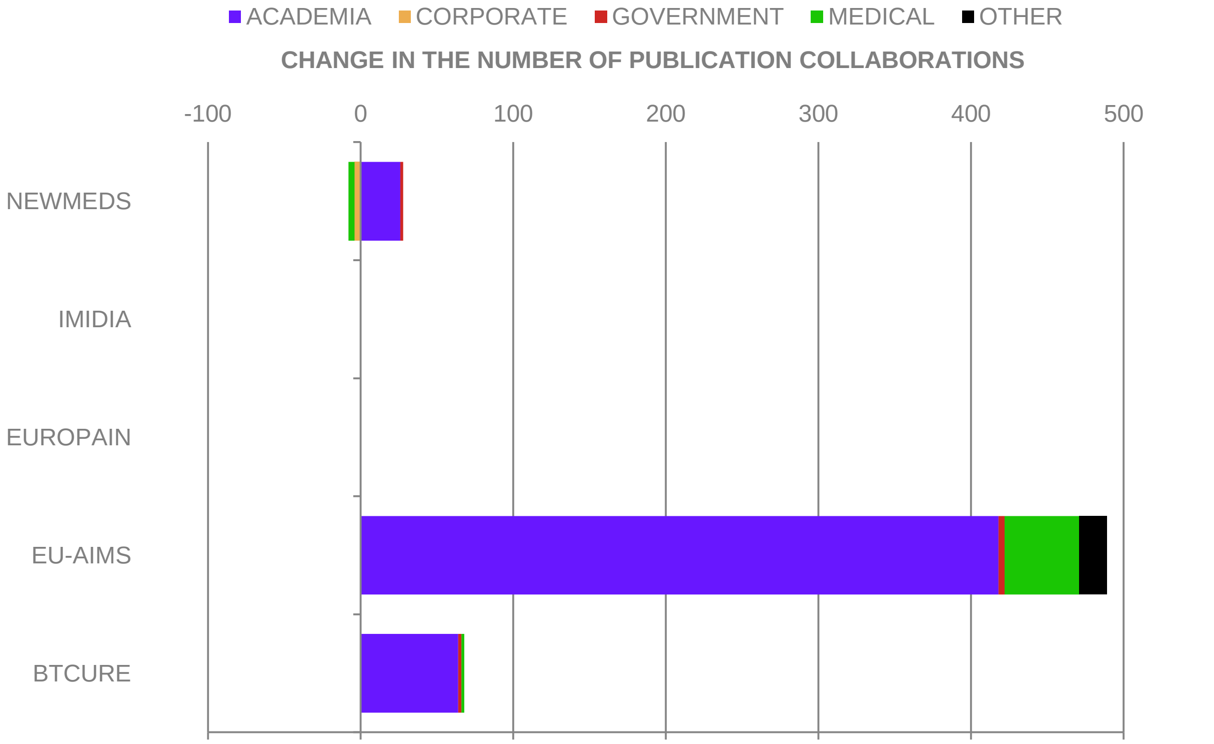
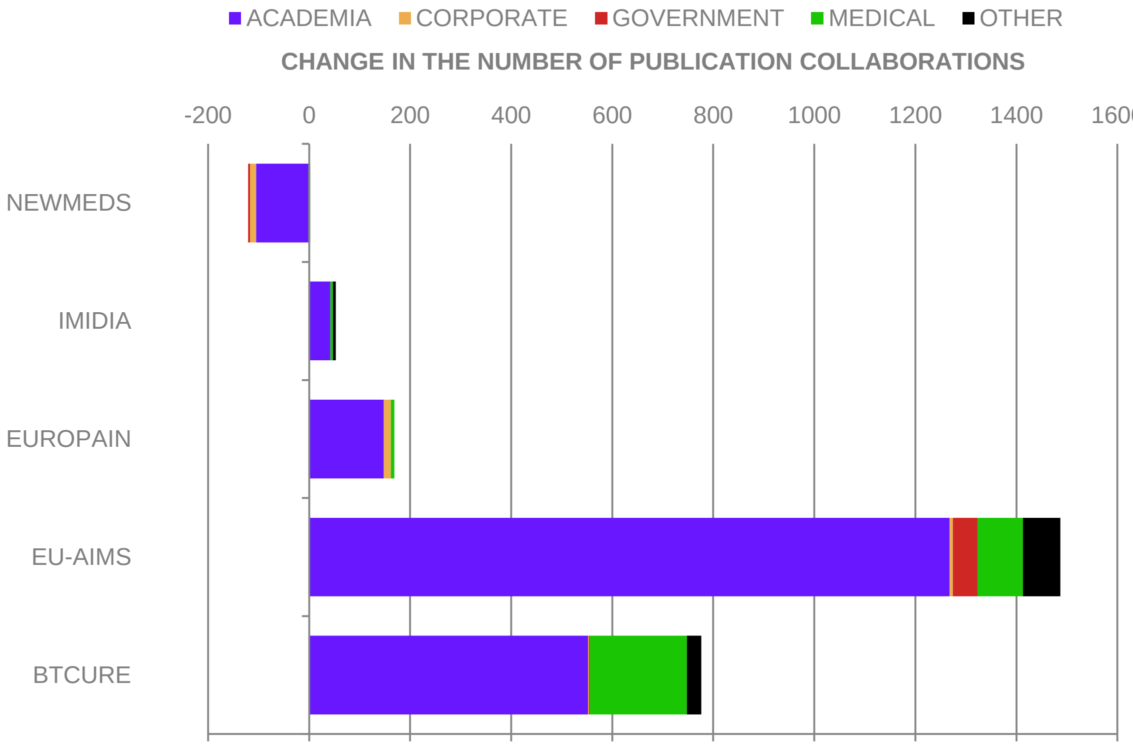


Figure 8.1.6 graphs the change in the number of publication collaborations from period 1 to period 2 for collaborations between medical and academia organisations, medical and corporate organisations, medical and government organisations, medical and medical organisations, and medical and other organisations.

- BTCURE had the largest increase in collaborations between medical organisations (+192).

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



8.2 COLLABORATION NETWORK GRAPHS BY IMI PROJECT

Figure 8.2.1 to Figure 8.2.10 present graphs of the network of publication collaborations for each project during period 1 (2009-2012) to period 2 (2013-2016).

- For all five projects the organisation collaboration activity increased substantially during period 2.
- Overview of the top five organisations during period 2 based on network degree centrality (extent of connectivity to other organisations):
    - In the BTCURE organisation network four (Karolinska Inst, Should be defined. Spanish National Research Council/ Consejo Superior de Investigaciones Científicas (CSIC), Univ Manchester, Univ Amsterdam) of the five organisations were IMI participants and one was not (Leiden Univ). CSIC (classified as other) was the only non-academia organisation among the top five.
    - Also in the EUROPAIN organisation network four (Aarhus Univ, Ruprecht Karl Univ Heidelberg, Imperial Coll London, Univ Kiel) of the five most central organisations were IMI participants and one was not (Karolinska Inst). All five are academia organisations.
    - In the NEWMEDS organisation network four (Kings Coll London, Eli Lilly, Roche Holding, Pfizer) organisations as well were IMI participants and one was not (Ruprecht Karl Univ Heidelberg). With three corporate organisations, NEWMEDS had the greatest number of non-academia organisations among the top five.
    - In the EU-AIMS network only one (Kings Coll London) organisation was an IMI participant with four (Ruprecht Karl Univ Heidelberg, Univ Toronto, Tech Univ Dresden, Univ Hamburg) non-IMI participants. All five are academia organisations.
    - In the IMIDIA network three (Imperial Coll London, Univ Geneva, Univ Pisa) organisations were IMI participants and two (Univ Sorbonne Paris Cite-USPC COMUE, Univ Oxford) were not. All five are academic organisations.

FIGURE 8.2.1 COLLABORATION NETWORK ANALYSIS: BTCURE PERIOD 1 (2009-2012)

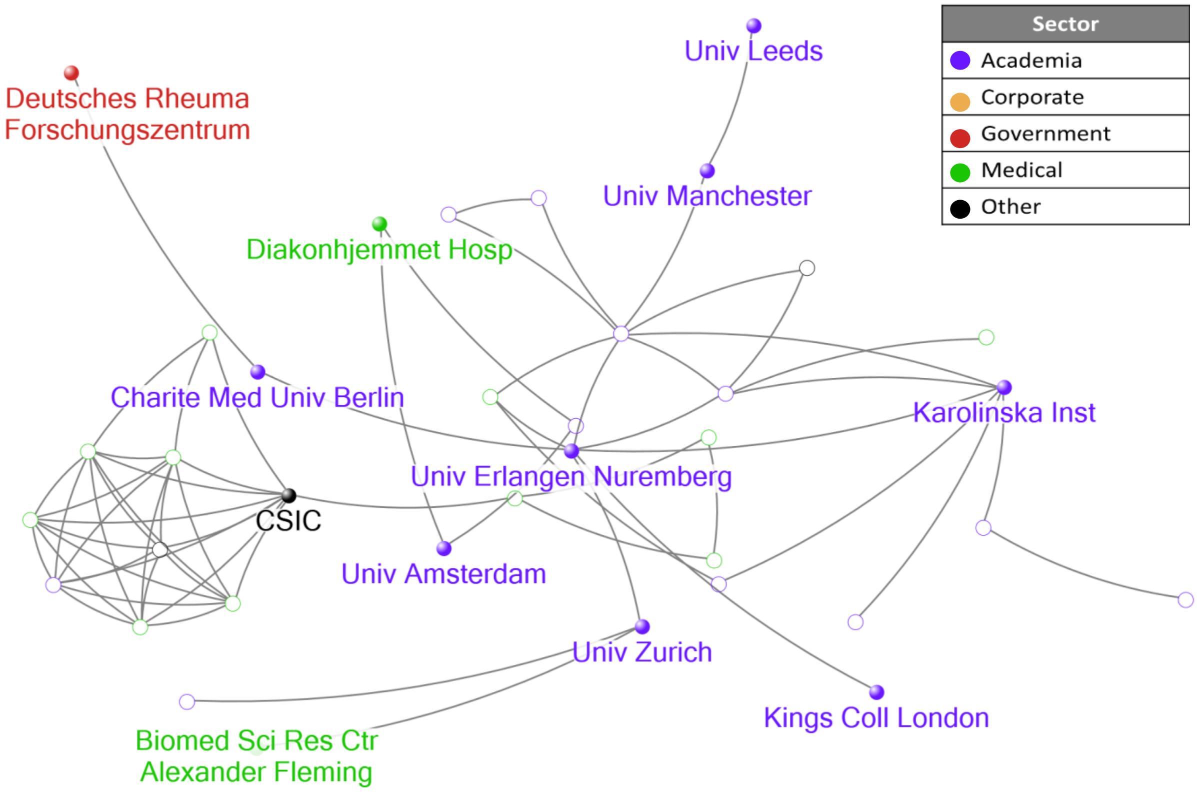


FIGURE 8.2.2 COLLABORATION NETWORK ANALYSIS: BTCURE PERIOD 2 (2013-2016)

