Bibliometric analysis of ongoing projects

7th 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 2015, using citations as an index of research quality and co-authorship as an index of collaboration. This is the seventh 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 1 678 publications which have been matched to the Thomson Reuters Web of Science™. This represents a 48% increase from the 1 134 publications matched to the Web of Science in Report 6, which included IMI project research published between 2009 and 2014.

Around three quarters of IMI project research (73.6%) 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 6.00. 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 (1.93) was almost twice the world average (1.00), which indicates the research was internationally influential. Between 2009 and 2015, the citation impact for IMI project papers (1.93) was nearly twice the EU's citation impact (1.1) in similar fields (journal categories). Around 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 287 publications as of this report. This is a 35.4% increase from the 212 publications attributed to BTCure in Report 6. Among more recent projects, EU-AIMS (Call 3) has shown substantial growth (67.1%) in output, from 73 publications in Report 6 to 122 publications in this report, and its research was cited more than two times the world average (2.65).

Projects funded by IMI were highly collaborative. Almost 60% of all IMI publications were cross-sector (for example, between academic institutions and the pharmaceutical industry). Collaborative IMI project research was internationally influential, with a citation impact well above twice the world average. IMI collaborative research also had a higher citation impact when compared to non-collaborative IMI project research. The majority of internationally collaborative papers from the top five projects, ranked by publication output, were co-authored with researchers from North America and Europe.

Even though IMI is a 'young' funding agency, its performance is on par with the well-established funding bodies such as the Medical Research Council (MRC) and the Wellcome Trust, as indicated by IMI's citation impact (1.93), and percentage of highly-cited papers (23.5%).

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

Summary of key findings – IMI project research

Since its first call for proposals in 2008, IMI has funded a total of 73 projects from a total of 20 funding calls. Of the calls, 11 were from IMI's first phase, which ran from 2008 to 2013, and 9 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 1 678 unique Web of Science publications (Figure 4.1.1). IMI project research continues to show substantial growth, with research publication count increasing every year between 2009 and 2015 (Figure 4.3.1).
- More IMI project publications appeared in *PLOS ONE* than in other journals (83 publications), followed by *Annals of the Rheumatic Diseases* (50 publications). The 50 publications from *Annals of the Rheumatic Diseases* were exclusively 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 55.87. IMI project research published five publications in *Nature*, which has a Journal Impact Factor of 41.46 (Table 4.4.2).
- IMI project research was most frequently published in Neurosciences journals (Figure 4.5.1). Of the 262 papers published in this field, 26% were highly-cited, 9.9% appeared in open access journals, and the average citation impact of these papers was two-times the world average for the field to which they relate (Table 4.5.3).
- IMI project research had a higher citation impact than the European (EU-28) average across all of the ten journal subject categories to which most IMI publications are assigned (Table 4.6.1).
- Nearly a quarter (23.5%) 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 almost twice the world average (1.93) between 2009 and 2015. 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 158 publications, before falling from 2014. Since the first year of project publication, the number of publications for Calls 2, 3 and 4 has increased annually, except for a slightly drop for Call 2 in 2015 (Figure 5.1.1).
- Research associated with three of the projects in Call 1 (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 (58.5%) of IMI project papers were published by co-authors affiliated with more than one sector. More than three-quarters (75.9%) of IMI project papers involved collaboration between institutions. And more than half (53.3%) of all IMI project papers were internationally collaborative (Table 6.1.1).
- BTCure had the most cross-sector collaborative papers, 178 out of 283 (54.4%), as well as the most internationally collaborative papers (154 out of 282) (Table 6.2.1-6.2.3).
- IMI's research output grew faster (2805.3%) between 2010 and 2015 than any of the seven selected comparators (Table 7.2.1.2).
- In 2012 and 2014, IMI had the highest citation impact (2.31 and 2.23 respectively) of the organisations analysed (Table 7.2.2.1).

2 INTRODUCTION

2.1 OVERVIEW

The Innovative Medicines Initiative Joint Undertaking (IMI) has commissioned Thomson Reuters 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 seventh 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 seventh evaluation.

2.2 INNOVATIVE MEDICINES INITIATIVE JOINT UNDERTAKING (IMI)

The Innovative Medicines Initiative (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 European Union 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 another nine Calls for proposals under its second phase. The first Funding Call was announced in 2008 and the latest, was launched on 27 April 2016. This report covers the research output (publications and papers) of a total of 47 projects from Calls 1 to 10 of the first IMI phase.

2.3 THOMSON REUTERS

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Thomson Reuters 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. Visit our WEBPAGE for more information.

Thomson Reuters Research Data & Services team provides reporting and consultancy services within Research Analytics using customized 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.

Our consultants have up to 20 years of experience in research performance analysis and interpretation. In addition, the Thomson Reuters regional Sales team will provide effective project management and on-site support to maximize values of our projects and meet the expectations of IMI.

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, Grand Challenges in Global Health, Indian Council of Medical Research, Medical Research Council (MRC), and the Wellcome Trust.
- Section 8 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 Thomson Reuters 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 this evaluation, bibliometric data will be sourced from databases underlying the Thomson Reuters 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 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 Thomson Reuters 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 12 000 of the highest impact journals worldwide, including Open Access journals and over 150 000 conference proceedings.

[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 UK. (*Adams J, et al.)* 48pp.

Coverage is 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] Thomson Reuters 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: Thomson Reuters 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 Thomson Reuters, 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 field-normalised citation impact (nci_F) of all papers within that dataset.

Web of Science journal categories or Thomson Reuters 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 the Intellectual Property & Science business of Thomson Reuters).

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 the paper on page 65 which has been cited 189 times to the end of December 2014, the expected citation rate for a paper in Acta Biomaterialia published in 2005 would be 49.57 and the nci_J would be 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 64 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 PUBLICATIONS 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 Thomson Reuters Web of Science up to December 2015. The census point for inclusion of publications into the sixth report was December 2014. 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 2015.

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 Thomson Reuters citation data is outlined in Figure 4.1.1.

The IMI project dataset started with 1 122 publications which were previously identified by IMI. Separately, 731 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 1 853 unique publication records associated with IMI-supported projects. Of these 1 853 publications that were matched to the databases underlying the Thomson Reuters Web of Science, 99 were eliminated since they were published in 2016, and 76 were excluded by IMI because they were not IMI publications. Therefore, 1 678 Web of Science publications remained.

The aggregated list of publications was reviewed by Thomson Reuters and supplied to IMI for validation prior to inclusion in the analyses. Of the identified records, 26 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 Thomson Reuters Web of Science and were extracted at the end of 2015. Normalised bibliometric indicators were calculated using standard methodology and the Thomson Reuters National Science Indicators (NSI) database for 2015.

FIGURE 4.1.1 IDENTIFYING PUBLICATIONS FROM IMI-SUPPORTED PROJECTS WITH THOMSON REUTERS CITATION DATA

IMI-identified publications

- There were 1 122 publications previously idenfitied as IMI publications.

Web of Science

- 731 publications were identified as IMI-associated through Web of Science funding text, with no time period restriction
- The combination of the previously identified publications and those identified for this report, led to 1 853 unique records in IMI dataset overall

Publications (total)

- 1 853 were matched in Thomson Reuters database
- 99 records are not used because they were published in 2016
- IMI reviewed and removed another 76 non-IMI publications

IMI project dataset

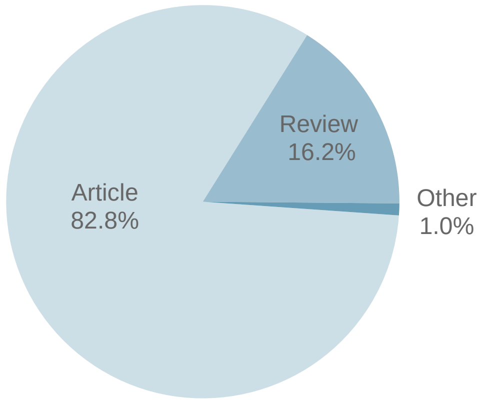
- 1 678 unique Web of Science publications linked to Thomson Reuters citation databases; all publications were published before end-2015 and so have 2015 citation data
- 1 661 papers (articles and reviews; 99%); 17 other document types (13 editorials, 2 meeting abstracts, 1 letter, and 1 news-item; 1.0%)

4.2 SHARE OF PAPERS RELATIVE TO OTHER PUBLICATION TYPES

FIGURE 4.1.1 CATEGORISATION OF IMI PROJECT RESEARCH BY DOCUMENT TYPE

Figure 4.1.1 shows the share of papers (articles and reviews) relative to other document types, for all Web of Science publications from IMI-associated projects. Papers are the subset of publications for which citation data are most informative and which are used in calculations of normalised citation impact.

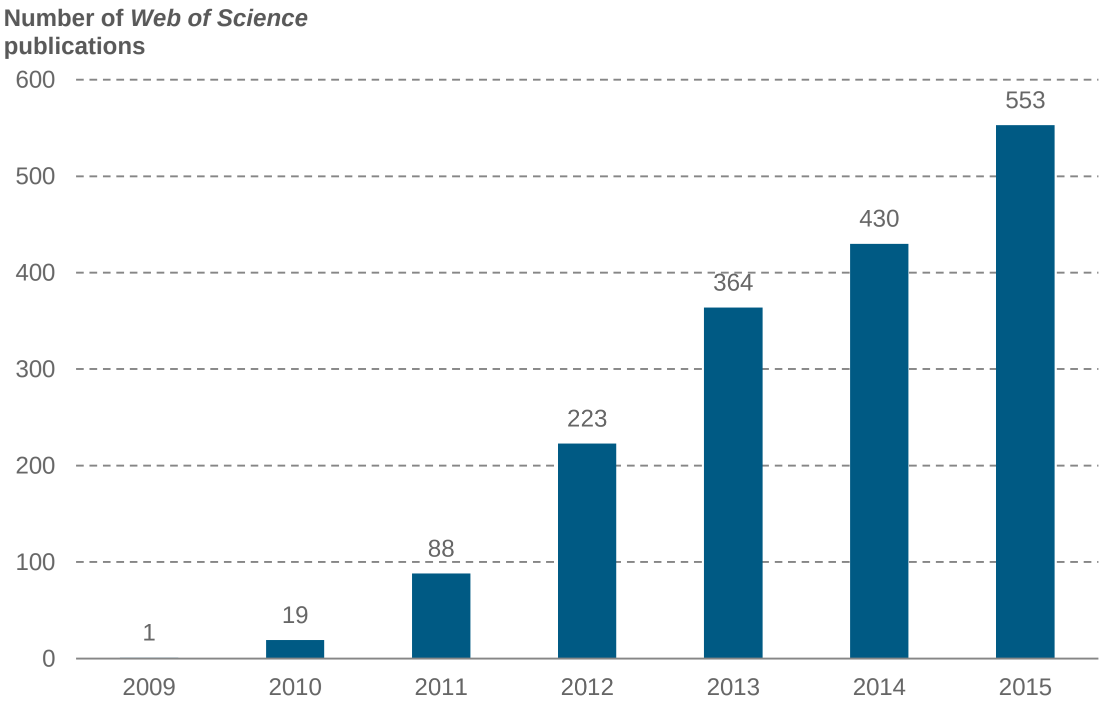
IMI project research comprised 1 678 unique Web of Science publications. Of these publications 99% were substantive articles and reviews with only seventeen documents not falling into this grouping. These documents (classified as 'Other') comprised nine editorials, two meeting abstracts, one letter, and one news item.



4.3 TRENDS IN PUBLICATION OUTPUT

Figure 4.3.1 shows the annual number of Web of Science publications arising from IMI projects between 2009 and 2015.

FIGURE 4.3.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS FOR IMI PROJECTS BY YEAR, 2009-2015

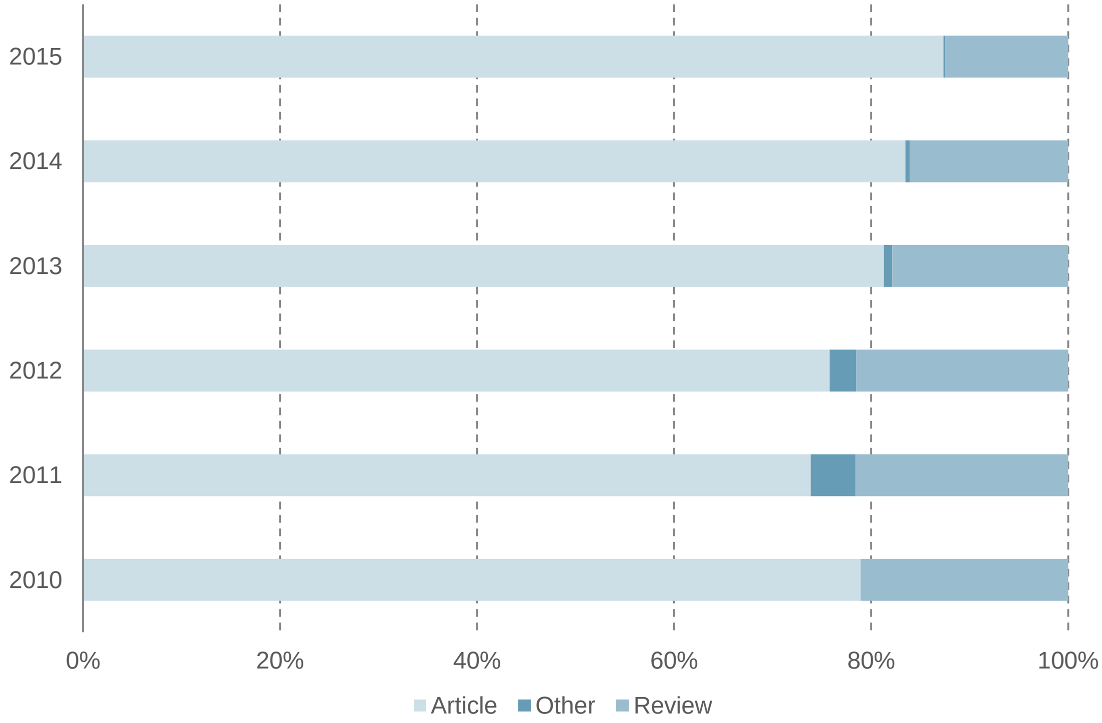


IMI project research continued to show substantial growth with publication count increasing every year between 2009 and 2015:

- The percentage change in the output of IMI project-supported publications between 2014 and 2015 was 28.6%, and the percentage change of publications between 2013 and 2015 was 51.9%.
- IMI projects produced more than 550 publications in 2015 (553 in total) and growth looks set to continue.

Figure 4.3.2 shows the proportion of papers (articles and reviews) relative to other document types for IMI project research between 2010 and 2015.[4]

FIGURE 4.3.2 CATEGORISATION OF WEB OF SCIENCE PUBLICATIONS FOR IMI PROJECTS BY YEAR AND DOCUMENT TYPE, 2010-2015



- IMI project research continued to generate a high proportion of papers relative to other document types. Articles accounted for nearly 80% of all publications, every year between 2010 and 2015. Review papers were approximately 20% of publications between 2010 and 2012, but began to decrease to 17.9% in 2013 and further to 12.5% in 2015.

[4] 2009 publications comprise a single meeting abstract – this has been omitted from Figure 4.3.2 for clarity.

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 2009 and 2015, are listed in Table 4.4.1. Together, the 20 most frequently used journals cover 451 Web of Science publications - more than one-quarter (26.9%) of the total number of publications in the dataset.

IMI project publications appeared most frequently in *PLOS ONE* (83 publications), followed by *Annals of the Rheumatic Diseases* (50 publications). The publications from *Annals of the Rheumatic Diseases* were exclusively from the Call 2 project BTCure.

There was a strong focus on Rheumatology, as four of the top ten journals fall into that category, including *Annals of the Rheumatic Diseases* However, the top 20 journals for IMI projects highlight the diversity of IMI-supported research. There are multidisciplinary titles (such as *PLOS ONE*, *PNAS*), as well as specialised titles in other disease areas such as diabetes (such as *Diabetologia*, *Diabetes*).

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 fourth quartile.

IMI project publications were published in a total of 604 journals, of which 393 were ranked in the top quartile (by Journal Impact Factor) of journals in their specific journal category. A total of 1 235 publications (73.6% of IMI project publications) were published in these well regarded journals. The average Journal Impact Factor of all IMI project publications is 6.00.

The journal with the highest Impact Factor in which IMI project research was published is the *New England Journal of Medicine*, with a journal impact factor of 55.87. IMI projects published five publications in *Nature*, which had a Journal Impact Factor of 41.46.

The 11 open access journals appearing most frequently (ranked by number of publications) in the IMI project publications dataset, 2009-2015, are listed in Table 4.4.3. Of the top 11 open access journals in which IMI project research published most frequently, *Nature Communications*had the highest impact factor (11.47). *PLOS ONE* is the open access journal with the highest number of IMI publications (83).

TABLE 4.4.1 JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 20 RANKED BY NUMBER OF WEB OF SCIENCE PUBLICATIONS, 2009-2015

Journal	Number of Web of Science Publications	Number of Papers	Journal Impact Factor (2014)	Web of Science Journal Categories
PLOS ONE	83	83	3.234	Multidisciplinary Sciences
Annals Of The Rheumatic Diseases	50	49	10.377	Rheumatology
Psychopharmacology	39	39	3.875	Neurosciences Pharmacology & Pharmacy Psychiatry
Arthritis Research & Therapy	31	31	3.753	Rheumatology
Pain	28	28	5.213	Anesthesiology Clinical Neurology Neurosciences
Drug Safety	21	21	2.824	Pharmacology & Pharmacy Public, Environmental & Occupational Health Toxicology
Arthritis and Rheumatism	20	19	7.764	Rheumatology
Diabetologia	17	17	6.671	Endocrinology & Metabolism
Proceedings of the National Academy of Sciences of The United States of America	16	16	9.674	Multidisciplinary Sciences
Molecular Informatics	15	15	1.647	Chemistry, Medicinal Computer Science, Interdisciplinary Applications Mathematical & Computational Biology
Arthritis & Rheumatology	15	15	N/A	Rheumatology
Bioorganic & Medicinal Chemistry	14	14	2.793	Biochemistry & Molecular Biology Chemistry, Medicinal Chemistry, Organic
European Journal of Pharmaceutical Sciences	14	13	3.35	Pharmacology & Pharmacy
Journal of Alzheimers Disease	14	14	4.151	Neurosciences
Toxicological Sciences	14	14	3.854	Toxicology
Diabetes	13	13	8.095	Endocrinology & Metabolism
European Journal of Immunology	12	11	4.034	Immunology
European Neuropsychopharmacology	12	12	4.369	Clinical Neurology Neurosciences Pharmacology & Pharmacy Psychiatry
Neuroimage	12	12	6.357	Neuroimaging Neurosciences Radiology, Nuclear Medicine & Medical Imaging
Pharmacoepidemiology and Drug Safety	11	11	2.939	Pharmacology & Pharmacy

TABLE 4.4.2 JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 20 RANKED BY JOURNAL IMPACT FACTOR, 2009-2015

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	55.873	Medicine, General & Internal
Lancet	2	2	45.217	Medicine, General & Internal
Nature Reviews Drug Discovery	2	0	41.908	Biotechnology & Applied Microbiology Pharmacology & Pharmacy
Nature Biotechnology	1	0	41.514	Biotechnology & Applied Microbiology
Nature	5	5	41.456	Multidisciplinary Sciences
Nature Reviews Cancer	1	1	37.4	Oncology
Nature Reviews Genetics	1	1	36.978	Genetics & Heredity
JAMA-Journal of The American Medical Association	4	4	35.289	Medicine, General & Internal
Nature Reviews Immunology	1	1	34.985	Immunology
Science	3	3	33.611	Multidisciplinary Sciences
Chemical Society Reviews	1	1	33.383	Chemistry, Multidisciplinary
Nature Methods	1	1	32.072	Biochemical Research Methods
Nature Reviews Neuroscience	1	1	31.427	Neurosciences
Nature Genetics	4	2	29.352	Genetics & Heredity
Nature Medicine	4	4	27.363	Biochemistry & Molecular Biology Cell Biology Medicine, Research & Experimental
Lancet Oncology	1	1	24.69	Oncology
Lancet Infectious Diseases	1	1	22.433	Infectious Diseases
Lancet Neurology	5	5	21.896	Clinical Neurology
Immunity	3	3	21.561	Immunology
Nature Immunology	2	2	20.004	Immunology

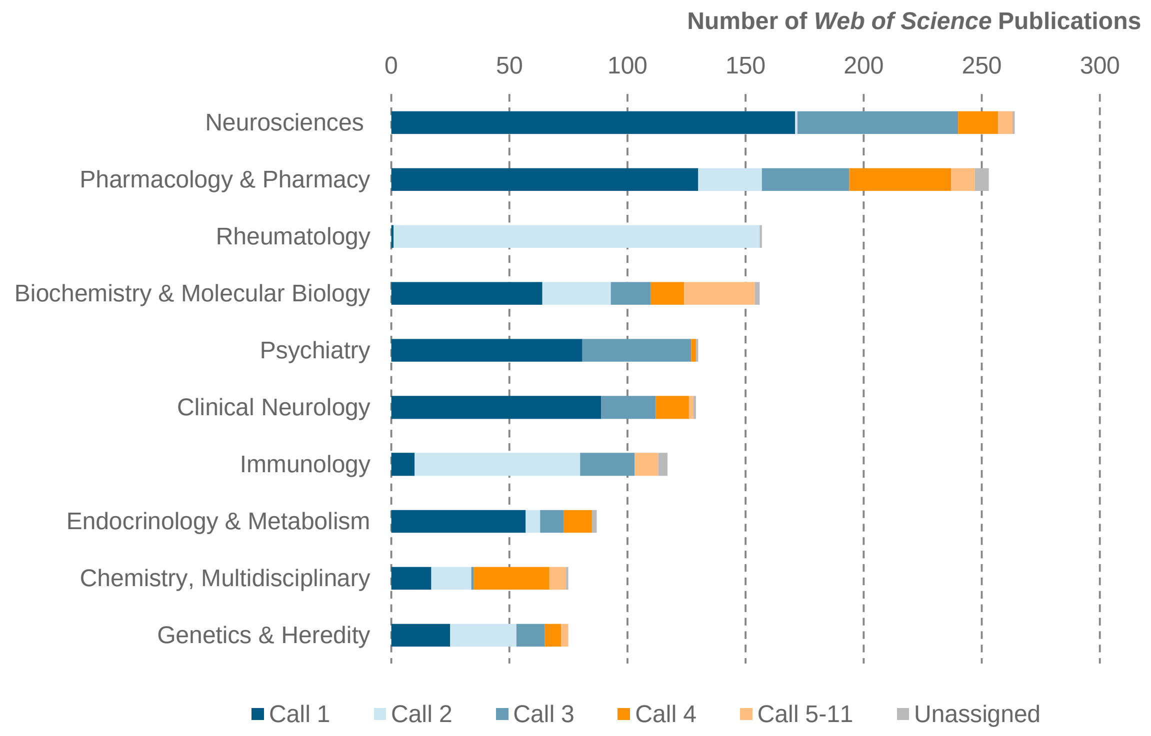
TABLE 4.4.3 OPEN ACCESS JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 11 RANKED BY NUMBER OF WEB OF SCIENCE PUBLICATIONS, 2009-2015

Open Access Journal	Number of Web of Science Publications	Number of Papers	Journal Impact Factor (2014)	Web of Science Journal Categories
PLOS ONE	83	83	3.234	Multidisciplinary Sciences
Arthritis Research & Therapy	31	31	3.753	Rheumatology
Scientific Reports	11	11	5.578	Multidisciplinary Sciences
Genome Biology	10	9	10.81	Biotechnology & Applied Microbiology Genetics & Heredity
Nature Communications	10	10	11.47	Multidisciplinary Sciences
Nucleic Acids Research	10	10	9.112	Biotechnology & Applied Microbiology
BMC Bioinformatics	9	9	2.576	Biochemical Research Methods Biotechnology & Applied Microbiology Mathematical & Computational Biology
Genome Medicine	8	6	5.338	Genetics & Heredity
Biomed Research International	7	7	1.579	Biotechnology & Applied Microbiology Medicine, Research & Experimental
Journal of Biomedical Semantics	7	7	2.262	Mathematical & Computational Biology
International Journal of Molecular Sciences	7	7	2.862	Biochemistry & Molecular Biology Chemistry, Multidisciplinary

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[5] by rank associated with IMI project research[6]. 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, 2009-2015



- IMI projects generated more publications in Neurosciences than in other journal categories, followed by Pharmacology and Pharmacy and Rheumatology. This has changed from Report 6 in which Pharmacology & Pharmacy had the highest number of publications.
- The majority of publications (98.7%) 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.

[5] Journals can be associated with more than one Web of Science category.
[6] It should be noted that there are 13 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. Tables 4.5.2 and 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, 2009-2015

	Number of publications by IMI Call											
Journal Category	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Unassigned**
Neurosciences	171	1	68	17				4	2			1
Pharmacology & Pharmacy	130	27	37	43	2	5	1		2			6
Rheumatology	1	155										1
Biochemistry & Molecular Biology	64	29	17	14	14	8		3			5	2
Psychiatry	81		46	2								1
Clinical Neurology	89		23	14				2				1
Immunology	10	70	23				1	6		3		4
Endocrinology & Metabolism	57	6	10	12								2
Chemistry, Multidisciplinary	17	17	1	32	5	1		1				1
Genetics & Heredity	25	28	12	7				1			2	

TABLE 4.5.2 FIELD NORMALISED, JOURNAL NORMALISED AND RAW CITATION IMPACT OF PAPERS IN TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED, 2009-2015

		Citation Impact		
Journal category	**Number of Papers**	**Normalised at field level**	**Normalised at journal level**	**Raw citation impact**
Neurosciences	262	2.00	1.26	12.72
Pharmacology & Pharmacy	249	1.66	1.18	6.98
Rheumatology	155	1.87	0.87	9.72
Biochemistry & Molecular Biology	154	1.89	1.38	10.57
Psychiatry	130	2.17	1.05	11.15
Clinical Neurology	129	2.53	1.31	16.09
Immunology	116	1.69	1.24	9.55
Endocrinology & Metabolism	87	1.22	0.87	8.77
Chemistry, Multidisciplinary	75	1.82	1.27	9.91
Genetics & Heredity	68	3.58	1.54	24.78

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, 2009-2015

Journal Category	Number of Web of Science publications	% of Open Access publications	Number of papers	% of Highly Cited Papers
Neurosciences	262	9.9%	262	26.0%
Pharmacology & Pharmacy	252	2.4%	249	21.3%
Rheumatology	157	29.3%	155	24.5%
Biochemistry & Molecular Biology	154	22.7%	154	22.1%
Psychiatry	130	5.4%	130	23.8%
Clinical Neurology	129	6.2%	129	30.2%
Immunology	117	17.1%	116	26.7%
Endocrinology & Metabolism	87	14.9%	87	14.9%
Chemistry, Multidisciplinary	75	10.7%	75	22.7%
Genetics & Heredity	74	47.3%	68	42.6%

- IMI project research was most frequently published in Neurosciences journals. Of the 262 papers published in this field, 26% were highly-cited and the average citation impact of these papers was 2. In addition, 9.9% of total publications (262) appeared in open access journals.
- There were 74 publications (68 papers) in the journal category of Genetics & Heredity. This category has the highest percentage of highly cited papers (42.6%), percentage of publications in open access journals (47.3%) and average citation impact (3.58).

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 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, 2010-2015

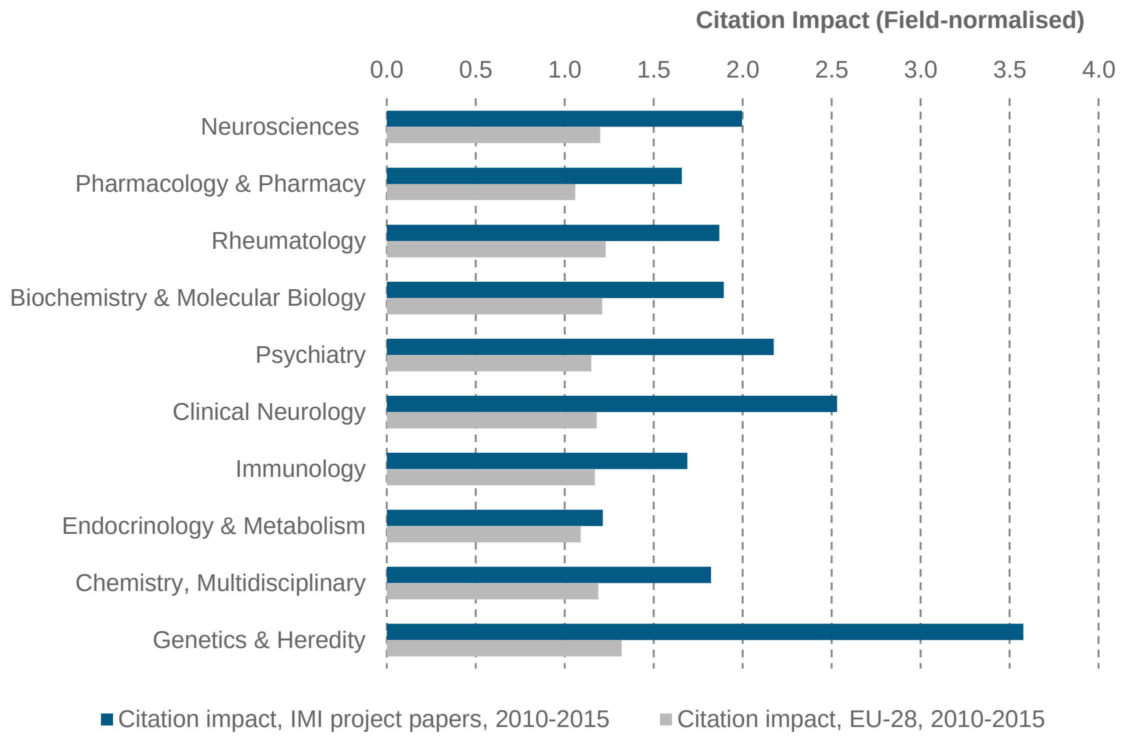


TABLE 4.6.1 CITATION IMPACT AND PERCENTAGE OF PAPERS IN TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED, BENCHMARKED AGAINST EU-28 PAPERS IN THE SAME JOURNAL CATEGORIES, 2010-2015

Journal category	% of IMI papers	% of EU-28 papers	Citation impact normalised at field level	
			IMI papers	EU-28
Neurosciences	15.8%	3.1%	2.00	1.20
Pharmacology & Pharmacy	15.0%	2.4%	1.66	1.06
Rheumatology	9.3%	0.5%	1.87	1.23
Biochemistry & Molecular Biology	9.3%	4.1%	1.89	1.21
Psychiatry	7.8%	1.5%	2.17	1.15
Clinical Neurology	7.8%	2.1%	2.53	1.18
Immunology	7.0%	1.8%	1.69	1.17
Endocrinology & Metabolism	5.2%	1.5%	1.22	1.09
Chemistry, Multidisciplinary	4.5%	2.9%	1.82	1.19
Genetics & Heredity	4.1%	1.6%	3.58	1.32

- 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 with the highest citation impact for EU-28 paper was Genetics & Heredity (1.32); this was also the journal category for which IMI-supported papers had the highest citation impact (3.58).

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.

Tables 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, 2009-2015

		Citation Impact			
	Number of Papers	**Normalised at field level**	**Normalised at journal level**	**Average Percentile**	**% Highly cited papers**
IMI projects	1 661	1.93	1.19	42.47	23.5%

TABLE 4.7.2 SUMMARY OF IMI SUPPORTED RESEARCH PUBLICATIONS, 2009-2015

	Number of Publications	**% Publications in Open access journals**	**Number of papers**	**Citations**	**Raw citation impact**
IMI Projects	1 678	19.3%	1 661	17 267	10.40

SUMMARY OF KEY FINDINGS

- The citation impact of IMI project papers was 1.93 (world average is 1.0) for the 6-year period, 2009-2015. 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 (1.1)[7,8] relative to the world baseline (1.00) for 2009-2015, in the same group of journal categories.
- Nearly a quarter (23.5%) of IMI papers were highly-cited, that is, they were in the world's top 10% of most highly-cited papers in the relevant journal category and year of publication.

[7] EU-28 grouping of countries: Thomson Reuters National Science Indicators 2015 database; similar research has been defined as including the same journal categories as in the IMI project dataset.

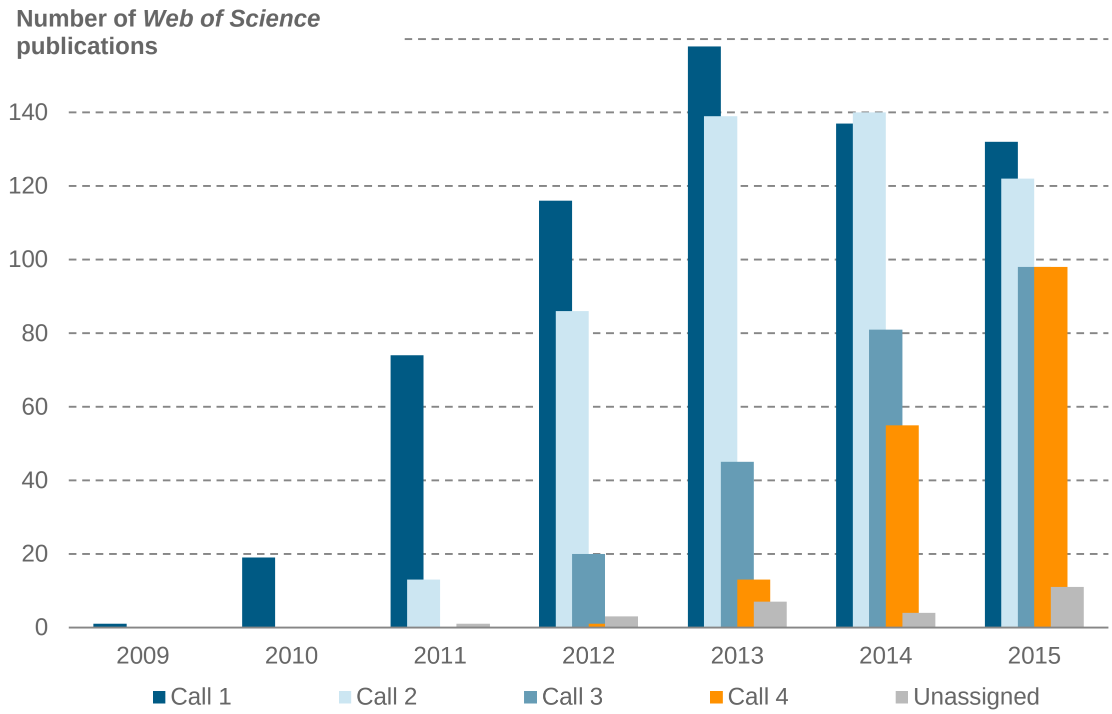
[8] For this analysis, only papers are considered since only these publication types have normalised citation impact data (see Section 3).

5 CITATION ANALYSIS – AT IMI PROJECT LEVEL

5.1 TRENDS IN PUBLICATION OUTPUT BY IMI FUNDING CALL

Figure 5.1.1 shows the number of Web of Science publications between 2009 and 2015 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, 2009-2015



- The number of publications from Call 1 increased from 2009 to a peak of 158 in 2013. In 2014, Call 2 had the highest number of publications (140).
- The number of publications from Calls 2, 3 and 4 increased every year after the initial set of publications for that call, except for a slightly drop for Call 2 in 2015.