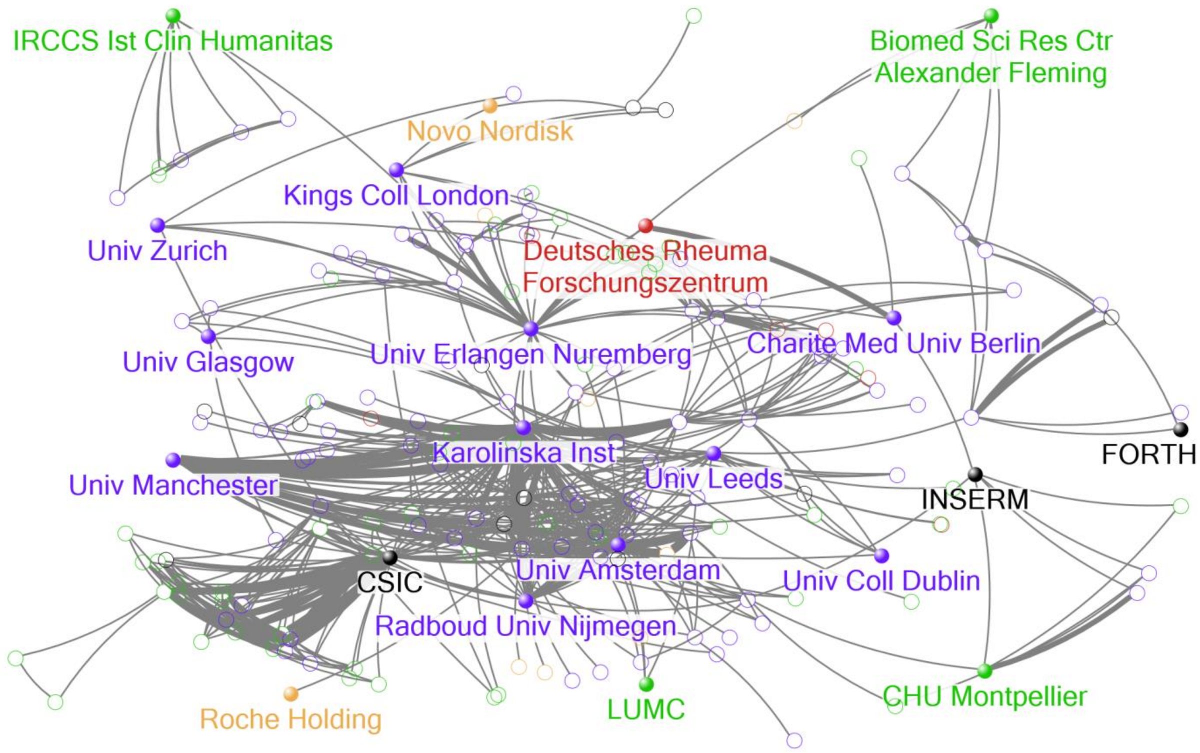


FIGURE 8.2.3 COLLABORATION NETWORK ANALYSIS: EU-AIMS PERIOD 1 (2009-2012)

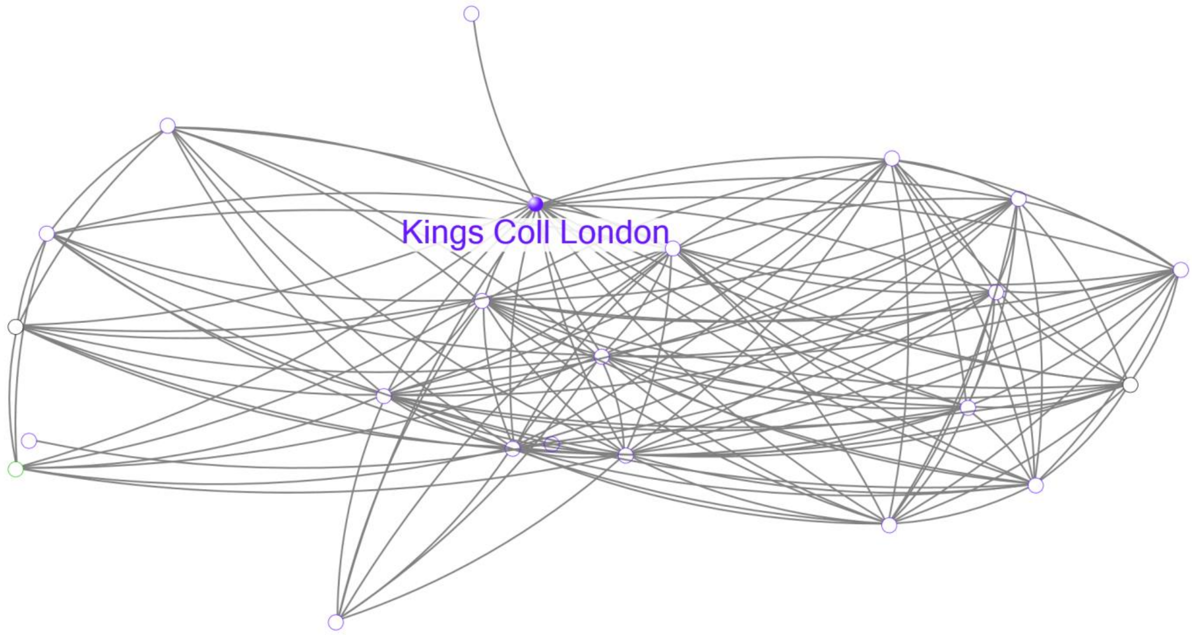


FIGURE 8.2.4 COLLABORATION NETWORK ANALYSIS: EU-AIMS PERIOD 2 (2013-2016)

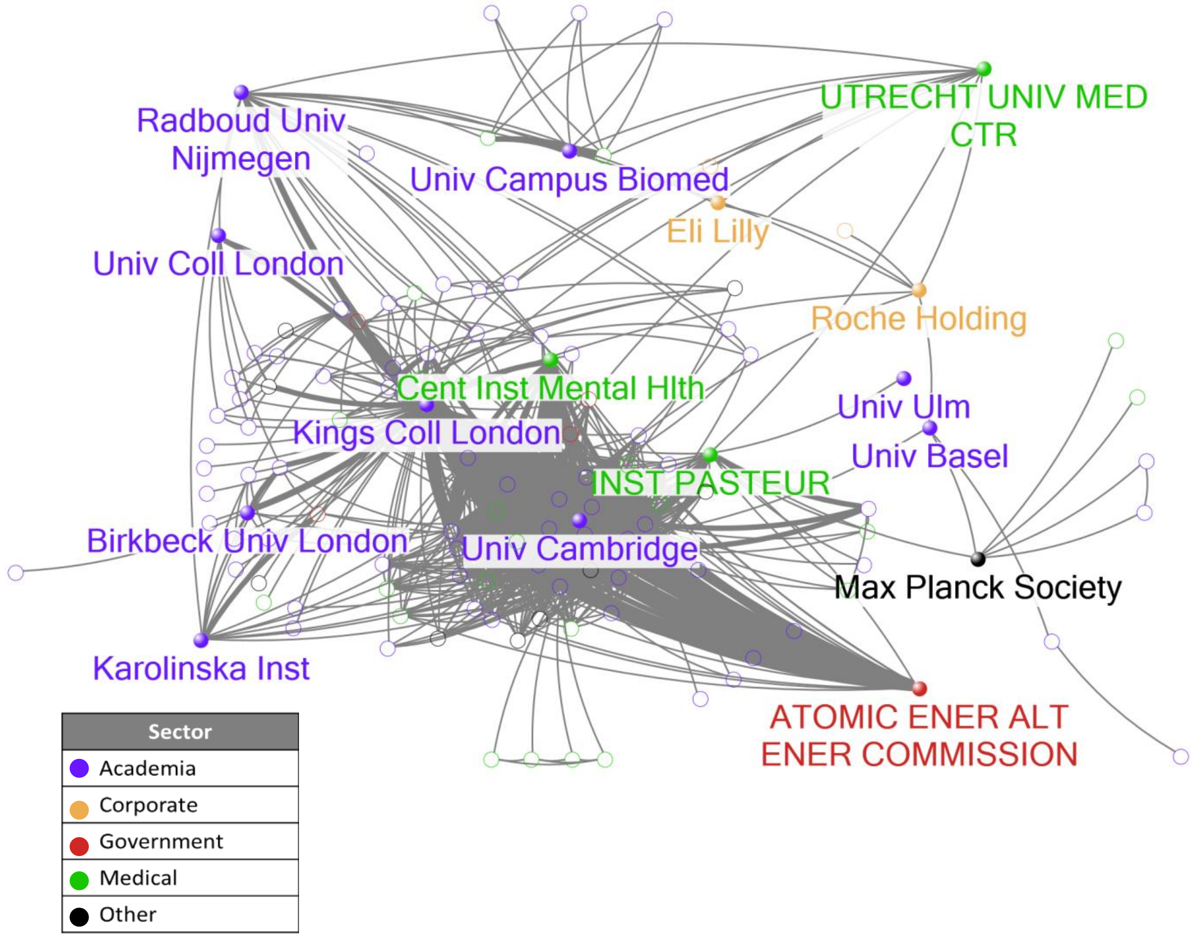


FIGURE 8.2.5 COLLABORATION NETWORK ANALYSIS: EUROPAIN PERIOD 1 (2009-2012)