FIGURE 5.1.2 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL, 2013-2015

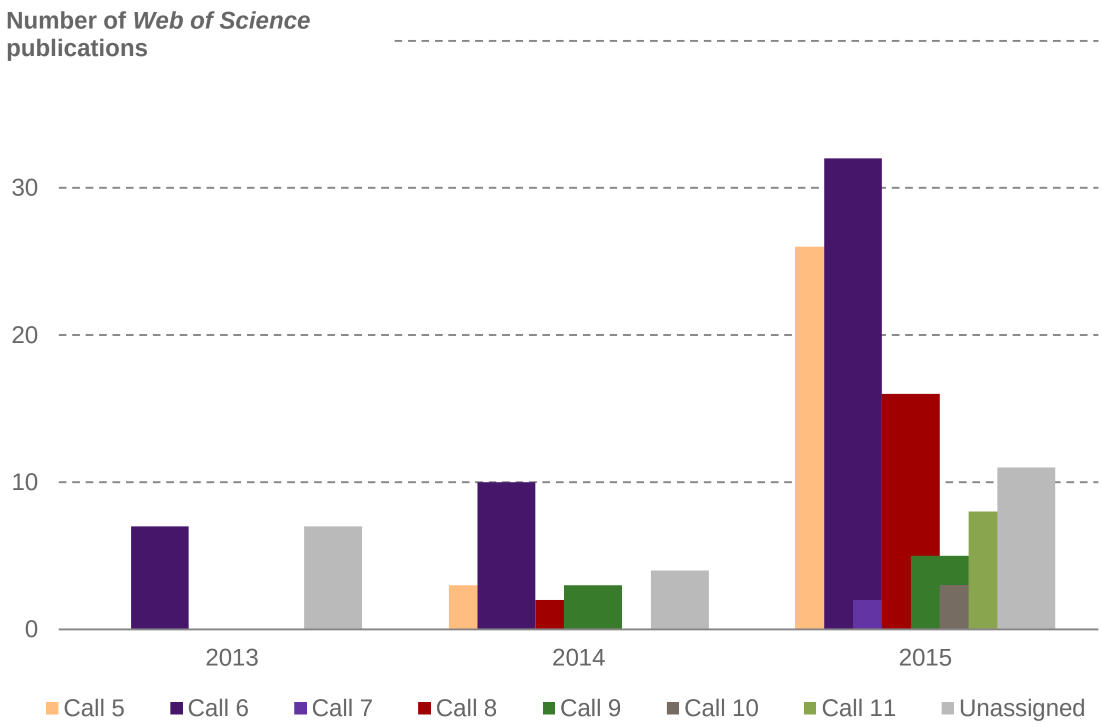


TABLE 5.1.1 SUMMARY BIBLIOMETRIC ANALYSES OF IMI PROJECTS AGGREGATED BY FUNDING CALL, 2009-2015

				Citation Impact		
IMI Call	Number of Publications	% Publications in Open access journals	Number of Papers	Raw citation impact	Normalised at field level	Normalised at journal level
Unassigned	26	26.92%	26	9.31	2.07	1.19
1	637	15.70%	632	13.33	1.81	1.21
2	500	26.80%	492	10.55	1.94	1.19
3	244	18.44%	240	10.98	2.33	1.25
4	167	11.98%	167	5.11	2.33	1.18
5	29	0.00%	29	1.55	2.13	1.97
6	49	26.53%	49	2.73	1.01	0.94
7	2	0.00%	2	2.00	3.49	1.75
8	18	22.22%	18	1.06	0.94	0.54
9	8	25.00%	8	2.50	1.66	1.40
10	3	0.00%	3	0.00	0.00	0.00
11	8	25.00%	8	0.38	0.53	0.12

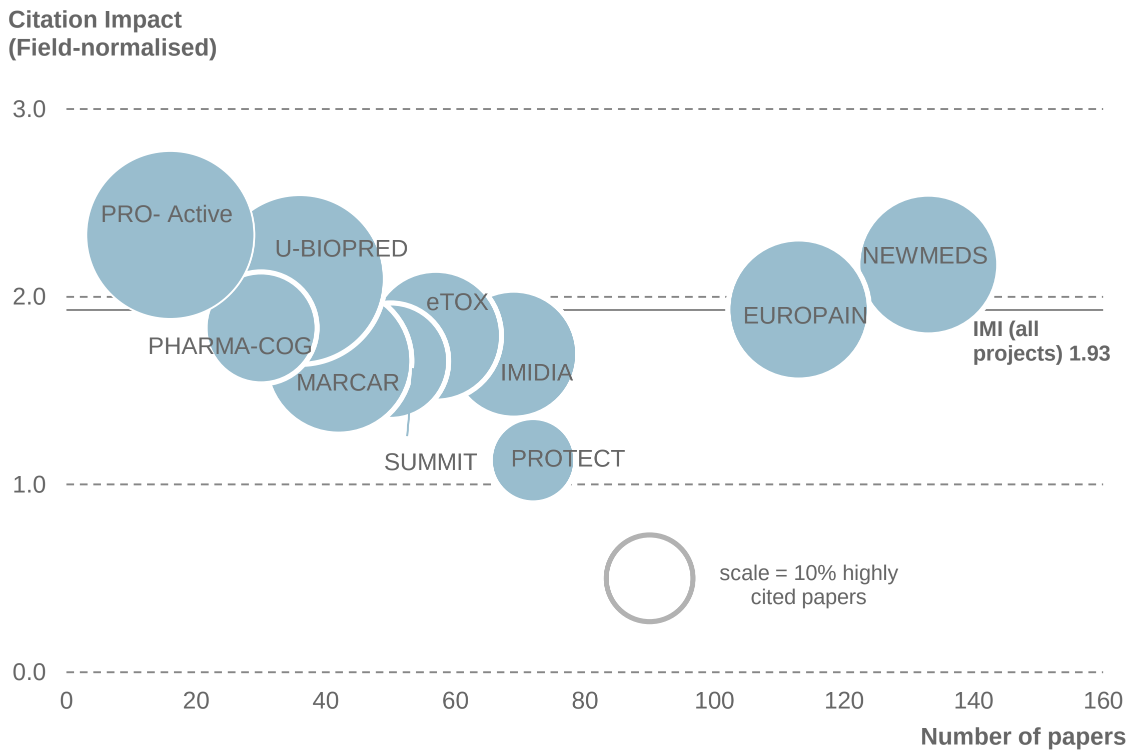
- IMI Call 1 generated the highest number of Web of Science publications (637), and papers (632). Of the 637 publications in Call 1, 15.7% were published in open access journals. The publications generated by IMI Call 1 also had the highest raw citation impact (13.33).
- The papers which were assigned to Call 7 had the highest field normalised citation impact (3.49)[9].

[9] This was due to the relatively small number of publications in this group. A smaller number of publications make it possible for outliers with high citation impact to skew the data for the group.

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 (2009-2015) 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, 2009-2015



The data in Figure 5.2.1 shows that:

- The average citation impact of all of these projects was above the world average (1.0) and the percentage of highly-cited research was above the world average (10%). This shows excellent research performance of IMI-associated research.
- Research associated with three of the projects (NEWMEDS, PRO-Active, U-BIOPRED) in Call 1 was cited over twice the world average.
- Of the 13 projects in Call 1, three (NEWMEDS, PRO-Active, U-BIOPRED) had papers with an average citation impact greater than the average citation impact of all IMI project papers (1.93).

Table 5.2.1 shows citation impact normalised against world average values and is an expansion of 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, 2009-2015

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level**	**Normalised at journal level**	**Average Percentile**	**% Highly cited papers**
eTOX	57	1.79	1.60	33.54	22.81%
EUROPAIN	113	1.93	1.39	35.91	26.55%
IMIDIA	69	1.69	1.09	38.76	21.74%
MARCAR	42	1.66	1.24	36.26	28.57%
NEWMEDS	133	2.17	1.14	39.56	26.32%
PHARMA-COG	30	1.83	0.94	36.43	16.67%
PharmaTrain	1	0.00	0.00	100.00	0.00%
PRO- Active	16	2.33	1.69	27.58	37.50%
PROTECT	72	1.13	1.08	41.41	9.72%
SafeSciMET	3	1.05	0.76	44.32	0.00%
SAFE-T	10	1.20	1.16	50.19	20.00%
SUMMIT	50	1.66	0.95	48.36	18.00%
U-BIOPRED	36	2.09	1.23	35.23	38.89%
Overall (IMI projects)	**1 661**	**1.93**	**1.19**	**42.47**	**23.48%**

TABLE 5.2.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 1, 2009-2015

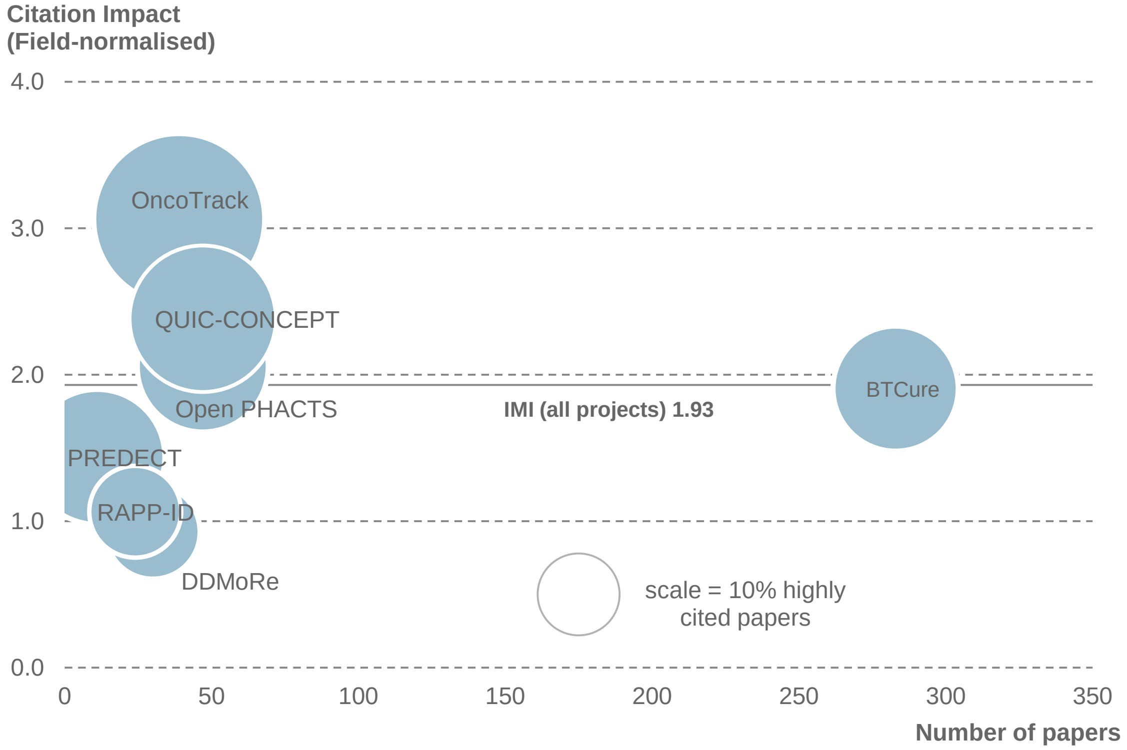
Project	**Number of Publications**	**Number of Papers**	**% Publications in Open access journals**	**Citations**	**Raw citation impact**
eTOX	58	57	34.5%	781	13.70
EUROPAIN	113	113	12.4%	1744	15.43
IMIDIA	69	69	8.7%	733	10.62
MARCAR	43	42	41.9%	350	8.33
NEWMEDS	134	133	3.7%	2071	15.57
PHARMA-COG	30	30	6.7%	680	22.67
PharmaTrain	1	1	100.0%	0	0.00
PRO- Active	16	16	43.8%	217	13.56
PROTECT	72	72	11.1%	490	6.81
SafeSciMET	4	3	0.0%	14	4.67
SAFE-T	11	10	27.3%	65	6.50
SUMMIT	50	50	24.0%	630	12.60
U-BIOPRED	36	36	11.1%	648	18.00

- Of the project in call 1, eTOX had the highest number of publications in open access journals (20). 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 (2009-2015) 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, 2009-2015



The data in Figure 5.3.1 shows that:

- The average citation impact of most Call 2 projects was above world average. DDMoRe had a citation impact very close to world average (0.93), and the two papers that were assigned to EBOVAC1 had not been cited by the end of 2015.
- BTCure was by far the most prolific IMI Call 2 project with 287 papers at the end of 2015. The citation impact of this research is almost twice the world average (1.91).
- Research associated with OncoTrack was very well-cited with a citation impact of more than three times (3.06) the world average.
- QUIC-CONCEPT, Open PHACTS and EHR4CR were also very well-cited with a citation impact of more than twice the world average at 2.06, 2.38 and 2.0 respectively.
- Four of the nine 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, 2009-2015

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level**	**Normalised at journal level**	**Average Percentile**	**% Highly cited papers**
BTCURE	283	1.91	0.99	40.48	23.32%
DDMoRe	30	0.93	0.76	61.59	13.33%
EBOVAC1	2	0.00	0.00	100.00	0.00%
EHR4CR	9	2.00	2.15	36.33	33.33%
OncoTrack	39	3.06	1.49	22.31	43.59%
Open PHACTS	47	2.06	1.84	44.85	25.53%
PREDECT	11	1.44	0.65	50.35	27.27%
QUIC-CONCEPT	47	2.38	1.85	35.07	31.91%
RAPP-ID	24	1.06	0.91	44.56	12.50%
Overall (IMI projects)	**1 661**	**1.93**	**1.19**	**42.47**	**23.48%**

TABLE 5.3.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 2, 2009-2014

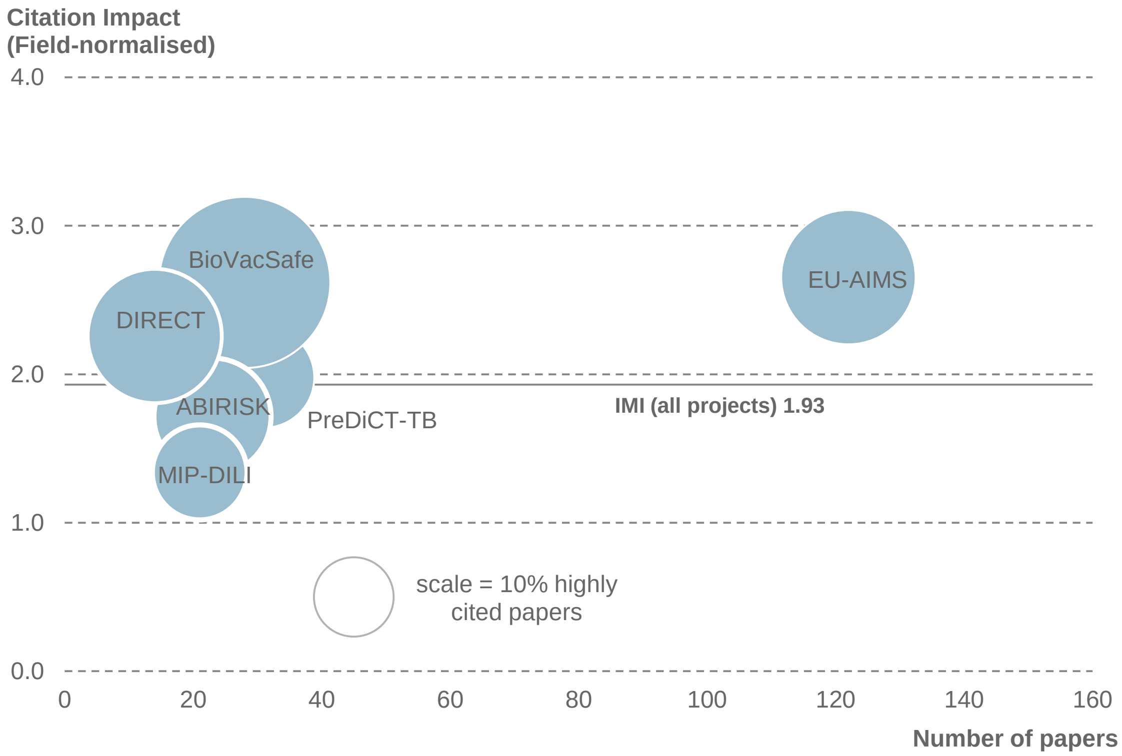
Project	**Number of Publications**	**Number of papers**	**% Publications in Open access journals**	**Citations**	**Raw citation impact**
BTCURE	287	283	25.4%	3037	10.73
DDMoRe	30	30	20.0%	96	3.20
EBOVAC1	2	2	100.0%	0	0.00
EHR4CR	9	9	44.4%	41	4.56
OncoTrack	40	39	30.0%	754	19.33
Open PHACTS	50	47	30.0%	470	10.00
PREDECT	11	11	27.3%	82	7.45
QUIC-CONCEPT	47	47	25.5%	531	11.30
RAPP-ID	24	24	29.2%	181	7.54

- BTCure is the project with the highest number of open access publications (73), but OncoTrack and Open PHACTS both had the highest percentage of publications in open access journals (30%).

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 (2009-2015) 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, 2009-2015



The data in Figure 5.4.1 shows that:

- The average citation impact of all projects in this call was above world average.
- EU-AIMS was by far the most prolific Call 3 project with 124 publications by the end of 2015. The citation impact of this research was more than three times the world average (2.65).
- Research associated with DIRECT and BioVacSafe was also very well-cited. Both of these projects had a citation impact that is over two times the world average.
- Four of the seven 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 has been normalised against world average values for Call 3 and is an expansion of the data used 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, 2009-2015

	Citation Impact				
Project	**Number of Papers**	**Normalised at field level**	**Normalised at journal level**	**Average Percentile**	**% Highly cited papers**
ABIRISK	23	1.71	1.00	44.74	21.74%
BioVacSafe	28	2.62	1.71	30.34	46.43%
DIRECT	14	2.26	1.04	51.69	28.57%
EU-AIMS	122	2.65	1.30	38.93	28.69%
EUPATI	1	1.78	4.47	30.18	0.00%
MIP-DILI	21	1.34	0.74	45.79	14.29%
PreDiCT-TB	31	1.98	1.15	56.36	16.13%
Overall (IMI projects)	**1 661**	**1.93**	**1.19**	**42.47**	**23.48%**

TABLE 5.4.2 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 3, 2009-2015

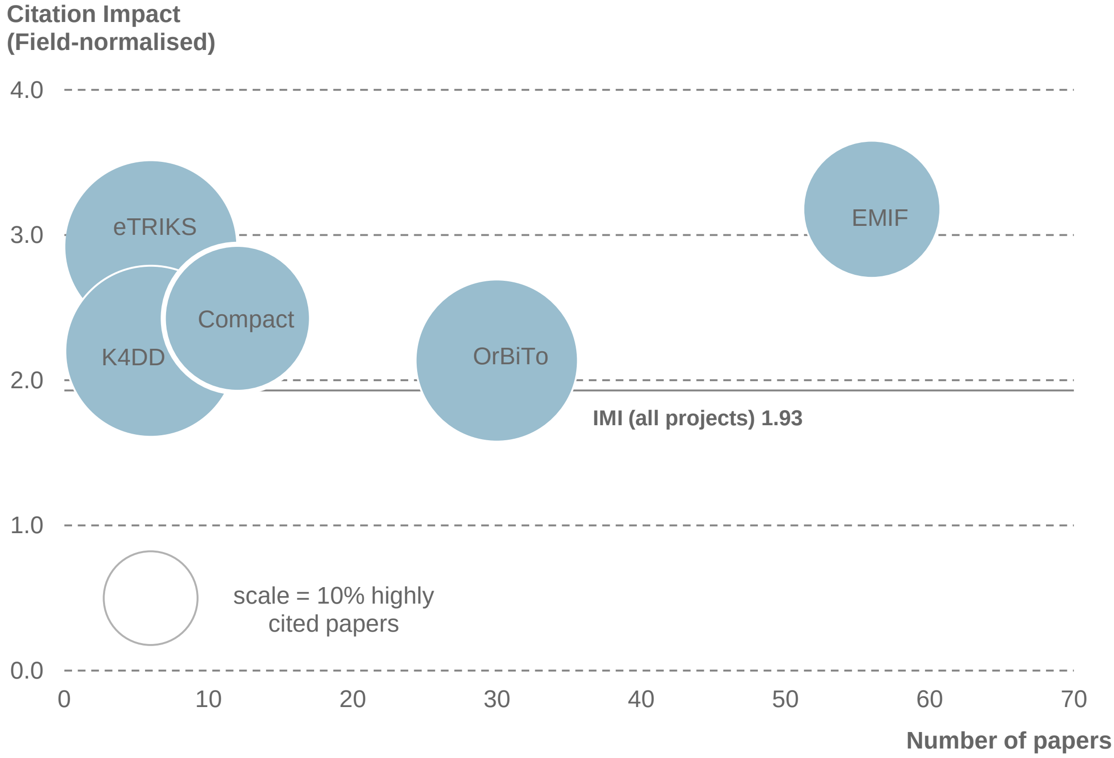
Project	**Number of Publications**	**Number of papers**	**% Publications in Open access journals**	**Citations**	**Raw citation impact**
ABIRISK	23	23	17.4%	175	7.61
BioVacSafe	29	28	17.2%	311	11.11
DIRECT	14	14	21.4%	157	11.21
EU-AIMS	124	122	14.5%	1719	14.09
EUPATI	1	1	100.0%	1	1.00
MIP-DILI	22	21	18.2%	130	6.19
PreDiCT-TB	31	31	32.3%	141	4.55

- EU-AIMS was the project with the highest number of publications in open access journals (18). However, PreDiCT-TB had the highest percentage of publications in open access journals (32.3%).