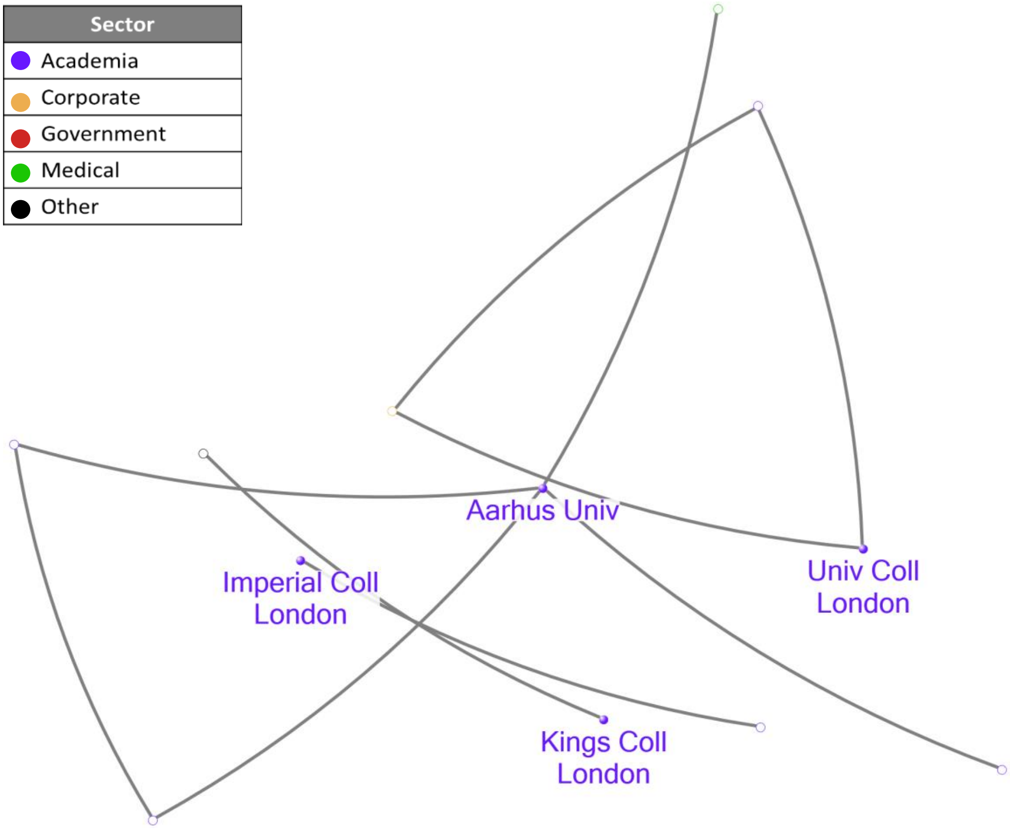


FIGURE 8.2.6 COLLABORATION NETWORK ANALYSIS: EUROPAIN PERIOD 2 (2013-2016)

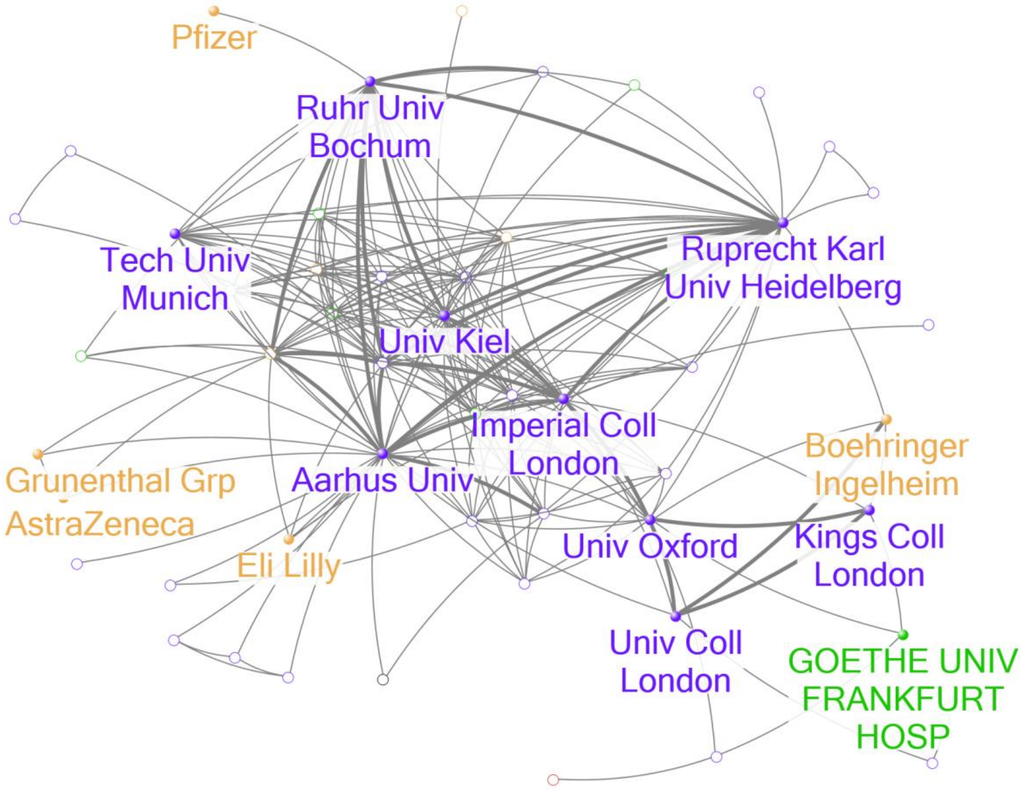


FIGURE 8.2.7 COLLABORATION NETWORK ANALYSIS: NEWMEDS PERIOD 1 (2009-2012)

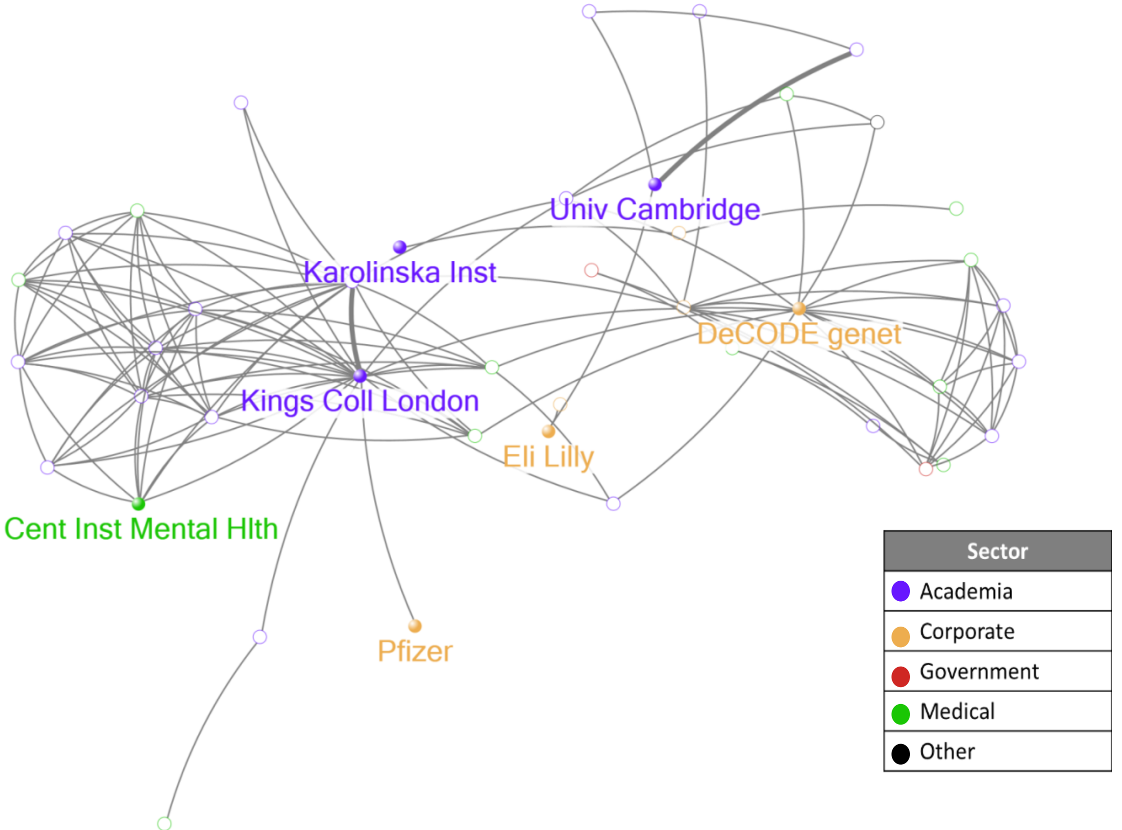


FIGURE 8.2.8 COLLABORATION NETWORK ANALYSIS: NEWMEDS PERIOD 2 (2013-2016)

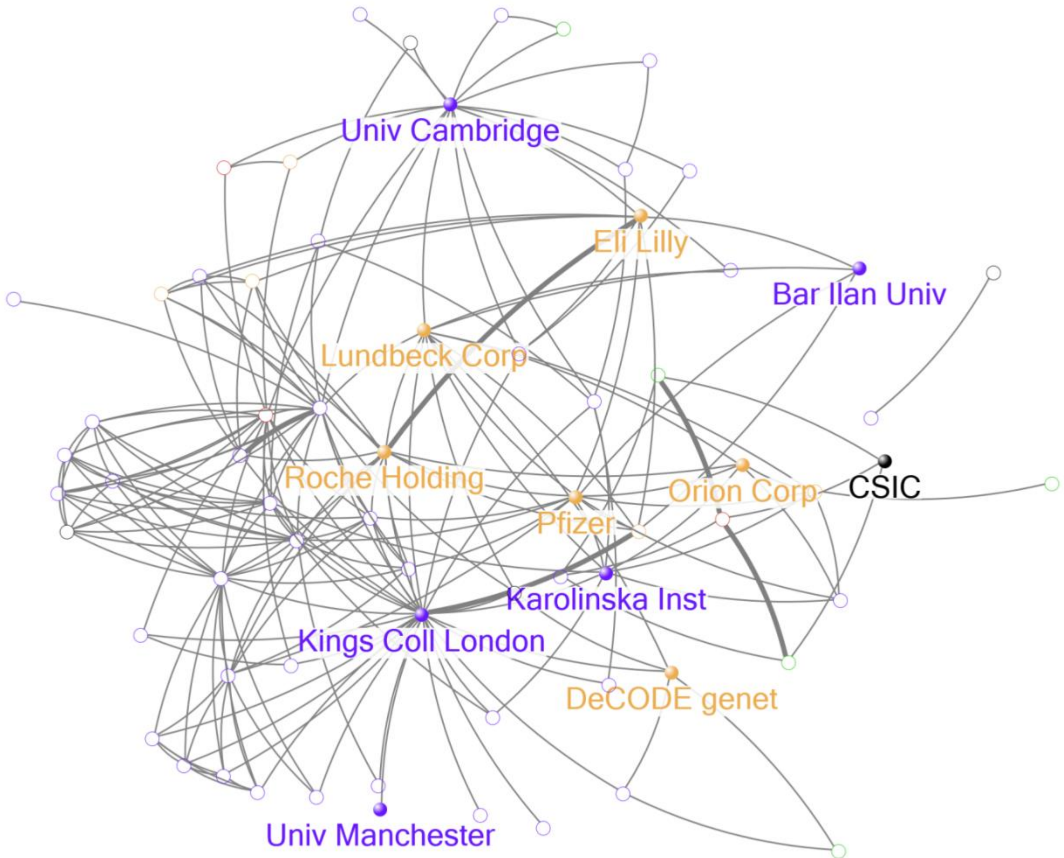


FIGURE 8.2.9 COLLABORATION NETWORK ANALYSIS: IMIDIA PERIOD 1 (2009-2012)

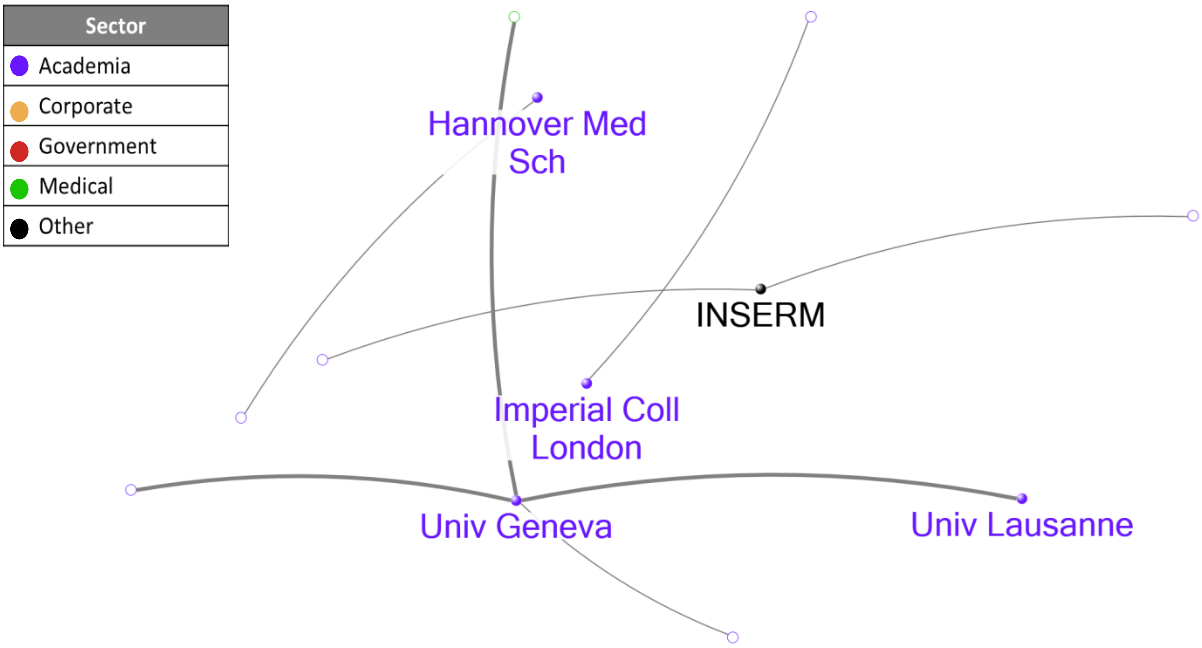
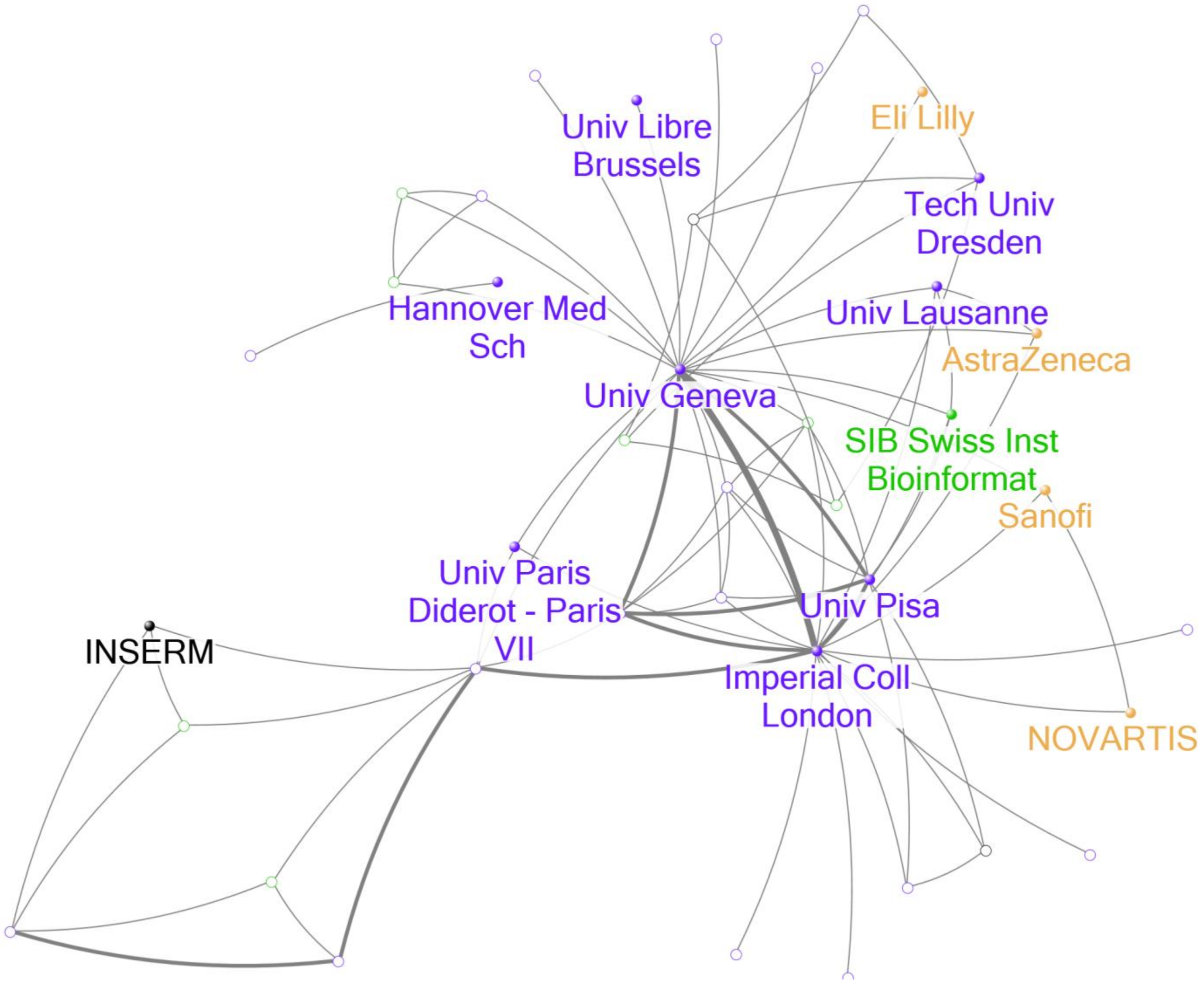


FIGURE 8.2.10 COLLABORATION NETWORK ANALYSIS: IMIDIA PERIOD 2 (2013-2016)



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 and organisations 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 32 and 17 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 (522 publications), Amsterdam (456), Stockholm (287), Copenhagen (220) and Paris (214). The largest clusters in North America are Boston (111), Toronto (99), Montreal (53), New York (48) and Bethesda (41). 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.