5.5 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 4

Figure 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 (2009-2015) 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, 2009-2015



The data in Figure 5.5.1 shows that:

- The average citation impact of these projects was above world average though none of these projects have more than 56 papers.
- EMIF and CHEM21 produced the highest number of papers in Call 3, with 56 and 36 respectively.
- Research associated with EMIF was very well-cited with a citation impact of more than three times the world average (3.18).
- Five of the seven projects in this Call had an average citation impact greater than the citation impact of all IMI related projects.

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

TABLE 5.5.1 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 4, 2009-2015

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level**	**Normalised at journal level**	**Average Percentile**	**% Highly cited papers**
CHEM21	36	1.56	1.06	45.31	13.89%
Compact	12	2.43	1.75	41.50	25.00%
EMIF	56	3.18	0.91	52.56	21.43%
eTRIKS	6	2.92	1.27	34.11	33.33%
K4DD	6	2.20	1.89	32.13	33.33%
OrBiTo	30	2.14	1.57	51.67	30.00%
StemBANCC	21	1.51	0.96	62.14	19.05%
Overall (IMI projects)	**1 661**	**1.93**	**1.19**	**42.47**	**23.48%**

TABLE 5.5.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 4, 2009-2015

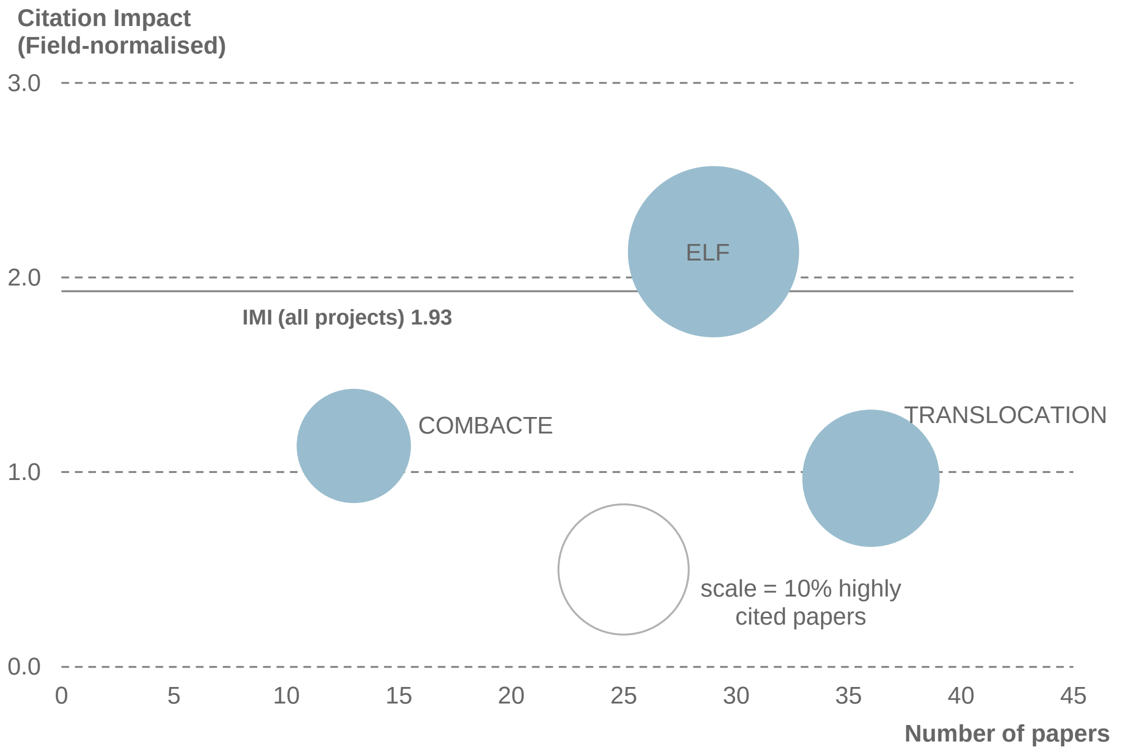
Project	**Number of Publications**	**Number of Papers**	**% Publications in Open access journals**	**Citations**	**Raw citation impact**
CHEM21	36	36	8.3%	255	7.08
Compact	12	12	0.0%	37	3.08
EMIF	56	56	19.6%	289	5.16
eTRIKS	6	6	16.7%	19	3.17
K4DD	6	6	16.7%	23	3.83
OrBiTo	30	30	0.0%	150	5.00
StemBANCC	21	21	19.0%	80	3.81

- 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 (11 and 20%).

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

Figure 5.5.1 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 (2009-2015) 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 5-11, 2009-2015



The data in Figure 5.5.1 shows that:

- Research associated with ELF was very well-cited with a citation impact of more than two times the world average (2.13), and 17% of papers that are highly-cited.

Table 5.5.1 presents indicators where citation impact has been normalised against world average values and is an expansion of the data used in Figure 5.5.1. Table 5.5.2 shows raw citation impact and percentage of open access journals by project for Call 5-11 publications.

TABLE 5.5.1 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 5-11, 2009-2015

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level**	**Normalised at journal level**	**Average Percentile**	**% Highly cited papers**
ADVANCE	1	5.20	2.79	4.47	100.00%
AETIONOMY	9	0.38	0.29	78.08	0.00%
CANCER-ID	2	0.65	0.25	65.72	0.00%
COMBACTE	13	1.13	0.72	48.55	7.69%
DRIVE-AB	1	6.25	3.33	2.99	100.00%
ELF	29	2.13	1.97	45.13	17.24%
ENABLE	3	0.46	0.06	77.17	0.00%
FLUCOP	3	0.00	0.00	100.00	0.00%
GetReal	1	1.78	0.71	30.18	0.00%
PRECISESADS	6	2.03	1.16	48.70	16.67%
SPRINTT	6	1.18	1.31	41.83	16.67%
TRANSLOCATION	36	0.97	1.02	65.55	11.11%
ULTRA-DD	6	0.49	0.07	84.84	16.67%
WEB-RADR	1	0.00	0.00	100.00	0.00%
Overall (IMI projects)	**1 661**	**1.93**	**1.19**	**42.47**	**23.48%**

TABLE 5.5.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 5-11, 2009-2015

Project	**Number of Publications**	**Number of Papers**	**% Open access journals**	**Citations**	**Raw citation impact**
ADVANCE	1	1	0.0%	3	3.00
AETIONOMY	9	9	33.3%	8	0.89
CANCER-ID	2	2	50.0%	1	0.50
COMBACTE	13	13	15.4%	47	3.62
DRIVE-AB	1	1	0.0%	4	4.00
ELF	29	29	0.0%	45	1.55
ENABLE	3	3	0.0%	1	0.33
FLUCOP	3	3	0.0%	0	0.00
GetReal	1	1	0.0%	1	1.00
PRECISESADS	6	6	16.7%	10	1.67
SPRINTT	6	6	33.3%	16	2.67
TRANSLOCATION	36	36	30.6%	87	2.42
ULTRA-DD	6	6	16.7%	2	0.33
WEB-RADR	1	1	0.0%	0	0.00

- Three of fourteen projects in Call 5-11 have more than 10 publications between 2009 and 2015.

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, 2009-2015

	Number of papers	**Percentage of Papers**	**Citation impact (normalised at field level)**
Cross-sector	1 012	58.5%	2.09
Single-sector	648	37.4%	1.71
Cross-institution	1 314	75.9%	2.00
Single-institution	346	20.0%	1.71
International	923	53.3%	2.12
Domestic	737	42.6%	1.72

- More than half (58.5%) of all IMI project papers were published by researchers affiliated with different sectors.
- More than three-quarters (75.9%) of IMI project papers involved collaboration between institutions.
- More than half (53.3%) 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 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, NEWMEDS, EUROPAIN, PROTECT and EU-AIMS. The countries with most frequent collaboration are shaded orange and those with little or no collaboration in grey.

It should be noted that the last column in Tables 6.2.1 – 6.2.3 do 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. 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 6.2.1-6.2.3).
- NEWMEDS had the second highest number of papers with authors from more than one country, while both NEWMEDS and EU-AIMS had the second highest number of papers with authors from more than one institution and sector (Table 6.2.1-6.2.3).
- The majority of collaborative papers from these top five projects were co-authored with researchers from the USA, Canada and Europe (Figure 6.2.1-6.2.5).
- For BTCure, there was also a substantial collaboration with China, Japan and Australia (Figure 6.2.1). NEWMEDS and EU-AIMS had collaborations in South America (Figure 6.2.2, 6.2.4).

TABLE 6.2.1 NUMBER, PERCENTAGE AND CITATION IMPACT[13] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE COUNTRY, 2009-2015.

Project	Number of papers	Number of internationally collaborative papers	Percentage of internationally collaborative papers	Citation impact (normalised at field level)
BTCURE	283	154	54.4%	2.10
NEWMEDS	133	84	63.2%	2.29
EU-AIMS	122	84	68.9%	2.70
EUROPAIN	113	39	34.5%	1.81
PROTECT	72	53	73.6%	1.19
IMIDIA	69	31	44.9%	1.96
eTOX	57	24	42.1%	1.41
EMIF	56	42	75.0%	3.90
SUMMIT	50	26	52.0%	2.30
QUIC-CONCEPT	47	33	70.2%	2.37
Open PHACTS	47	29	61.7%	2.06
MARCAR	42	18	42.9%	2.35
OncoTrack	39	13	33.3%	3.97
CHEM21	36	13	36.1%	1.29
TRANSLOCATION	36	18	50.0%	0.89
U-BIOPRED	36	19	52.8%	3.04
PreDiCT-TB	31	19	61.3%	2.39
DDMoRe	30	16	53.3%	0.97
OrBiTo	30	18	60.0%	2.81
PHARMA-COG	30	22	73.3%	2.18
ELF	29	15	51.7%	1.45
BioVacSafe	28	12	42.9%	2.44
Unassigned	26	16	61.5%	1.64
RAPP-ID	24	13	54.2%	1.20
ABIRISK	23	11	47.8%	1.73
MIP-DILI	21	10	47.6%	1.05
StemBANCC	21	8	38.1%	0.71
PRO- Active	16	13	81.3%	2.75
DIRECT	14	8	57.1%	2.37
COMBACTE	13	7	53.8%	1.31
Compact	12	7	58.3%	1.61
PREDECT	11	5	45.5%	1.43
SAFE-T	10	5	50.0%	1.52
AETIONOMY	9	3	33.3%	0.44
EHR4CR	9	7	77.8%	2.29
eTRIKS	6	6	100.0%	2.74
K4DD	6	2	33.3%	4.04
PRECISESADS	6	6	100.0%	2.03
SPRINTT	6	3	50.0%	1.19
ULTRA-DD	6	5	83.3%	0.59
SafeSciMET	3	3	100.0%	1.05
FLUCOP	3	3	100.0%	0.00

[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)
ENABLE	3	0	0.0%	0.00
EBOVAC1	2	0	0.0%	0.00
CANCER-ID	2	1	50.0%	1.29
ADVANCE	1	0	0.0%	0.00
DRIVE-AB	1	1	100.0%	6.25
GetReal	1	0	0.0%	0.00
EUPATI	1	1	100.0%	1.78
PharmaTrain	1	1	100.0%	0.00
WEB-RADR	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, 2009-2015

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	283	224	79.2%	1.95
NEWMEDS	133	111	83.5%	2.13
EU-AIMS	122	111	91.0%	2.69
EUROPAIN	113	68	60.2%	2.01
PROTECT	72	70	97.2%	1.14
IMIDIA	69	53	76.8%	1.62
eTOX	57	34	59.6%	2.42
EMIF	56	51	91.1%	3.42
SUMMIT	50	37	74.0%	1.95
QUIC-CONCEPT	47	39	83.0%	2.26
Open PHACTS	47	40	85.1%	2.57
MARCAR	42	29	69.0%	1.88
OncoTrack	39	29	74.4%	3.39
CHEM21	36	17	47.2%	1.40
TRANSLOCATION	36	26	72.2%	0.90
U-BIOPRED	36	27	75.0%	2.46
PreDiCT-TB	31	29	93.5%	2.12
DDMoRe	30	23	76.7%	0.82
OrBiTo	30	24	80.0%	2.25
PHARMA-COG	30	28	93.3%	1.90
ELF	29	19	65.5%	1.54
BioVacSafe	28	22	78.6%	2.47
Unassigned	26	24	92.3%	2.00
RAPP-ID	24	18	75.0%	1.17
ABIRISK	23	18	78.3%	1.95
MIP-DILI	21	16	76.2%	1.02
StemBANCC	21	12	57.1%	1.83
PRO- Active	16	16	100.0%	2.33
DIRECT	14	13	92.9%	2.37
COMBACTE	13	10	76.9%	1.15
Compact	12	9	75.0%	1.71
PREDECT	11	7	63.6%	1.02
SAFE-T	10	10	100.0%	1.20
AETIONOMY	9	9	100.0%	0.43
EHR4CR	9	8	88.9%	2.00
eTRIKS	6	6	100.0%	2.74
K4DD	6	5	83.3%	2.41
PRECISESADS	6	6	100.0%	2.03
SPRINTT	6	5	83.3%	1.23
ULTRA-DD	6	5	83.3%	0.59
SafeSciMET	3	3	100.0%	1.05
FLUCOP	3	3	100.0%	0.00

[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)
ENABLE	3	2	66.7%	0.00
EBOVAC1	2	0	0.0%	0.00
CANCER-ID	2	1	50.0%	1.29
ADVANCE	1	0	0.0%	0.00
DRIVE-AB	1	1	100.0%	6.25
GetReal	1	1	100.0%	1.78
EUPATI	1	1	100.0%	1.78
PharmaTrain	1	1	100.0%	0.00
WEB-RADR	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, 2009-2015

Project	Number of papers	Number of cross sector papers	Percentage of cross sector papers	Citation impact (normalised at field level)
BTCURE	283	178	62.9%	2.07
NEWMEDS	133	81	60.9%	2.61
EU-AIMS	122	81	66.4%	2.97
EUROPAIN	113	42	37.2%	2.40
PROTECT	72	69	95.8%	1.14
IMIDIA	69	35	50.7%	1.87
eTOX	57	16	28.1%	1.18
EMIF	56	43	76.8%	2.78
SUMMIT	50	26	52.0%	1.83
QUIC-CONCEPT	47	35	74.5%	2.28
Open PHACTS	47	31	66.0%	2.05
MARCAR	42	20	47.6%	1.79
OncoTrack	39	26	66.7%	3.14
CHEM21	36	4	11.1%	0.64
TRANSLOCATION	36	15	41.7%	0.78
U-BIOPRED	36	20	55.6%	2.77
PreDiCT-TB	31	20	64.5%	2.05
DDMoRe	30	21	70.0%	0.83
OrBiTo	30	20	66.7%	2.24
PHARMA-COG	30	26	86.7%	1.99
ELF	29	16	55.2%	1.74
BioVacSafe	28	21	75.0%	2.59
Unassigned	26	17	65.4%	2.43
RAPP-ID	24	13	54.2%	1.26
ABIRISK	23	13	56.5%	2.24
MIP-DILI	21	13	61.9%	1.11
StemBANCC	21	11	52.4%	1.99
PRO- Active	16	16	100.0%	2.33
DIRECT	14	12	85.7%	2.51
COMBACTE	13	10	76.9%	1.15
Compact	12	2	16.7%	4.34
PREDECT	11	6	54.5%	1.19
SAFE-T	10	10	100.0%	1.20
AETIONOMY	9	7	77.8%	0.36
EHR4CR	9	8	88.9%	2.09
eTRIKS	6	5	83.3%	3.09
K4DD	6	3	50.0%	1.78
PRECISESADS	6	5	83.3%	2.20
SPRINTT	6	3	50.0%	1.19
ULTRA-DD	6	3	50.0%	0.98
SafeSciMET	3	3	100.0%	1.05

[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)
FLUCOP	3	3	100.0%	0.00
ENABLE	3	0	0.0%	0.00
EBOVAC1	2	0	0.0%	0.00
CANCER-ID	2	1	50.0%	1.29
ADVANCE	1	0	0.0%	0.00
DRIVE-AB	1	1	100.0%	6.25
GetReal	1	1	100.0%	1.78
EUPATI	1	1	100.0%	1.78
PharmaTrain	1	1	100.0%	0.00
WEB-RADR	1	1	100.0%	0.00

FIG 6.2.1 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: BTCURE, 2009-2015