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 57.9% (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 organisations 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, 2010-2016

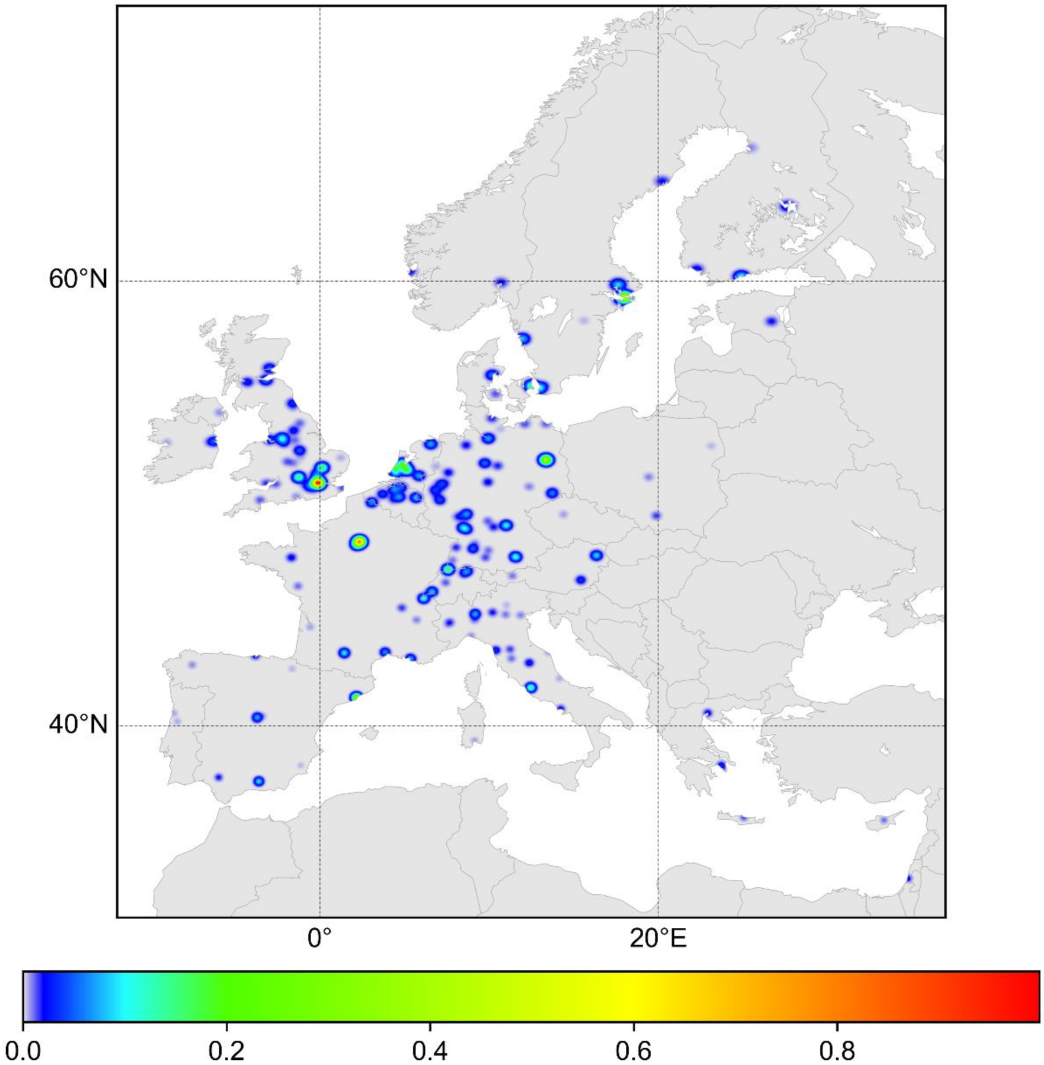


FIGURE 9.2 MAP SHOWING NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2016

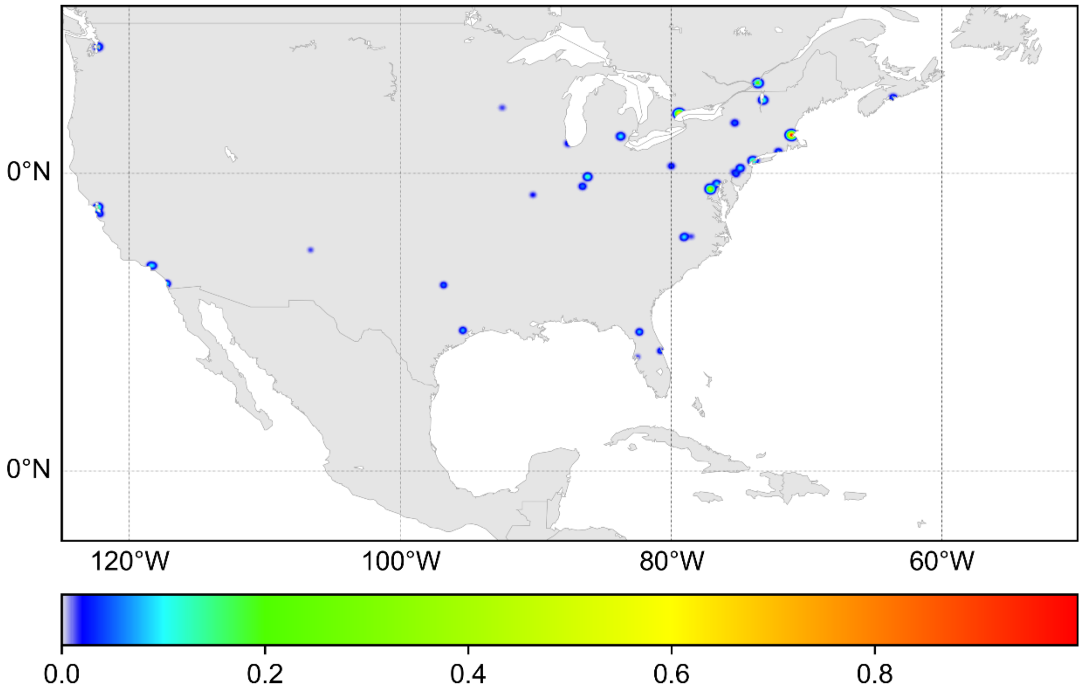


TABLE 9.1 OUTPUT AND RESEARCH PERFORMANCE OF EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2016

Cluster	Publications	Papers	Percentage publications open access	Raw Citation Impact	Percentage of internationally collaborative publications
London (UK)	522	513	15.4%	17.06	80.8%
Amsterdam (Netherlands)	456	448	12.3%	17.96	75.0%
Stockholm (Sweden)	287	283	15.5%	15.83	72.5%
Copenhagen (Denmark)	220	214	15.9%	12.25	72.7%
Paris (France)	214	207	13.5%	18.60	84.6%
Cambridge (UK)	150	149	21.5%	19.89	88.0%
Barcelona (Spain)	140	138	26.1%	13.50	67.1%
Basel (Switzerland)	134	131	16.0%	11.78	91.8%
Oxford (UK)	134	129	19.4%	15.32	81.3%
Berlin (Germany)	129	125	14.4%	15.57	71.3%
Mannheim (Germany)	120	117	9.4%	22.98	84.2%
Geneva (Switzerland)	107	106	14.2%	21.21	78.5%
Manchester (UK)	103	101	15.8%	14.95	85.4%
Erlangen (Germany)	102	102	8.8%	19.67	68.6%
Rome (Italy)	98	97	16.5%	14.56	72.4%
Uppsala (Sweden)	96	95	10.5%	10.34	71.9%
Vienna (Austria)	86	85	18.8%	11.41	68.6%
Molndal (Sweden)	84	84	13.1%	11.68	86.9%
Munich (Germany)	79	75	17.3%	19.38	78.5%
Groningen (Netherlands)	74	74	5.4%	15.09	82.4%
Maastricht (Netherlands)	73	71	18.3%	26.93	87.7%

Cluster	Publications	Papers	Percentage publications open access	Raw Citation Impact	Percentage of internationally collaborative publications
Hamburg (Germany)	72	69	14.5%	11.04	80.6%
Nijmegen (Netherlands)	67	66	19.7%	22.82	80.6%
Frankfurt (Germany)	58	56	8.9%	10.31	84.5%
Milan (Italy)	57	57	14.0%	16.33	86.0%
Helsinki (Finland)	55	55	20.0%	13.80	87.3%
Lausanne (Switzerland)	48	48	20.8%	23.83	68.8%
Antwerp (Belgium)	48	48	6.3%	7.35	70.8%
Marseille (France)	39	39	15.4%	12.90	89.7%
Madrid (Spain)	38	38	28.9%	14.87	57.9%
Toulouse (France)	38	38	21.1%	10.53	94.7%
Granada (Spain)	31	31	38.7%	18.90	61.3%

TABLE 9.2 RESEARCH PERFORMANCE OF EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH COMPARED TO NATIONAL BENCHMARKS, 2010-2016

	Field normalised citation impact		Journal normalised citation impact		Percentage of highly-cited papers	
Cluster	Cluster	National	Cluster	National	Cluster	National
London (UK)	2.28	1.48	1.31	1.11	31.0%	16.8%
Amsterdam (Netherlands)	2.59	1.58	1.39	1.14	30.8%	18.0%
Stockholm (Sweden)	2.51	1.48	1.33	1.13	29.7%	15.8%
Copenhagen (Denmark)	2.15	1.52	1.17	1.16	23.4%	16.4%
Paris (France)	2.54	1.34	1.41	1.09	30.9%	14.3%
Cambridge (UK)	2.99	1.48	1.38	1.11	34.9%	16.8%
Barcelona (Spain)	1.84	1.22	1.74	1.07	26.1%	12.9%
Basel (Switzerland)	1.78	1.65	1.54	1.19	27.5%	18.6%
Oxford (UK)	2.55	1.48	1.71	1.11	31.8%	16.8%
Berlin (Germany)	2.41	1.29	1.73	1.11	29.6%	14.2%
Mannheim (Germany)	2.85	1.29	1.19	1.11	34.2%	14.2%
Geneva (Switzerland)	2.14	1.65	1.34	1.19	30.2%	18.6%
Manchester (UK)	2.52	1.48	1.76	1.11	33.7%	16.8%
Erlangen (Germany)	2.23	1.29	1.31	1.11	29.4%	14.2%
Rome (Italy)	2.04	1.31	1.54	1.13	26.8%	14.0%
Uppsala (Sweden)	1.77	1.48	1.49	1.13	25.3%	15.8%
Vienna (Austria)	1.47	1.47	1.23	1.16	20.0%	16.2%
Molndal (Sweden)	2.55	1.48	1.89	1.13	33.3%	15.8%
Munich (Germany)	2.89	1.29	1.15	1.11	32.0%	14.2%
Groningen (Netherlands)	2.14	1.58	1.06	1.14	25.7%	18.0%
Maastricht (Netherlands)	4.03	1.58	2.45	1.14	47.9%	18.0%
Hamburg (Germany)	2.97	1.29	1.11	1.11	26.1%	14.2%
Nijmegen (Netherlands)	3.38	1.58	1.81	1.14	28.8%	18.0%
Frankfurt (Germany)	2.40	1.29	1.46	1.11	35.7%	14.2%
Milan (Italy)	2.69	1.31	1.21	1.13	31.6%	14.0%
Helsinki (Finland)	2.36	1.43	1.36	1.10	34.5%	15.0%
Lausanne (Switzerland)	2.28	1.65	1.39	1.19	31.3%	18.6%
Antwerp (Belgium)	2.40	1.62	1.54	1.22	29.2%	18.4%

Cluster	Field normalised citation impact		Journal normalised citation impact		Percentage of highly-cited papers	
	Cluster	National	Cluster	National	Cluster	National
Marseille (France)	2.06	1.34	1.14	1.09	28.2%	14.3%
Madrid (Spain)	1.98	1.22	0.73	1.07	13.2%	12.9%
Toulouse (France)	2.30	1.34	2.03	1.09	31.6%	14.3%
Granada (Spain)	2.79	1.22	1.05	1.07	25.8%	12.9%

TABLE 9.3 OUTPUT AND RESEARCH PERFORMANCE OF NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2016

Cluster	Publications	Papers	Percentage publications open access	Raw Citation Impact	Percentage of internationally collaborative publications
Boston (USA)	111	110	18.2%	34.45	99.1%
Toronto (Canada)	99	99	15.2%	18.45	90.9%
Montreal (Canada)	53	53	17.0%	15.75	100.0%
New York (USA)	48	48	6.3%	17.35	97.9%
Bethesda (USA)	41	41	12.2%	24.71	95.1%
Indianapolis (USA)	32	32	6.3%	15.06	96.9%
San Francisco (USA)	31	31	16.1%	32.61	100.0%
Burlington (USA)	31	31	9.7%	11.16	100.0%
Baltimore (USA)	29	29	10.3%	19.90	100.0%
Chapel Hill (USA)	20	19	31.6%	26.55	100.0%
La Jolla (USA)	19	19	36.8%	28.53	100.0%
Los Angeles (USA)	16	16	0.0%	55.56	93.8%
Ann Arbor (USA)	16	16	12.5%	19.19	100.0%
Titusville (USA)	15	14	7.1%	9.33	86.7%
Gainesville (USA)	13	13	7.7%	9.92	100.0%
Houston (USA)	11	11	9.1%	17.09	100.0%
Seattle (USA)	11	11	18.2%	61.00	100.0%

TABLE 9.4 RESEARCH PERFORMANCE OF NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH COMPARED TO NATIONAL BENCHMARKS, 2010-2016

Cluster	Field normalised citation impact		Journal normalised citation impact		Percentage of highly-cited papers	
	Cluster	National	Cluster	National	Cluster	National
Boston (USA)	4.29	1.33	1.87	1.05	43.6%	15.2%
Toronto (Canada)	2.89	1.41	1.26	1.09	26.3%	15.3%
Montreal (Canada)	2.06	1.41	1.25	1.09	26.4%	15.3%
New York (USA)	2.08	1.33	1.18	1.05	22.9%	15.2%
Bethesda (USA)	2.99	1.33	2.25	1.05	39.0%	15.2%
Indianapolis (USA)	2.11	1.33	1.12	1.05	21.9%	15.2%
San Francisco (USA)	6.11	1.33	1.39	1.05	51.6%	15.2%
Burlington (USA)	2.03	1.33	1.01	1.05	25.8%	15.2%
Baltimore (USA)	3.93	1.33	1.34	1.05	48.3%	15.2%
Chapel Hill (USA)	5.03	1.33	1.84	1.05	52.6%	15.2%
La Jolla (USA)	2.70	1.33	1.21	1.05	31.6%	15.2%

Cluster	Field normalised citation impact		Journal normalised citation impact		Percentage of highly-cited papers	
	Cluster	National	Cluster	National	Cluster	National
Los Angeles (USA)	3.46	1.33	0.94	1.05	31.3%	15.2%
Ann Arbor (USA)	2.17	1.33	0.80	1.05	43.8%	15.2%
Titusville (USA)	1.02	1.33	1.79	1.05	7.1%	15.2%
Gainesville (USA)	1.90	1.33	2.48	1.05	30.8%	15.2%
Houston (USA)	4.14	1.33	0.67	1.05	18.2%	15.2%
Seattle (USA)	7.07	1.33	1.98	1.05	72.7%	15.2%

TABLE 9.5 INSTITUTIONS CONSTITUTING EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2016

Cluster	Country	Institutions	Publications
London	United Kingdom	Kings College London	226
		Imperial College London	142
		University College London	115
		Eli Lilly Co	32
		Guy's & St Thomas' NHS Foundation Trust	20
		London School of Hygiene & Tropical Medicine	20
		GlaxoSmithKline	17
		Queen Mary University London	17
		Birkbeck University London	16
		South London & Maudsley NHS Trust	13
		European Medicines Agency	10
		Medicines and Healthcare products Regulatory Agency	9
		Royal Brompton & Harefield NHS Trust	7
		MRC Social, Genetic & Developmental Psychiatry Centre	6
		Royal Brompton & Harefield NHS Fdn Trust	6
		South London & Maudsley NHS Fdn	6
		University of London	5
		Lilly Research Labs	3
Amsterdam	Netherlands	Leiden University	161
		Vrije Universiteit Amsterdam	119
		Erasmus University Rotterdam	75
		Utrecht University Medical Center	72
		University of Utrecht	68
		University of Amsterdam	67
		Netherlands National Institute for Public Health & the Environment	9
		Jan van Breemen Res Inst Reade	6
Stockholm	Sweden	Karolinska Institutet	238
		Karolinska University Hospital	100
		AstraZeneca	14
		Stockholm City Council	14
		Royal Institute of Technology	12
		Stockholm University	12
Copenhagen	Denmark	University of Copenhagen	97
		Lund University	59

Cluster	Country	Institutions	Publications
		Lundbeck Corporation	30
		Technical University of Denmark	26
		Skane University Hospital	25
		Steno Diabetes Center	14
		Novo Nordisk	13
		Statens Serum Institut	5
Paris	France	Pierre & Marie Curie University - Paris 6	111
		INSERM	100
		University of Paris Descartes - Paris V	75
		University of Paris Sud - Paris XI	49
		CEA	34
		University of Paris Diderot - Paris VII	32
		Hopital Universitaire Pitie-Salpetriere - APHP	27
		Centre National de la Recherche Scientifique (CNRS)	23
		Institut Pasteur Paris	20
		Assistance Publique Hopitaux Paris (APHP)	17
		Hopital Universitaire Cochin - APHP	16
		Sanofi France	16
		Universite Paris Saclay (ComUE)	15
		Hopital Universitaire Europeen Georges-Pompidou - APHP	7
		Hopital Universitaire Necker-Enfants Malades - APHP	7
		Orsay Hosp	7
		Institut de Recherches Internationales Servier	6
		Muséum national d'Histoire naturelle	5
		Sorbonne Universites (COMUE)	5
		University of Versailles Saint-Quentin-En-Yvelines	5
		Universite Sorbonne Paris Cite-USPC (COMUE)	3
		Sanofi-Aventis	1

TABLE 9.6 INSTITUTIONS CONSTITUTING NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2016

Cluster	Country	Institutions	Publications
Boston	USA	Harvard University	95
		VA Boston Healthcare System	36
		Harvard Univ Medical Affiliates	29
		Broad Institute	21
		Pfizer	13
		Dana-Farber Cancer Institute	10
		Massachusetts General Hospital	4
		Massachusetts Institute of Technology (MIT)	1
Toronto	Canada	University of Toronto	99
		Hospital for Sick Children (SickKids)	25
		Univ Toronto Affiliates	10
		Centre for Addiction & Mental Health - Canada	5
Montreal	Canada	University of Montreal	39
		McGill University	30

Cluster	Country	Institutions	Publications
New York	USA	Pfizer	22
		Columbia University	21
		New York University	9
Bethesda	USA	NIH National Heart Lung & Blood Institute (NHLBI)	10
		AstraZeneca	6
		NIH National Cancer Institute (NCI)	5
		NIH National Institute of Mental Health (NIMH)	5