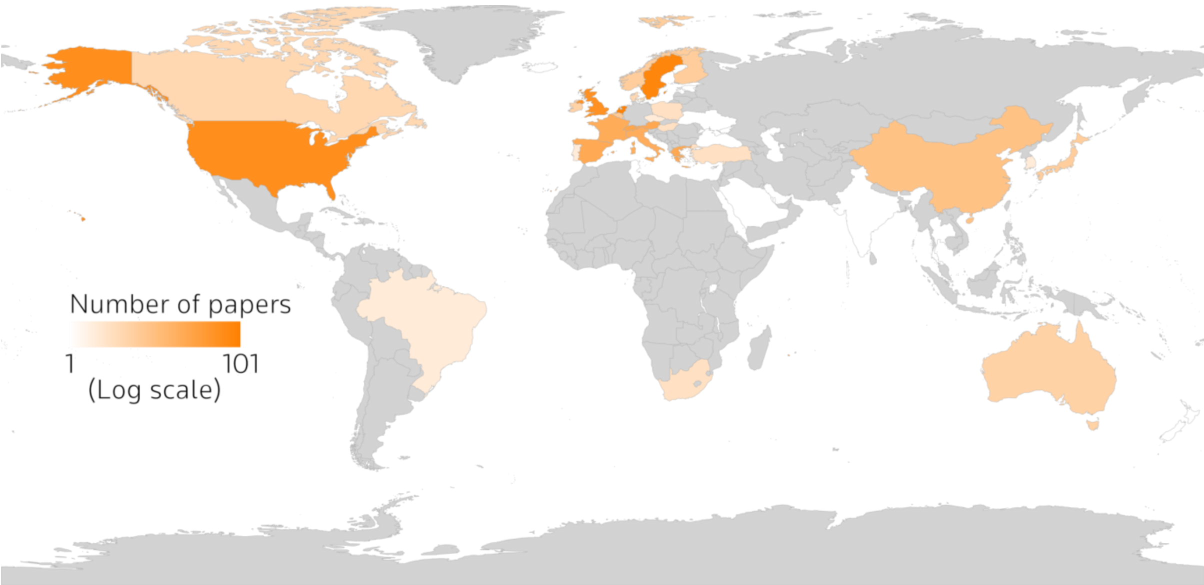


FIG 6.2.2 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: NEWMEDS, 2009-2015

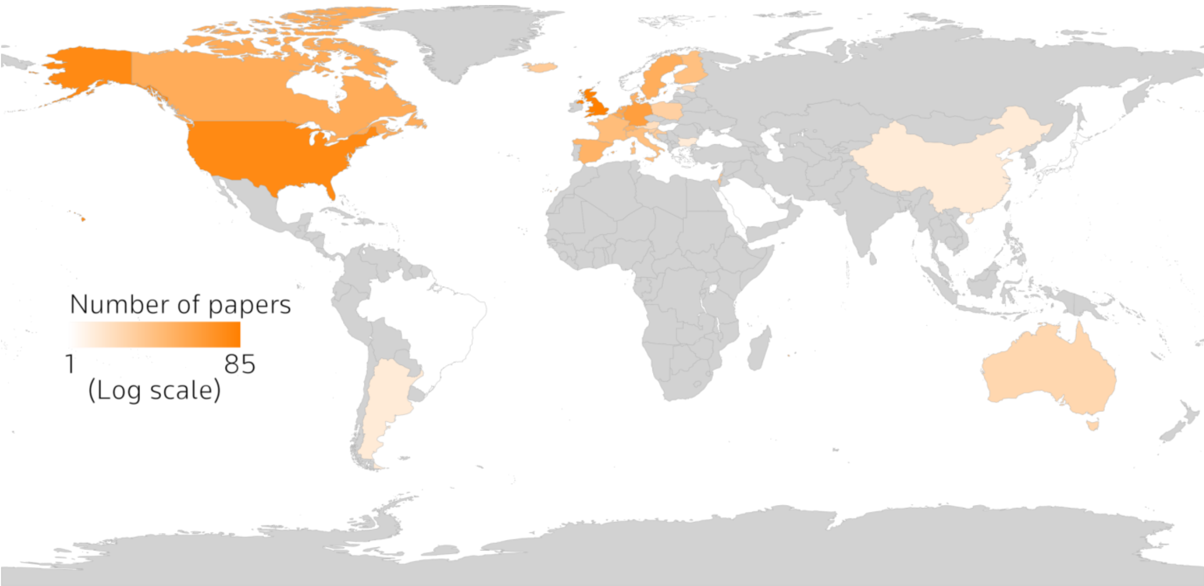


FIG 6.2.3 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: EUROPAIN, 2009-2015

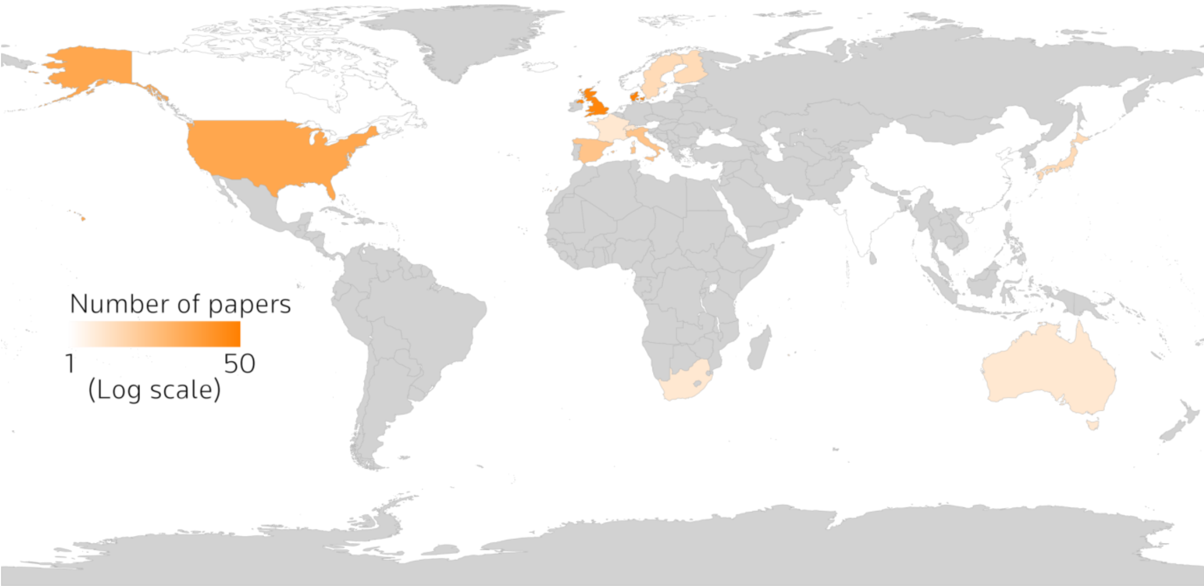


FIG 6.2.4 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: EU-AIMS, 2009-2015

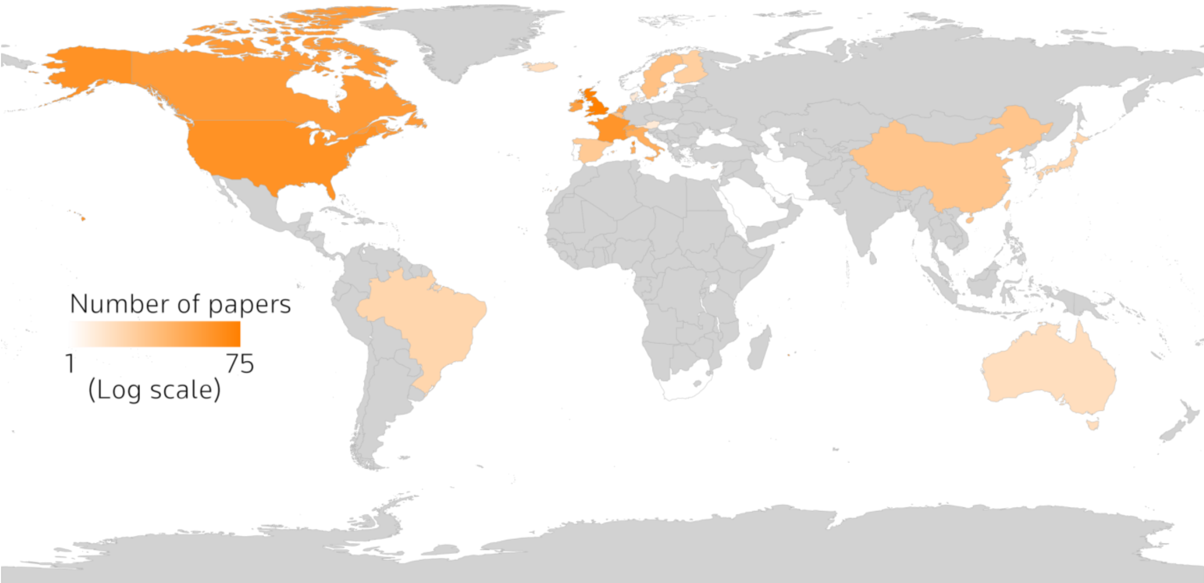
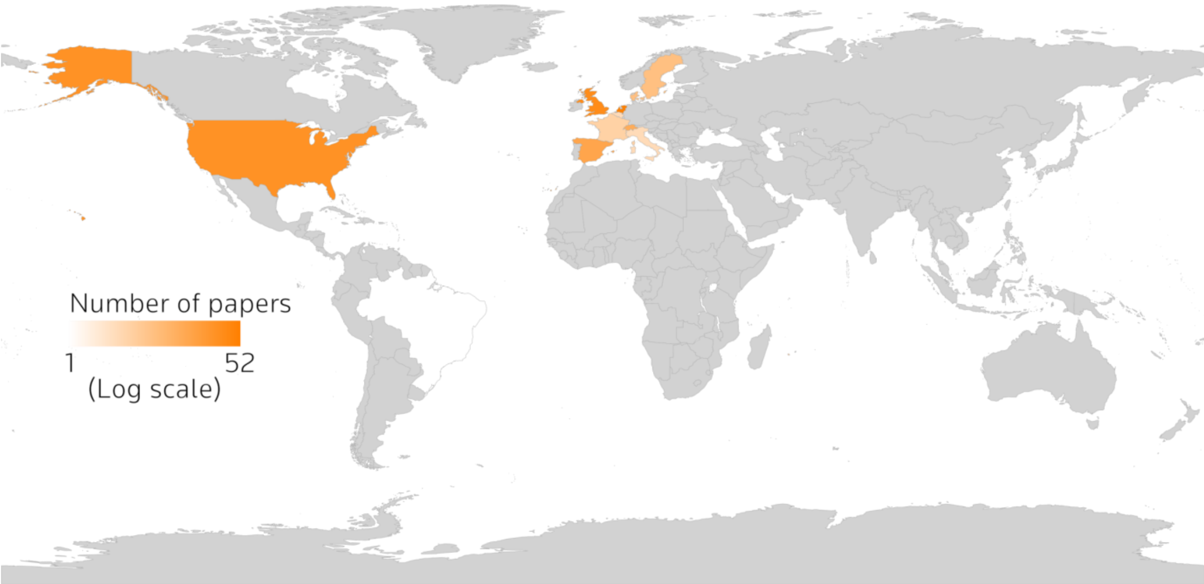


FIG 6.2.5 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: PROTECT, 2009-2015



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 2009 and 2015. The results for all projects are shown in Annex 3.

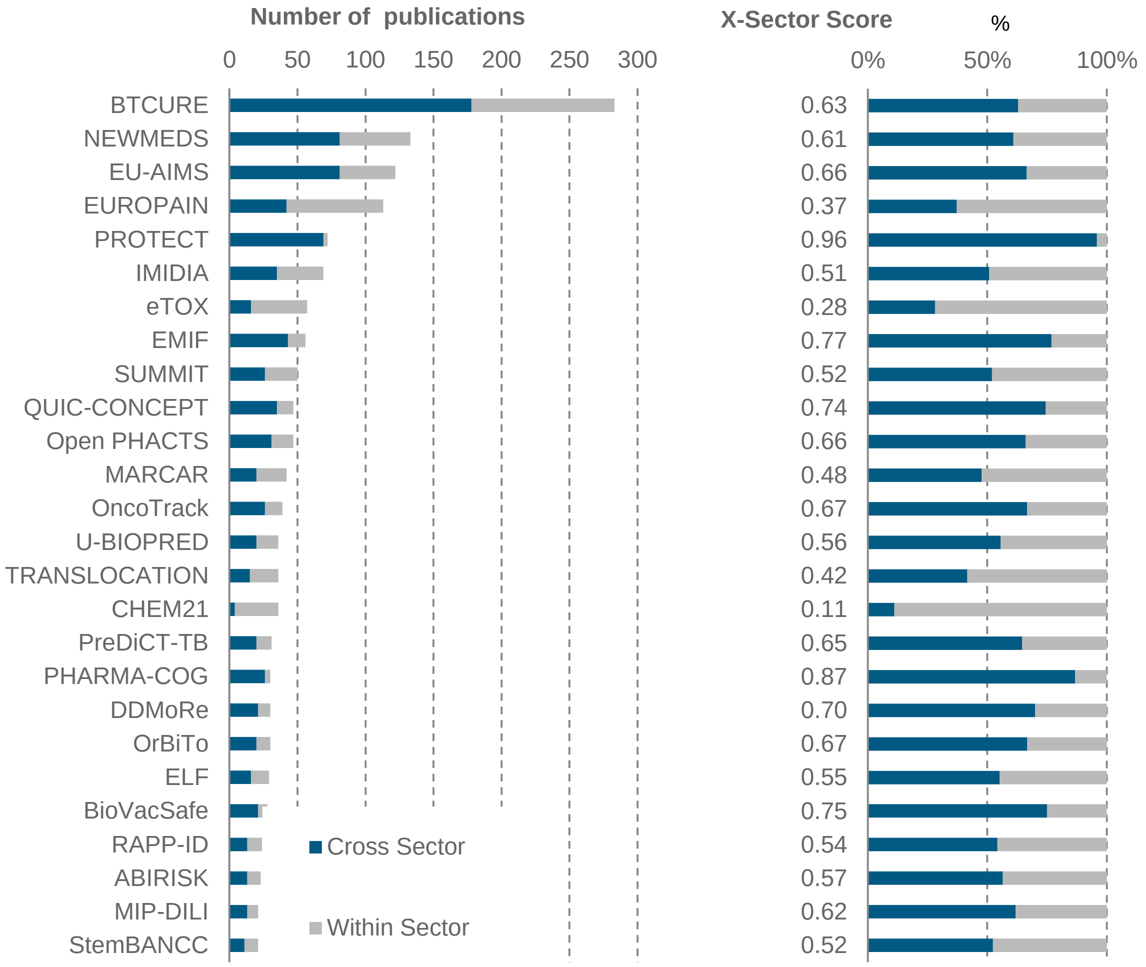
Three metrics were chosen to evaluate the collaborative nature of IMI projects:

- 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 Thomson Reuters 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 abstracted 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, 2009-2015



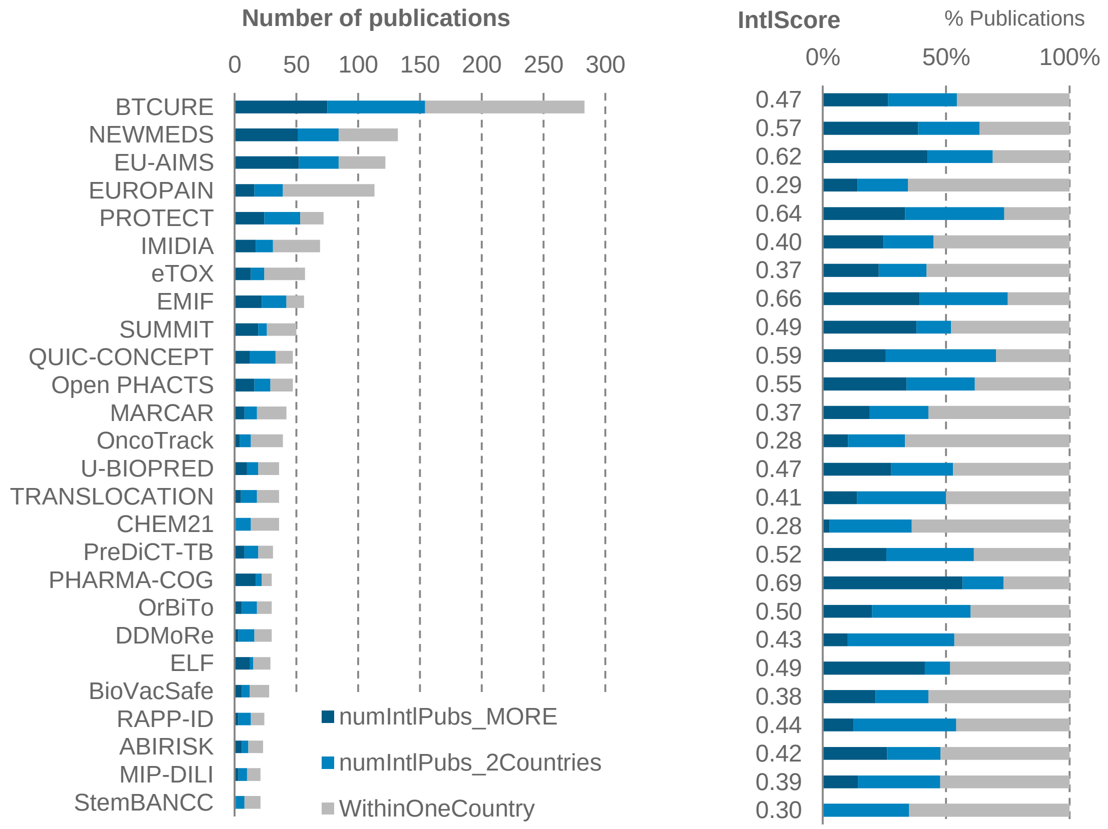
BTCure had the greatest number of cross-sector collaborative publications, 178 out of 283. PROTECT, PHARMA-COG and EMIF had the highest percentage of cross-sector collaborative publications (95.8%, 86.7% and 76.8% respectively).