TABLE 9.7 FIVE JOURNAL SUBJECT CATEGORIES IN WHICH EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH PUBLISHED MOST FREQUENTLY, 2010-2016

Cluster	Country	Journal Subject Category	Publications
London	United Kingdom	Neurosciences	145
		Psychiatry	93
		Pharmacology & Pharmacy	70
		Clinical Neurology	67
		Biochemistry & Molecular Biology	29
Amsterdam	Netherlands	Rheumatology	91
		Pharmacology & Pharmacy	71
		Neurosciences	40
		Immunology	37
		Public, Environmental & Occupational Health	33
Copenhagen	Denmark	Endocrinology & Metabolism	33
		Pharmacology & Pharmacy	33
		Anesthesiology	30
		Neurosciences	30
		Clinical Neurology	26
Stockholm	Sweden	Rheumatology	69
		Immunology	36
		Neurosciences	36
		Clinical Neurology	29
		Pharmacology & Pharmacy	20
Paris	France	Neurosciences	50
		Pharmacology & Pharmacy	25
		Psychiatry	23
		Biochemistry & Molecular Biology	15
		Endocrinology & Metabolism	15

TABLE 9.8 FIVE JOURNAL SUBJECT CATEGORIES IN WHICH NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH PUBLISHED MOST FREQUENTLY, 2010-2016

Cluster	Country	Journal Subject Category	Publications
Boston	USA	Genetics & Heredity	17
		Neurosciences	15
		Rheumatology	13
		Endocrinology & Metabolism	12
		Clinical Neurology	11
Toronto	Canada	Neurosciences	24
		Psychiatry	24
		Biochemistry & Molecular Biology	19
		Genetics & Heredity	12
		Chemistry, Medicinal	10
Montreal	Canada	Neurosciences	20
		Psychiatry	20
		Biochemistry & Molecular Biology	6
		Psychology	6
		Psychology, Developmental	6
New York	USA	Pharmacology & Pharmacy	24
		Public, Environmental & Occupational Health	13
		Neurosciences	10
		Toxicology	10
		Psychiatry	8
Bethesda	USA	Pharmacology & Pharmacy	16
		Public, Environmental & Occupational Health	14
		Toxicology	14
		Immunology	7
		Genetics & Heredity	5

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).[18]

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 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.

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

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.

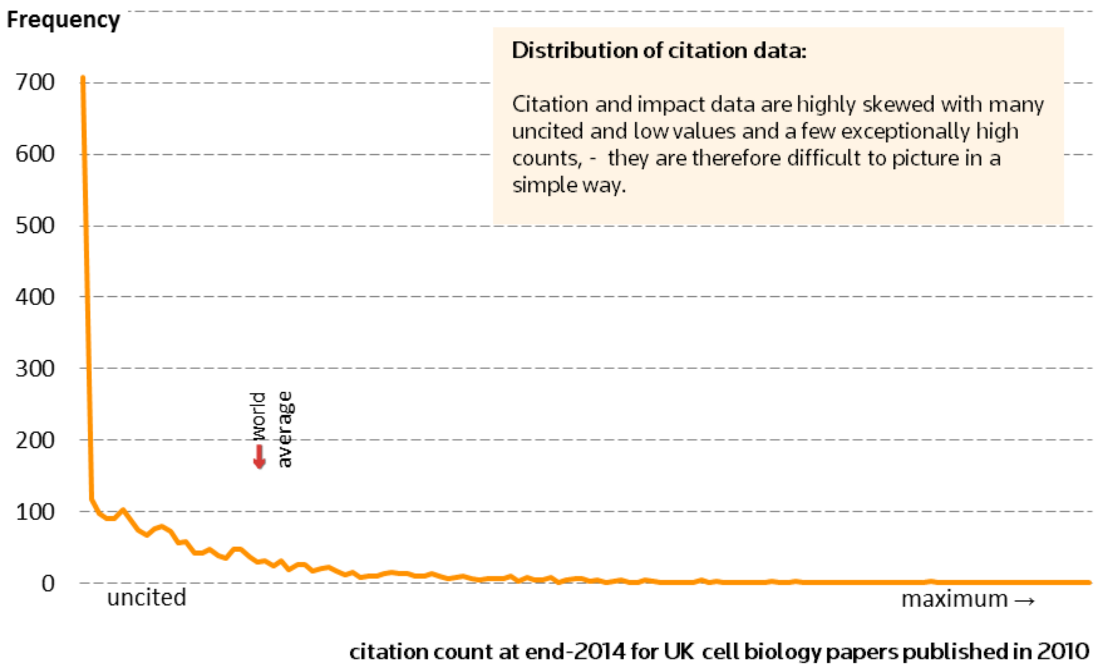
Citation counts

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.

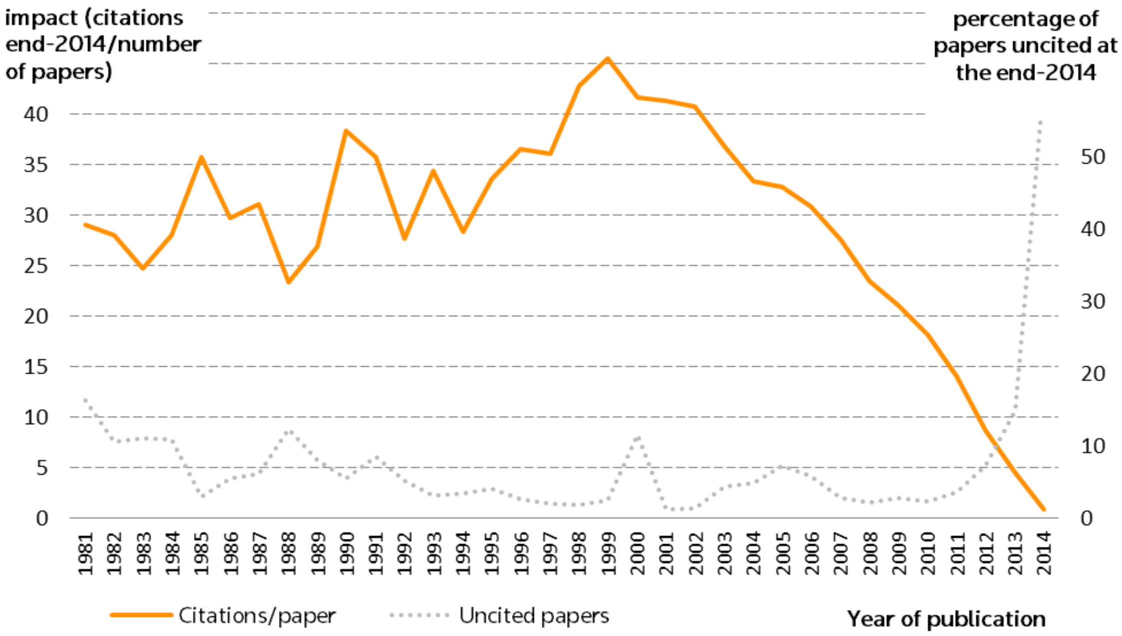
We do not seek to account separately for the effect of self-citation. If the citation count is significantly affected by self-citation then the paper is likely to have been infrequently cited. This is therefore only of consequence for low impact activity. Studies show that for large samples at national 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

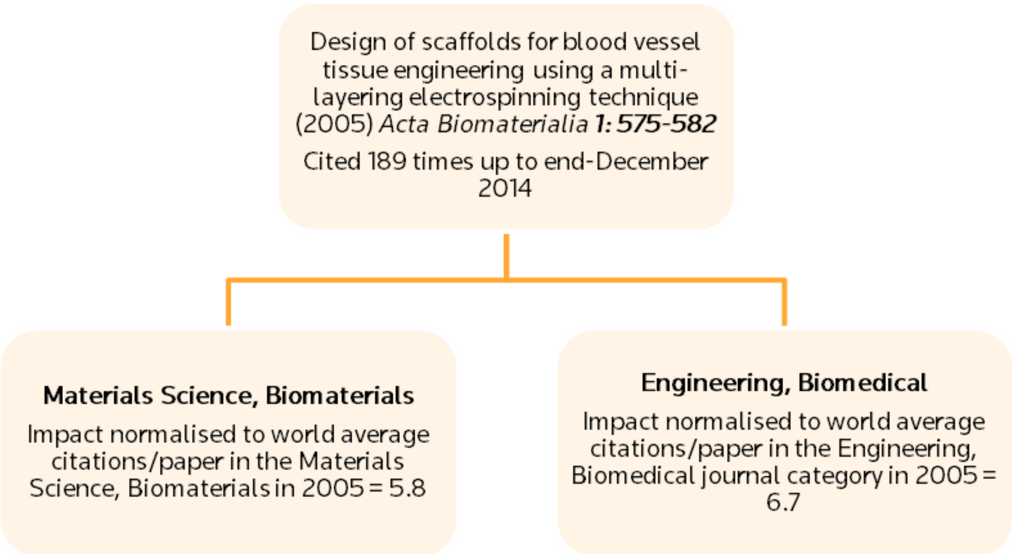
Multidisciplinary journals are now re-assigned to more specific research fields using an algorithm based on the research area(s) of the references cited by the article.

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[19] 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.

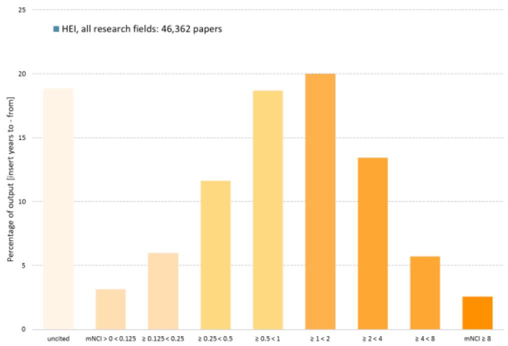
Papers which are "highly-cited" are often defined in our reports as those with an average citation impact (NCI_F) greater than or equal to 4.0, i.e. those papers which have received greater than or equal to four times the world average number of citations for papers in that subject published in that 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.