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, 2009-2015

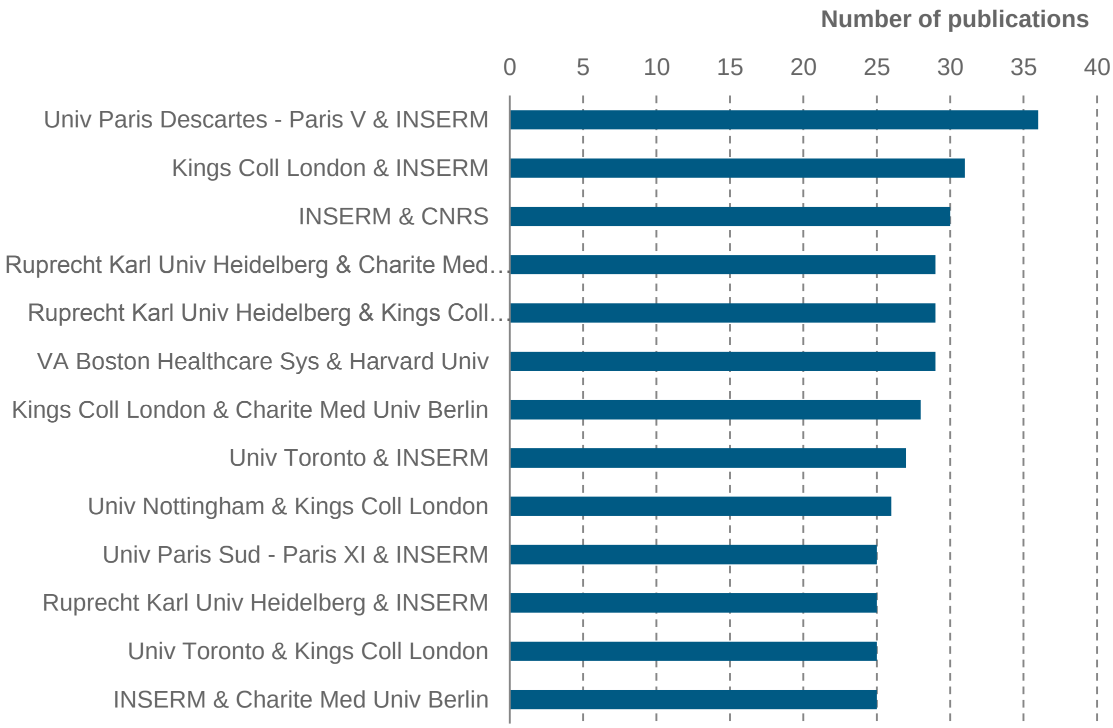


BTCure had the most internationally collaborative publications involving more than two countries (154 out of 283), with an International Score of 0.47. PHARMA-COG, EMIF and PROTECT, had the highest International Score (0.69, 0.66 and 0.64 respectively).

6.3.3 METRIC 3: TOP COLLABORATING ORGANISATIONS PER PUBLICATION

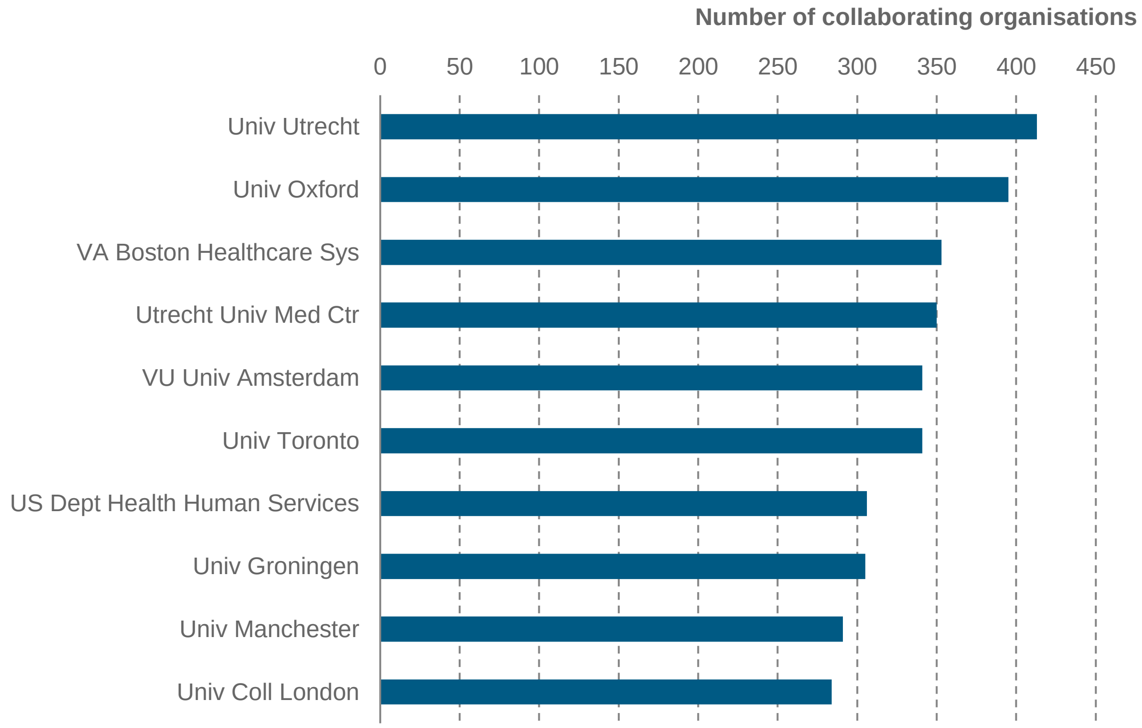
Metric 3 focuses on the top collaborating organisations and the number involved in publications associated with each project. Figure 6.3.3.1 shows the top ten collaborating organisation pairs and the total number of collaborating publications for each pair. Figure 6.3.3.2 shows the number of collaborating 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, 2009-2015



The organisations that collaborated together the most frequently in IMI project publications were the Paris Descartes University and INSERM.

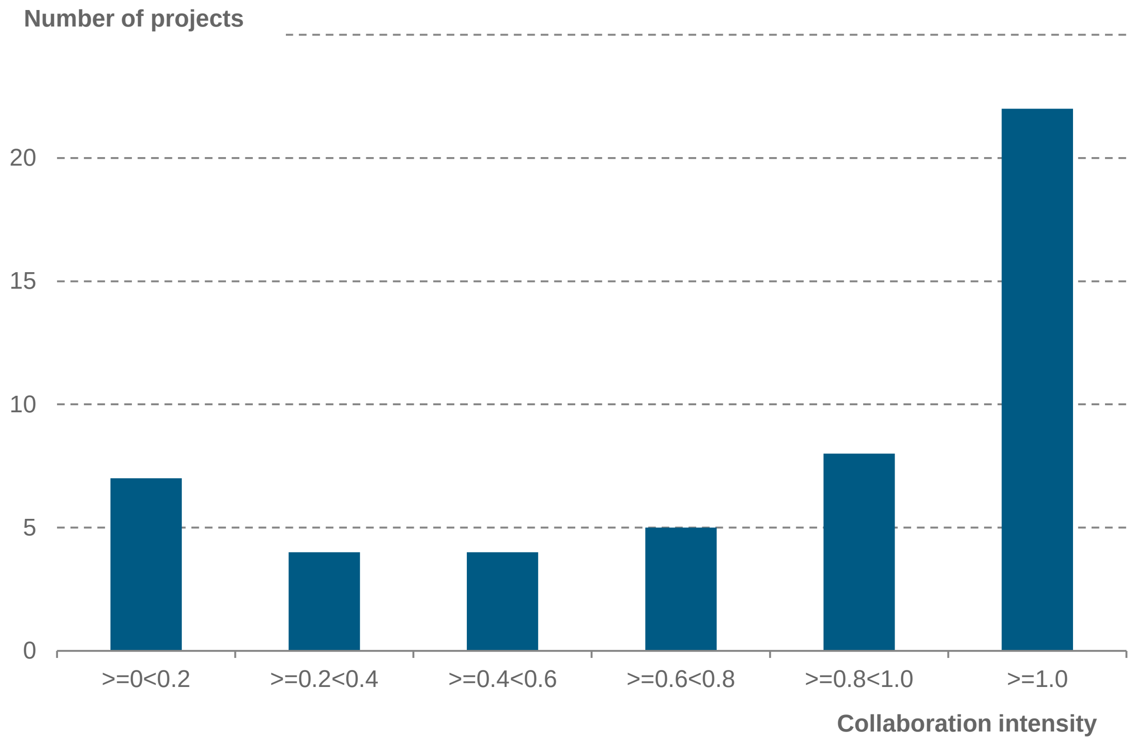
FIGURE 6.3.3.2 THE TEN MOST DIVERSE COLLABORATIVE ORGANISATIONS, 2009-2015



Utrecht University has collaborated with 400 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 authors affiliated with the top 50 institutions 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 is set to that value. For example, NEWMEDS had 220 author affiliations which belonged to the top 50 institutions, and 133 total publications, so the result for metric 3 was 1.65 and this was set to 1.0.

FIGURE 6.3.3.3 METRIC 3 SCORE DISTRIBUTION, 2009-2015



6.4 COLLABORATION INDEX

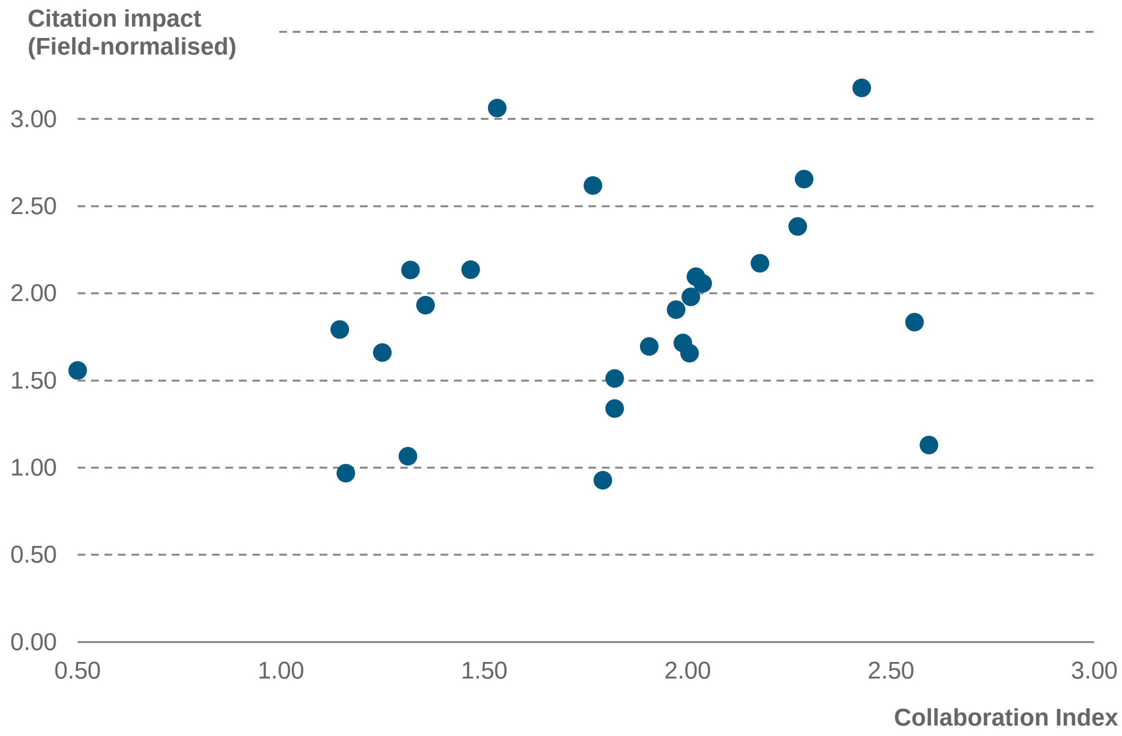
Metrics 1 and 2 (described above) measure different types of collaboration diversity. The first measures the fraction of publications that involve cross sector collaborations, and the second measures the fraction of publications that involve international collaborations. Metric 3 is based on the average 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). We note that a revised collaboration index might not include equal weighting of each metric, depending upon the relative importance IMI places on each collaboration type. PROTECT had the highest overall collaboration index score (2.59), followed by PHARMA-COG, EMIF and EU-AIMS (2.56, 2.43, and 2.29 respectively).

TABLE 6.4.1 SUMMARY SCORE FOR COLLABORATION METRICS, TOTAL NUMBER PUBLICATIONS, AND CITATION IMPACT FOR IMI PROJECTS, 2009-2015

Project	X-sector Score	IntlScore	Metric 3	Collaboration Index	Total Project publications	Citation impact (normalised at field level)
BTCURE	0.63	0.47	0.87	1.97	283	1.91
NEWMEDS	0.61	0.57	1.00	2.18	133	2.17
EU-AIMS	0.66	0.62	1.00	2.29	122	2.65
EUROPAIN	0.37	0.29	0.69	1.36	113	1.93
PROTECT	0.96	0.64	1.00	2.59	72	1.13
IMIDIA	0.51	0.40	1.00	1.91	69	1.69
eTOX	0.28	0.37	0.49	1.14	57	1.79
EMIF	0.77	0.66	1.00	2.43	56	3.18
SUMMIT	0.52	0.49	1.00	2.01	50	1.66
QUIC-CONCEPT	0.74	0.59	0.94	2.27	47	2.38
Open PHACTS	0.66	0.55	0.83	2.04	47	2.06
MARCAR	0.48	0.37	0.40	1.25	42	1.66
OncoTrack	0.67	0.28	0.59	1.53	39	3.06
CHEM21	0.11	0.28	0.11	0.50	36	1.56
TRANSLOCATION	0.42	0.41	0.33	1.16	36	0.97
U-BIOPRED	0.56	0.47	1.00	2.02	36	2.09
PreDiCT-TB	0.65	0.52	0.84	2.01	31	1.98
DDMoRe	0.70	0.43	0.67	1.79	30	0.93
OrBiTo	0.67	0.50	0.30	1.47	30	2.14
PHARMA-COG	0.87	0.69	1.00	2.56	30	1.83
ELF	0.55	0.49	0.28	1.32	29	2.13
BioVacSafe	0.75	0.38	0.64	1.77	28	2.62
RAPP-ID	0.65	0.44	0.33	1.42	26	1.06
ABIRISK	0.54	0.42	1.00	1.97	24	1.71
MIP-DILI	0.57	0.39	0.81	1.77	23	1.34
StemBANCC	0.62	0.30	1.00	1.92	21	1.51
PRO- Active	0.52	0.75	1.00	2.27	21	2.33

No substantial correlation is apparent between the collaboration index (or the component metrics) and the average field-normalised citation impact of the research published by IMI projects (Figure 6.4.1). However, given the limited volumes of publications analysed and the many factors which influence citation rates, we cannot draw any strong conclusions from this observation.

FIGURE 6.4.1 COLLABORATION INDEX VERSUS CITATION IMPACT PER PROJECT



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 abstracted 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

In Thomson Reuters previous report (2015) to IMI, a total of eighty candidate comparators were reviewed and seventeen were supplied to IMI for further validation.

Following discussions with IMI, seven comparators (with sufficient publications to allow a robust analysis) were selected. This report uses the same comparators as the 2015 report (these are shown in Table 7.1.1)[16].

TABLE 7.1.1 SUMMARY INFORMATION OF IMI-SELECTED COMPARATORS, 2010-2015

Comparator	Publications (2010-2015)	Papers (2010-2015)	Country	Region
Commonwealth Scientific and Industrial Research Organization (CSIRO)	287	287	Australia	Australia
Critical Path (C-Path)	226	226	USA	North America
Foundation for the National Institutes of Health (FNIH)	1 407	1 407	USA	North America
Grand Challenges in Global Health (GCGH)	669	669	USA	North America
Indian Council of Medical Research (ICMR)	5 321	5 317	India	Asia
Medical Research Council (MRC)	26 704	26 637	UK	Europe
Wellcome Trust (WT)	34 967	34 886	UK	Europe

[16] The total publications for CSIRO between 2010 and 2015 was 5 112; 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 7.2.1.1 shows the percentage of the organisation's papers published each year to the total number of papers published between 2010 and 2015. Table 7.2.1.1 shows the same data as in Figure 7.2.1.1. Table 7.2.1.2 gives the number of papers per year for IMI and the select comparators.

FIGURE 7.2.1.1 TRENDS IN OUTPUT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

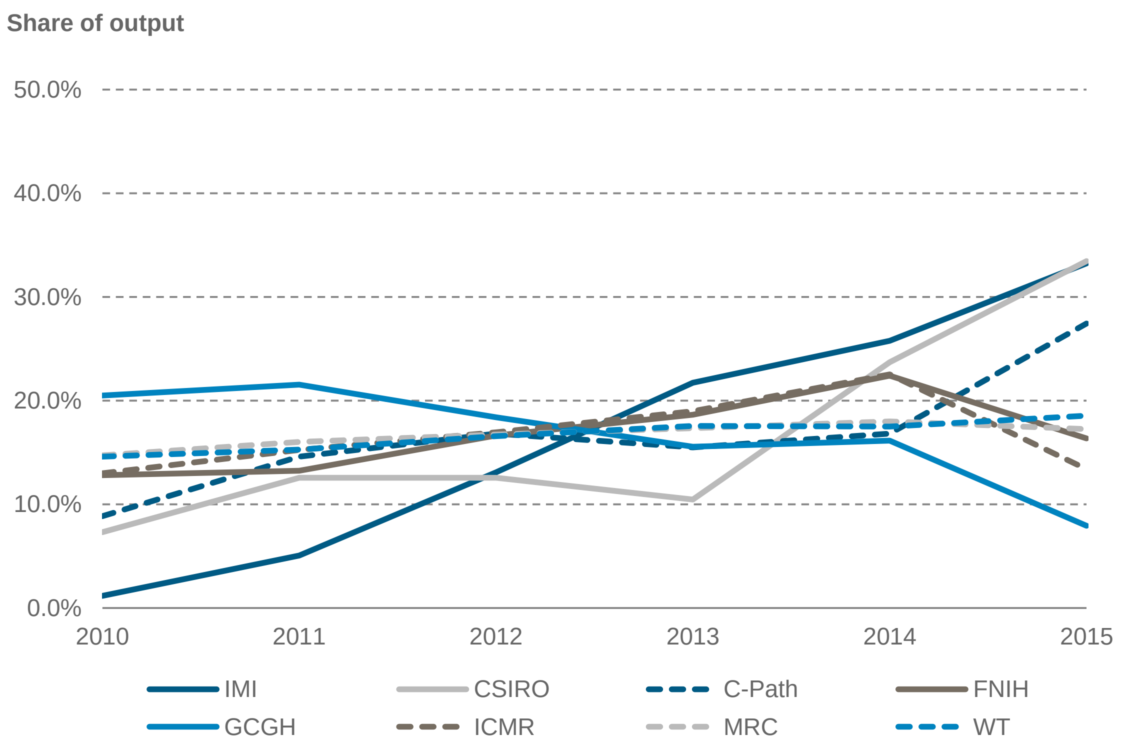


TABLE 7.2.1.1 SHARE OF OUPUT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	1.1%	7.3%	8.8%	12.8%	20.5%	13.0%	14.7%	14.6%
2011	5.1%	12.5%	14.6%	13.2%	21.5%	15.2%	16.0%	15.3%
2012	13.1%	12.5%	16.8%	16.6%	18.4%	16.9%	16.7%	16.6%
2013	21.7%	10.5%	15.5%	18.6%	15.5%	19.0%	17.3%	17.6%
2014	25.8%	23.7%	16.8%	22.4%	16.1%	22.5%	18.0%	17.5%
2015	33.2%	33.4%	27.4%	16.3%	7.9%	13.4%	17.3%	18.5%

TABLE 7.2.1.2 NUMBER OF PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	19	21	20	180	137	690	3 919	5 092
2011	84	36	33	186	144	810	4 265	5 329
2012	217	36	38	234	123	900	4 452	5 775
2013	361	30	35	262	104	1 009	4 614	6 127
2014	428	68	38	315	108	1 197	4 791	6 097
2015	552	96	62	230	53	711	4 596	6 466
Total	**1 661**	**287**	**226**	**1 407**	**669**	**5 317**	**26 637**	**34 886**

- FNIH, GCGH and ICMR were the comparators that showed a decrease in their share of output between 2010 and 2015.
- IMI had the highest percentage increase (2805.3%) of its research paper output between 2010 and 2015. The Wellcome Trust had the highest number of papers between 2010 and 2015.

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, field-normalised citation impact 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 field-normalised citation impact of IMI and the comparators between 2010 and 2015. Table 7.2.2.1 has the same data as in Figure 7.2.2.1.

FIGURE 7.2.2.1 TRENDS IN FIELD NORMALISED CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

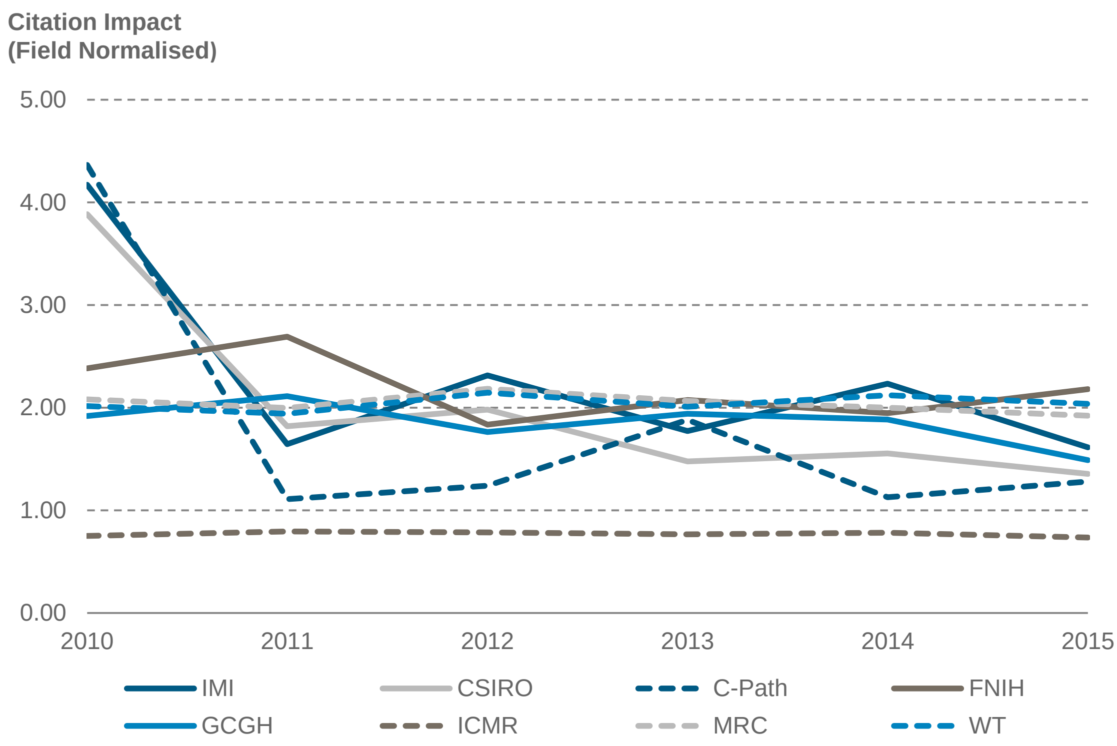


TABLE 7.2.2.1 FIELD NORMALISED CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	4.17	3.88	4.37	2.38	1.92	0.75	2.08	2.02
2011	1.65	1.82	1.11	2.69	2.11	0.79	2.00	1.94
2012	2.31	1.98	1.24	1.83	1.76	0.79	2.18	2.15
2013	1.77	1.48	1.88	2.07	1.94	0.77	2.07	2.01
2014	2.23	1.56	1.13	1.95	1.88	0.78	2.00	2.12
2015	1.61	1.35	1.28	2.18	1.49	0.74	1.92	2.04
AVG	**1.93**	**1.74**	**1.59**	**2.14**	**1.90**	**0.77**	**2.04**	**2.05**

- In 2012 and 2014, IMI had the highest citation impact (2.31 and 2.23 respectively) of the funding organisations analysed.
- The citation impact of MRC and the Wellcome Trust were stable at around twice the world average between 2010 and 2015, indicating highly-cited internationally significant research.
- The exceptionally high citation impact of IMI, CSIRO and C-Path project research in 2010 was driven by a small number of highly-cited papers.

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

As discussed in Section 3, an alternative indicator to field-normalised citation impact is journal normalised citation impact. 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 shows the journal normalised citation impact of IMI and the comparators between 2010 and 2015. Table 7.2.3.1 shows the same data as in Figure 7.2.3.1.

FIGURE 7.2.3.1 TRENDS IN JOURNAL NORMALISED CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

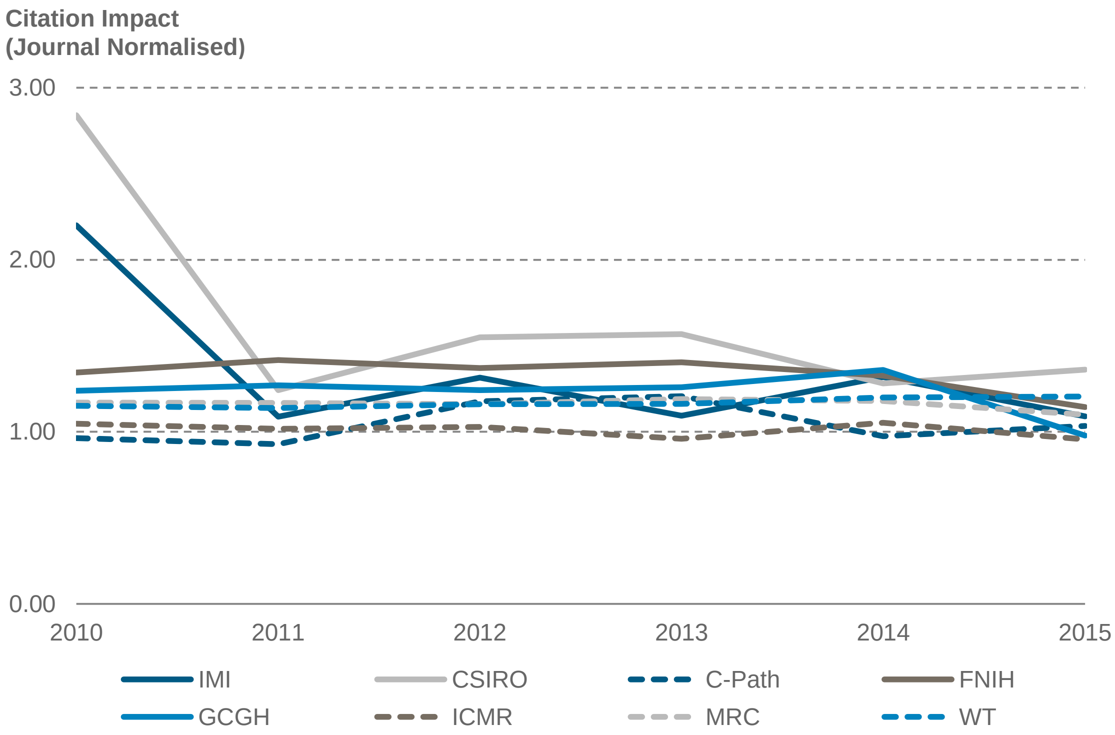


TABLE 7.2.3.1 JOURNAL NORMALISED CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	2.20	2.84	0.96	1.34	1.24	1.05	1.17	1.15
2011	1.09	1.24	0.93	1.42	1.27	1.02	1.17	1.14
2012	1.31	1.55	1.18	1.37	1.24	1.03	1.16	1.16
2013	1.09	1.57	1.21	1.40	1.26	0.96	1.19	1.16
2014	1.32	1.28	0.98	1.33	1.36	1.05	1.18	1.20
2015	1.09	1.36	1.03	1.14	0.98	0.96	1.10	1.20
AVG	**1.19**	**1.48**	**1.05**	**1.33**	**1.25**	**1.01**	**1.16**	**1.17**

- In 2014, IMI had the second highest journal normalised citation impact (1.32) of the organisations analysed, and GCGH had the highest (1.36).
- The journal normalised citation impact of the MRC and Wellcome Trust remained relatively stable, while CSIRO and C-Path showed greater variability. This is to be expected given the smaller number of papers funded by CSIRO and C-Path, 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 2015. Table 7.2.4.1 has the same data as in Figure 7.2.4.1.

FIGURE 7.2.4.1 TRENDS IN RAW CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

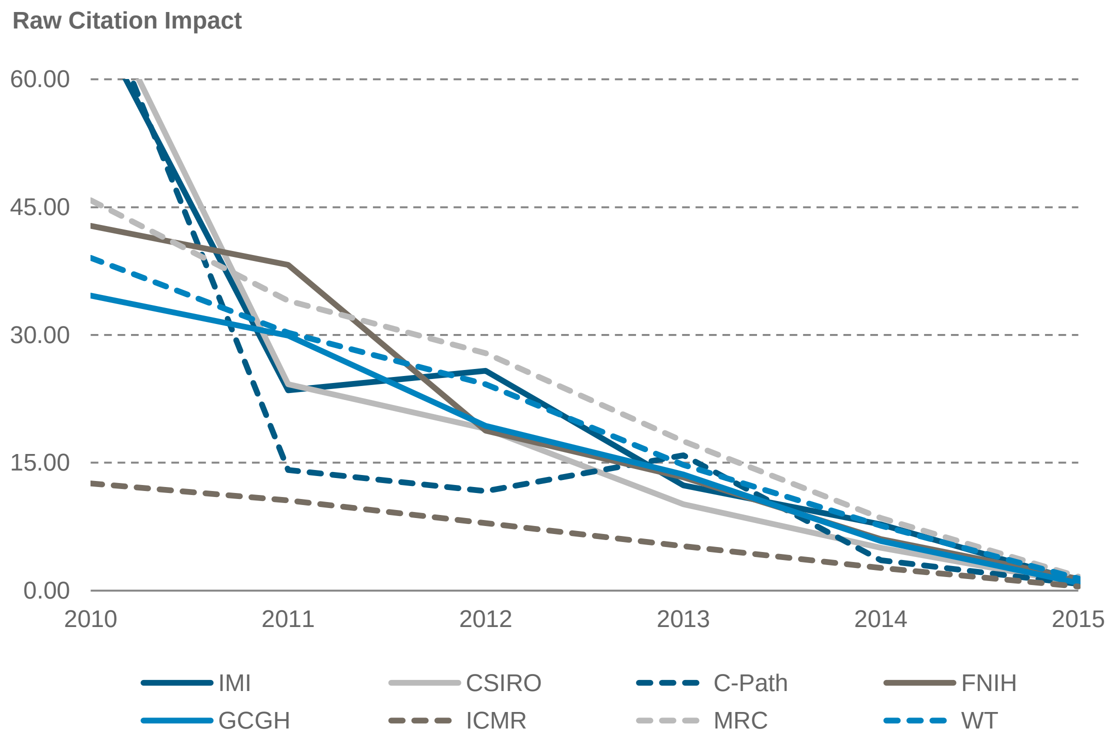


TABLE 7.2.4.1 RAW CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	67.89	71.52	72.05	42.81	34.61	12.58	45.81	39.04
2011	23.49	24.22	14.15	38.21	29.93	10.58	34.00	30.25
2012	25.79	19.00	11.66	18.78	19.35	7.93	27.86	24.21
2013	12.35	10.13	15.89	13.30	13.63	5.20	17.54	14.74
2014	7.78	5.01	3.58	6.03	5.83	2.66	8.53	7.63
2015	1.12	0.88	0.79	1.37	0.89	0.49	1.64	1.42
AVG	**10.40**	**13.20**	**13.68**	**17.70**	**20.22**	**6.24**	**21.70**	**18.51**

- The raw citation impact of all organisations decreased from 2010 to 2015. This is expected as more recent publications have had less time to accumulate citations, and the raw citation impact is not normalised.

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 2015 for IMI and the selected comparators. Table 7.2.5.1 has the same data as in Figure 7.2.5.1.

FIGURE 7.2.5.1 TRENDS IN UNCITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

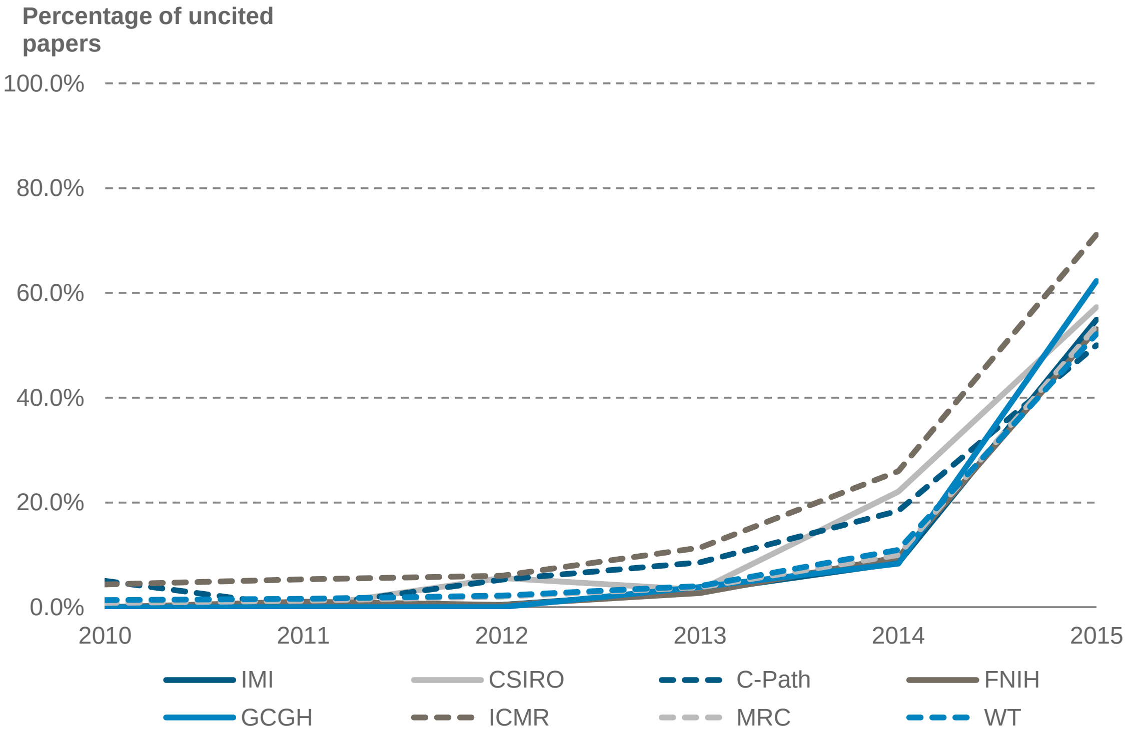


TABLE 7.2.5.1 PERCENTAGE OF UNCITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	0.0%	0.0%	5.0%	0.0%	0.0%	4.3%	0.8%	1.3%
2011	0.0%	0.0%	0.0%	1.1%	0.0%	5.3%	1.2%	1.6%
2012	0.5%	5.6%	5.3%	0.4%	0.0%	6.0%	2.0%	2.2%
2013	3.0%	3.3%	8.6%	2.7%	3.8%	11.4%	3.8%	4.1%
2014	8.4%	22.1%	18.4%	9.5%	8.3%	26.0%	10.0%	11.0%
2015	54.9%	57.3%	50.0%	53.0%	62.3%	71.2%	53.7%	52.2%
Total	**21.1%**	**25.4%**	**19.5%**	**11.5%**	**6.9%**	**19.9%**	**12.4%**	**13.1%**

- IMI project research had a similar percentage of uncited research as the comparators between 2010 and 2015. No IMI project papers published in 2010 and 2011 are uncited.
- 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 2014 and 2015 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 recognized as having a greater impact, and Thomson Reuters 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 2015 for IMI and the selected comparators. Table 7.2.6.1 has the same data as in Figure 7.2.6.1.