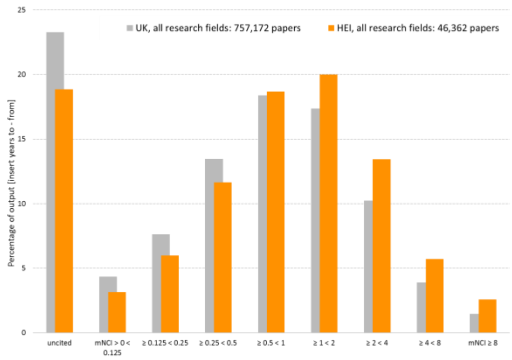
[19] Adams J, Gurney K & Marshall S (2007) Profiling citation impact: A new methodology. *Scientometrics* **72**: 325-344.

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

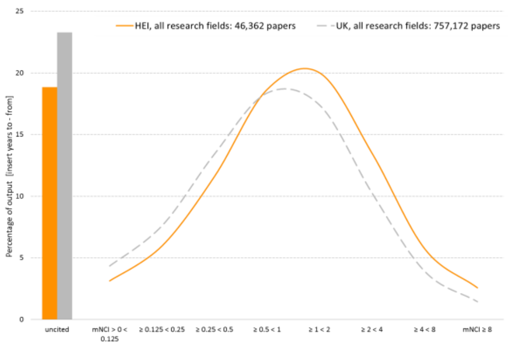
A



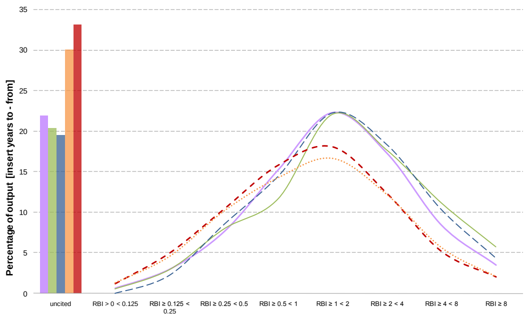
B



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	IntlScore	Metric 3	Collaboration Index	Total Project publications	Citation impact (normalised at field level)
BTCURE	0.64	0.49	1.02	2.15	461	2.24
EU-AIMS	0.65	0.63	3.26	4.54	199	2.51
NEWMEDS	0.65	0.56	1.66	2.87	157	2.36
EUROPAIN	0.38	0.34	1.06	1.78	147	2.85
IMIDIA	0.54	0.46	1.26	2.25	112	1.91
EMIF	0.80	0.63	2.13	3.55	109	2.60
PROTECT	0.98	0.64	1.46	3.08	90	1.27
SUMMIT	0.64	0.58	2.51	3.73	81	1.79
CHEM21	0.22	0.24	0.10	0.56	77	4.31
eTOX	0.50	0.37	0.67	1.54	72	1.78
ORBITO	0.58	0.49	0.40	1.47	67	1.83
Open PHACTS	0.73	0.61	1.11	2.45	64	2.28
QUIC-CONCEPT	0.71	0.58	1.13	2.42	63	2.69
TRANSLOCATION	0.44	0.50	0.48	1.42	62	1.85
PHARMA-COG	0.87	0.73	1.31	2.91	55	1.76
PreDiCT-TB	0.64	0.49	0.85	1.98	53	1.75
MIP-DILI	0.69	0.42	0.75	1.86	52	1.97
ELF	0.48	0.51	0.38	1.38	52	1.27
ULTRA-DD	0.49	0.55	0.98	2.02	51	2.13
DDMoRe	0.70	0.49	1.13	2.32	47	0.72
MARCAR	0.46	0.37	0.43	1.26	46	1.77
StemBANCC	0.62	0.43	0.71	1.76	45	2.36
U-BIOPRED	0.64	0.54	1.91	3.09	45	2.76
Onco Track	0.68	0.29	1.09	2.06	44	3.04
ABIRISK	0.72	0.36	1.72	2.80	43	2.37
BioVacSafe	0.74	0.44	0.92	2.10	39	1.70
CANCER-ID	0.71	0.45	0.83	1.99	35	4.65
Compact	0.24	0.37	0.82	1.43	33	3.85
RAPP-ID	0.53	0.41	0.40	1.34	30	1.01
COMBACTE	0.73	0.37	1.00	2.10	26	1.03
PREDECT	0.65	0.54	0.69	1.88	26	2.04
K4DD	0.50	0.42	0.75	1.67	24	1.66
PRO-active	1.00	0.76	1.82	3.58	22	2.19
DIRECT	0.76	0.63	1.62	3.01	21	3.36
AETIONOMY	0.78	0.44	2.33	3.56	18	1.31
eTRIKS	0.67	0.89	2.72	4.28	18	2.82
PRECISESADS	0.94	0.66	2.00	3.60	17	1.68
SPRINTT	0.41	0.38	0.71	1.50	17	2.08
ND4BB	0.63	0.58	1.25	2.45	16	2.46
EHR4CR	0.86	0.61	2.86	4.32	14	1.75

Project	X-sector Score	IntlScore	Metric 3	Collaboration Index	Total Project publications	Citation impact (normalised at field level)
SAFE-T	1.00	0.48	1.17	2.65	12	1.38
FLUCOP	0.91	0.57	0.18	1.66	11	0.79
DRIVE-AB	0.67	0.58	0.89	2.14	9	3.25
ENABLE	0.44	0.00	0.56	0.00	9	1.53
GetReal	0.89	0.78	2.00	3.67	9	0.92
ZAPI	1.00	0.81	0.75	2.56	8	4.98
EBOVAC1	0.43	0.00	1.14	0.00	7	1.25
COMBACTE-CARE	1.00	0.00	2.40	0.00	5	0.26
iPiE	1.00	0.00	0.80	0.00	5	1.14
EMI	0.75	0.63	3.50	4.88	4	0.00
APPROACH	0.25	0.94	0.50	1.69	4	1.20
EPAD	0.75	0.94	1.50	3.19	4	1.34
SafeSciMET	0.75	0.00	1.25	0.00	4	1.53
EBiSC	0.75	0.69	1.50	2.94	4	0.84
iABC	0.67	0.58	1.00	2.25	3	1.71
COMBACTE-MAGNET	0.67	0.00	5.00	0.00	3	0.00
EUCLID	0.67	0.00	1.33	0.00	3	0.73
ADAPT-SMART	1.00	0.00	1.50	0.00	2	0.84
WEB-RADR	0.50	0.00	0.00	0.00	2	0.68
VSV-EBOVAC	0.50	0.00	0.50	0.00	2	0.57
ADVANCE	0.50	0.00	0.00	0.00	2	3.75
INNODIA	0.50	0.00	0.50	0.00	2	0.48
EUPATI	1.00	0.00	1.00	0.00	2	1.42
COMBACTE-NET	1.00	0.00	1.00	0.00	1	0.00
RHAPSODY	0.00	0.00	1.00	0.00	1	0.00
PHARMATRAIN	1.00	0.00	1.00	0.00	1	0.00
Eu2P	0.00	0.00	1.00	0.00	1	0.00
EbolaMoDRAD	1.00	0.00	1.00	0.00	1	0.00
RADAR-CNS	1.00	0.00	1.00	0.00	1	0.00

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). 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: Russo, Mariangela et al. (2016) Tumor Heterogeneity and Lesion-Specific Response to Targeted Therapy in Colorectal Cancer, CANCER DISCOVERY 6 (2): 147-153, DOI: 10.1158/2159-8290.CD-15-1283
- DIRECT: Pedersen, Helle Krogh et al. (2016) Human gut microbes impact host serum metabolome and insulin sensitivity, NATURE 535 (7612): 376-+, DOI: 10.1038/nature18646
- EU-AIMS: Bourgeron, Thomas (2015) From the genetic architecture to synaptic plasticity in autism spectrum disorder, NATURE REVIEWS NEUROSCIENCE 16 (9): 551-563, DOI: 10.1038/nrn3992
- EU-AIMS: Ecker, Christine et al. (2015) Neuroimaging in autism spectrum disorder: brain structure and function across the lifespan, LANCET NEUROLOGY 14 (11): 1121-1134, DOI: 10.1016/S1474-4422(15)00050-2

HIGHLY-CITED PAPERS ASSOCIATED WITH IMI PROJECTS

- ABIRISK: Chemin, Karine et al. (2016) A Novel HLA-DRB1*10:01-Restricted T Cell Epitope From Citrullinated Type II Collagen Relevant to Rheumatoid Arthritis, ARTHRITIS & RHEUMATOLOGY 68 (5): 1124-1135, DOI: 10.1002/art.39553
- ABIRISK: Hemmer, Bernhard et al. (2015) Role of the innate and adaptive immune responses in the course of multiple sclerosis, LANCET NEUROLOGY 14 (4): 406-419
- ABIRISK: Kieseier, Bernd C. et al. (2013) Disease Amelioration With Tocilizumab in a Treatment-Resistant Patient With Neuromyelitis Optica Implication for Cellular Immune Responses, JAMA NEUROLOGY 70 (3): 390-393, DOI: 10.1001/jamaneurol.2013.668
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- ABIRISK: Warnke, Clemens et al. (2015) Natalizumab exerts a suppressive effect on surrogates of B cell function in blood and CSF, MULTIPLE SCLEROSIS JOURNAL 21 (8): 1036-1044, DOI: 10.1177/1352458514556296
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