FIGURE 7.2.6.1 TRENDS IN HIGHLY CITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

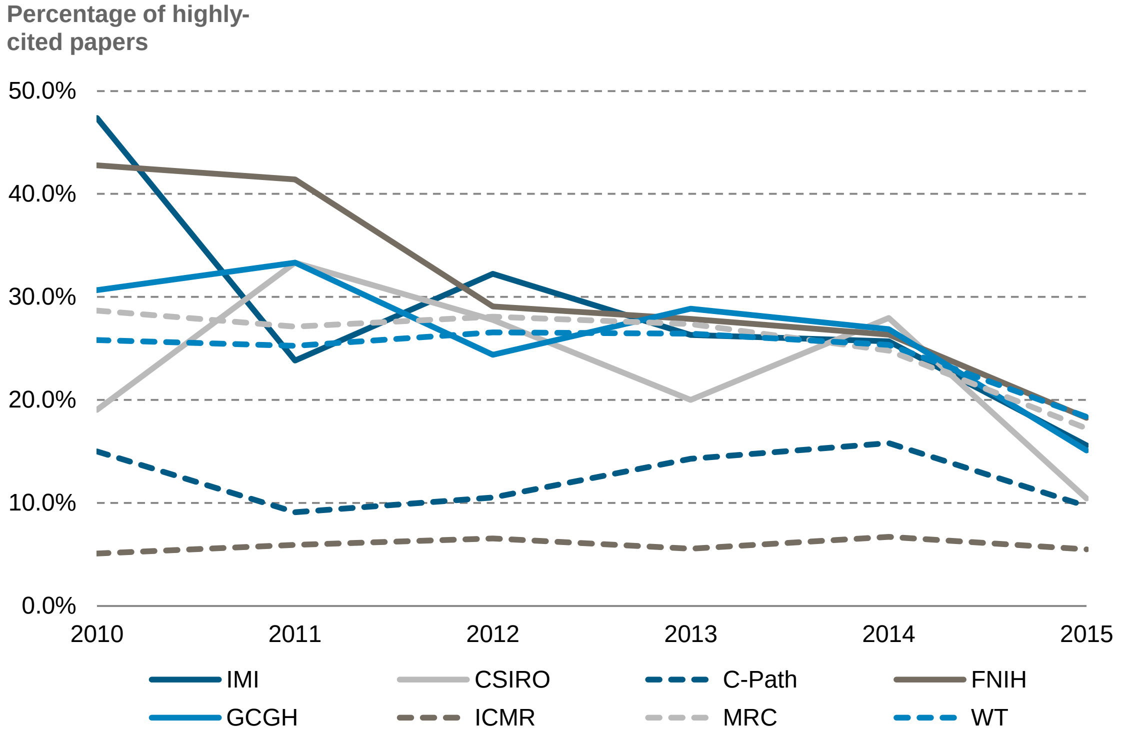


TABLE 7.2.6.1 PERCENTAGE OF HIGHLY CITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	47.4%	19.0%	15.0%	42.8%	30.7%	5.1%	28.7%	25.8%
2011	23.8%	33.3%	9.1%	41.4%	33.3%	5.9%	27.1%	25.3%
2012	32.3%	27.8%	10.5%	29.1%	24.4%	6.6%	28.1%	26.6%
2013	26.3%	20.0%	14.3%	27.9%	28.8%	5.6%	27.4%	26.4%
2014	25.7%	27.9%	15.8%	26.3%	26.9%	6.7%	24.8%	25.3%
2015	15.6%	10.4%	9.7%	18.3%	15.1%	5.5%	17.2%	18.3%
Total	**23.5%**	**21.3%**	**11.9%**	**29.9%**	**28.0%**	**6.0%**	**25.4%**	**24.5%**

- The majority of organisations had a higher than expected percentage of highly-cited papers between 2010 and 2015. The exception was ICMR.
- As of 2015, IMI had more highly-cited papers than CSIRO, C-Path, GCGH and ICMR.

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 2015 for IMI and the selected comparators. Table 7.2.7.1 has the same data as in Figure 7.2.6.1.

FIGURE 7.2.7.1 TRENDS IN OPEN-ACCESS PUBLICATIONS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

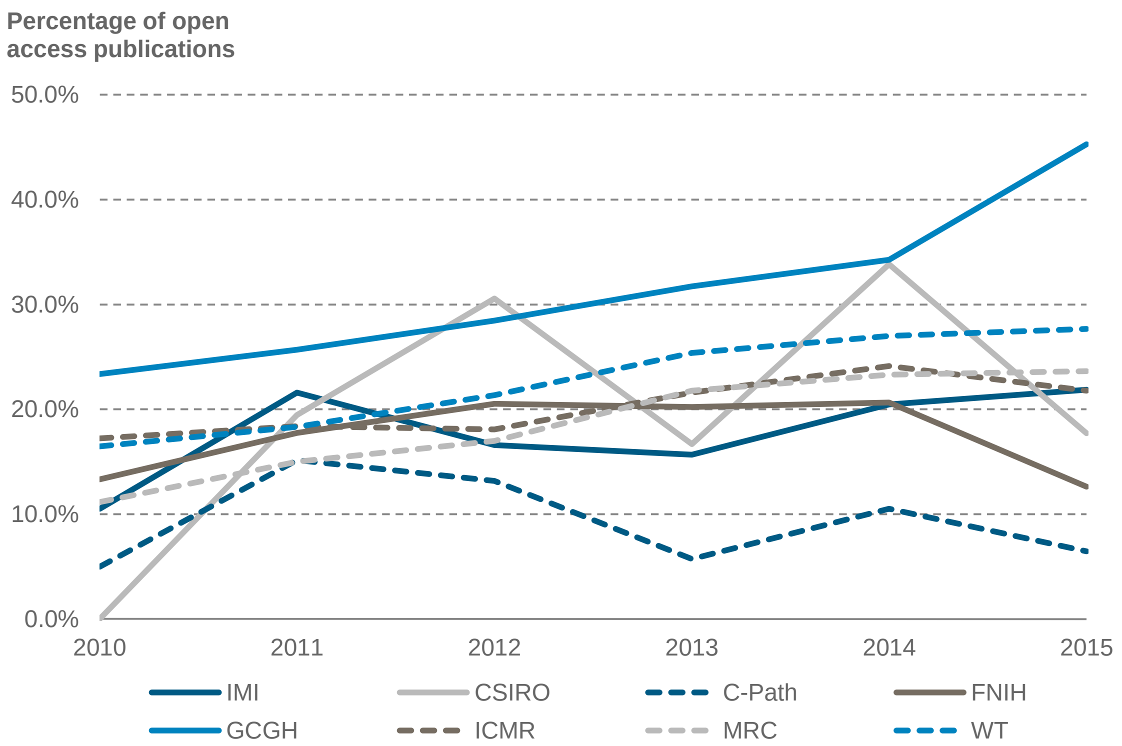


TABLE 7.2.7.1 PERCENTAGE OF OPEN-ACCESS PUBLICATIONS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2015

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	10.5%	0.0%	5.0%	13.3%	23.4%	17.2%	11.2%	16.5%
2011	21.6%	19.4%	15.2%	17.7%	25.7%	18.4%	14.9%	18.3%
2012	16.6%	30.6%	13.2%	20.5%	28.5%	18.1%	17.0%	21.3%
2013	15.7%	16.7%	5.7%	20.2%	31.7%	21.6%	21.8%	25.4%
2014	20.5%	33.8%	10.5%	20.6%	34.3%	24.1%	23.3%	27.0%
2015	21.9%	17.7%	6.5%	12.6%	45.3%	21.8%	23.7%	27.8%
Total	**19.3%**	**22.0%**	**9.3%**	**17.9%**	**29.6%**	**20.5%**	**18.9%**	**23.1%**

- The majority of organisations had around 20% of publications that were published in open-access journals, except for C-Path which had less than 10% of publications appeared in open-access journals.
- GCGH had the highest percentage of publications (29.6%) that were published in open-access journals between 2010 and 2015, peaking at 45.3% in 2015.

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, 2010-2015

	Number of papers	Citation impact (normalised at field level)	Percentage of uncited papers	Percentage of highly-cited papers
IMI	1 661	1.93	21.1%	23.5%
CSIRO	287	1.74	25.4%	21.3%
C-Path	226	1.59	19.5%	11.9%
FNIH	1 407	2.14	11.5%	29.9%
GCGH	669	1.90	6.9%	28.0%
ICMR	5 321	0.77	19.9%	6.0%
MRC	26 704	2.04	12.4%	25.4%
WT	34 967	2.05	13.1%	24.5%

8 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 25 and 16 geographic clusters respectively with the highest output within a 20km radius.

The clusters are visualised as maps in Figure 8.1 and 8.2. 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 8.1 and 8.2 show the research publication outputs of the individual clusters along with bibliometric indicators of their research performance.

The organisations that constitute the top five clusters within each of the European and North American regions are shown in Tables 8.3 and 8.4 respectively. The list of 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 8.5 and 8.6 respectively

FIGURE 8.1 MAP SHOWING EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2015

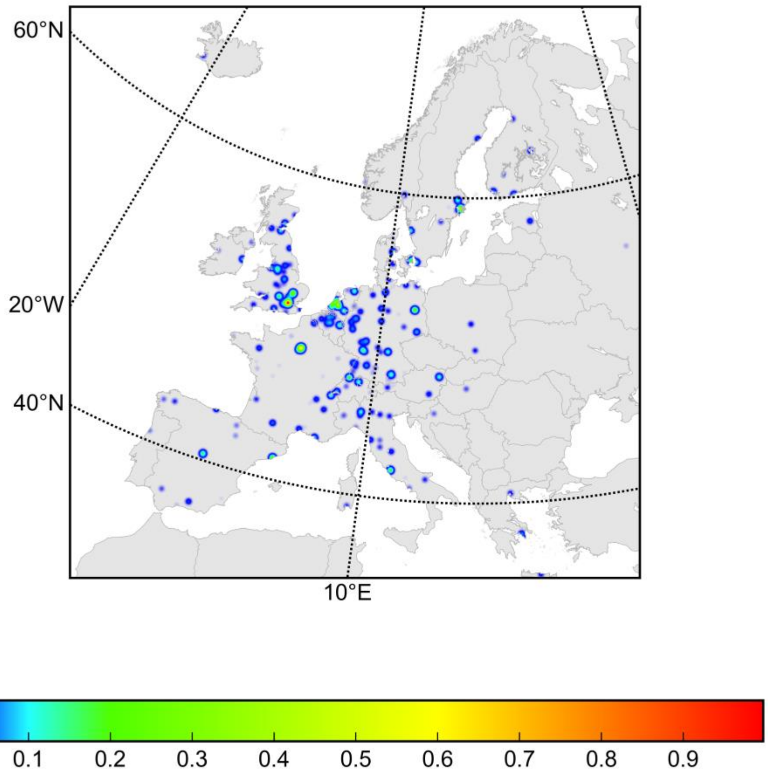


FIGURE 8.2 MAP SHOWING NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2015

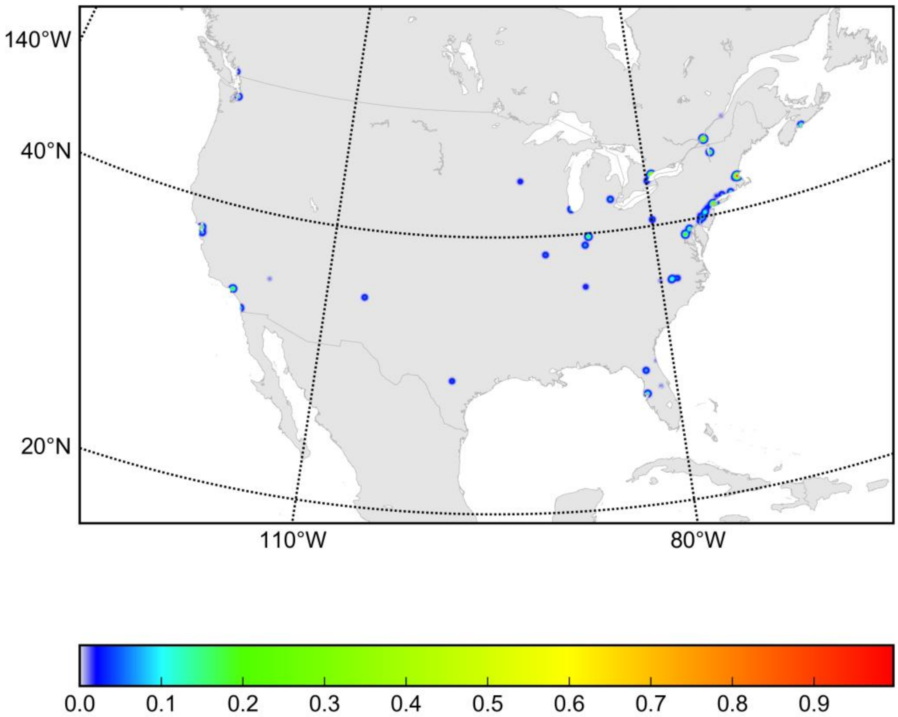


TABLE 8.1 OUTPUT AND RESEARCH PERFORMANCE OF EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2015

Cluster	Country	Papers	Raw Citation Impact	Field normalised citation impact	Journal normalised citation impact	Percentage of highly-cited papers	Percentage of internationally collaborative papers
London	United Kingdom	322	14.52	2.79	1.26	27.6%	76.4%
Utrecht	Netherlands	289	17.18	2.93	1.27	29.4%	74.7%
Stockholm	Sweden	179	10.72	2.42	1.12	25.1%	67.6%
Copenhagen	Denmark	124	10.51	2.28	1.27	19.4%	64.5%
Paris	France	122	17.34	3.08	1.25	34.4%	82.8%
Cambridge	United Kingdom	114	16.17	3.15	1.49	30.7%	85.1%
Basel	Switzerland	90	9.07	1.69	1.31	23.3%	91.1%
Barcelona	Spain	86	10.60	1.96	1.61	26.7%	61.6%
Berlin	Germany	77	11.97	2.44	1.48	35.1%	68.8%
Oxford	United Kingdom	68	15.46	2.87	1.77	35.3%	83.8%
Mannheim	Germany	66	15.68	2.67	1.06	24.2%	80.3%
Manchester	United Kingdom	63	14.23	2.77	1.48	28.6%	90.5%
Geneva	Switzerland	54	18.58	2.58	1.31	35.2%	85.2%
Uppsala	Sweden	54	8.53	2.17	1.35	25.9%	53.7%

Cluster	Country	Papers	Raw Citation Impact	Field normalised citation impact	Journal normalised citation impact	Percentage of highly-cited papers	Percentage of internationally collaborative papers
Rome	Italy	53	12.48	1.97	1.26	34.0%	69.8%
Maastricht	Netherlands	52	15.32	3.55	2.17	38.5%	84.6%
Erlangen	Germany	51	19.65	2.49	1.07	37.3%	68.6%
Nijmegen	Netherlands	51	20.85	3.08	1.58	21.6%	82.4%
Groningen	Netherlands	50	13.72	3.51	1.05	22.0%	84.0%
Munich	Germany	50	17.02	2.45	1.45	22.0%	90.0%
Vienna	Austria	48	9.50	1.57	0.98	22.9%	66.7%
Madrid	Spain	47	6.46	1.19	0.67	10.6%	59.6%
Zurich	Switzerland	45	14.16	2.02	0.94	26.7%	77.8%
Milan	Italy	37	14.14	4.45	1.42	35.1%	78.4%
Mölndal	Sweden	36	8.47	2.47	1.59	27.8%	86.1%

TABLE 8.2 OUTPUT AND RESEARCH PERFORMANCE OF NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2015

Cluster	Country	Papers	Raw Citation Impact	Field normalised citation impact	Journal normalised citation impact	Percentage of highly-cited papers	Percentage of internationally collaborative papers
Boston	USA	85	30.00	4.85	1.70	37.6%	96.5%
Toronto	Canada	51	20.00	3.40	1.50	33.3%	98.0%
New York	USA	45	20.79	4.15	1.31	20.0%	100.0%
Montreal	Canada	37	15.96	3.38	0.92	29.7%	100.0%
San Francisco	USA	26	28.76	9.63	1.73	53.8%	100.0%
Bethesda	USA	25	24.27	3.70	1.65	36.0%	96.0%
Burlington	USA	21	10.52	4.55	0.77	23.8%	100.0%
Indianapolis	USA	21	12.71	2.85	1.16	23.8%	100.0%
Los Angeles	USA	20	30.77	3.58	1.14	40.0%	95.0%
Baltimore	USA	16	12.65	5.15	1.84	43.8%	100.0%
Halifax	Canada	15	10.94	1.53	1.02	33.3%	93.3%
Titusville	USA	13	8.00	1.50	1.44	15.4%	92.3%
Groton	USA	12	11.71	1.53	1.00	33.3%	83.3%
Chapel Hill	USA	11	21.92	6.52	2.39	54.5%	100.0%
Seattle	USA	10	28.00	7.95	1.59	50.0%	100.0%
Tampa	USA	8	20.31	2.53	2.04	37.5%	100.0%

TABLE 8.3 INSTITUTIONS CONSTITUTING EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2015

Cluster	Country	Institutions	Publications
London	United Kingdom	Kings Coll London	158
		Imperial Coll London	97
		Univ Coll London	76
		London Sch Hyg Trop Med	23
		Med & Healthcare Prod Regulatory Agcy	22
		Queen Mary Univ London	13
		GlaxoSmithKline	12
		Guys St Thomas NHS Trust	11
		Birkbeck Univ London	11
		European Med Agcy	8
		S London Maudsley NHS Trust	8
		St Georges Univ London	5
		Kings Coll Hosp	5
		Kings College Hospital NHS Foundation Trust	5
		MRC Social Genet & Dev Psychiat SGDP Ctr	5
		Pfizer	2
		Royal Soc Chem	2
		Inst Canc Res	2
		UCB PHARMA	2
Utrecht	Netherlands	Leiden Univ	97
		Utrecht Univ Med Ctr	70
		VU Univ Amsterdam	67
		Univ Utrecht	63
		Erasmus Univ Rotterdam	62
		Univ Amsterdam	60
		Med Evaluat Board	13
		Netherlands Natl Inst Publ Hlth & Environm	10
		Univ Groningen	8
		St Antonius Hosp	6
		GlaxoSmithKline	3
		Netherlands Bioinformat Ctr	2
		Med Ctr Leeuwarden	1
Stockholm	Sweden	Karolinska Inst	97
		Karolinska Univ Hosp	70
		Stockholm Univ	14
		Stockholm City Coun	10
		Royal Inst Technol	9
		Astra Zeneca	4
Copenhagen	Denmark	Univ Copenhagen	61
		Lundbeck Corp	21
		Lund Univ	20
		Tech Univ Denmark	19
		Skane Univ Hosp	15
		Steno Diabet Ctr	7
		Novo Nordisk	7

Cluster	Country	Institutions	Publications
Paris	France	INSERM	68
		Univ Paris Descartes - Paris V	43
		Univ Paris Sud - Paris XI	43
		Pierre & Marie Curie Univ - Paris 6	33
		Atomic Ener Alt Ener Commission	27
		CNRS	27
		Univ Paris Diderot - Paris VII	24
		INST PASTEUR PARIS	14
		SANOFI FRANCE	10
		Inst Rechs Intes Serv	8
		Hop Cochin	7
		Museum National Dhistoire Naturelle	6
		Hop Necker Enfants Malad	6
		Univ Paris Sorbonne - Paris IV	6
		Univ Versailles St-Quentin-En-Yvelines	5
		INRIA	5
		Hop Europeen Georges-Pompidou	5
		Sanofi	2

TABLE 8.4 INSTITUTIONS CONSTITUTING NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2015

Cluster	Country	Institutions	Publications
Boston	USA	Harvard Univ	28
		Mass Gen Hosp	22
		Broad Inst	20
		Dana Farber Canc Ctr	11
		Pfizer	11
		Boston Univ	5
		ASTRA ZENECA	4
		Natl Heart Lung Blood Inst (NHLBI)	3
		Novartis	1
Toronto	Canada	Univ Toronto	29
		Hosp Sick Children Canada	22
		Ontario Inst Canc Res	7
New York	USA	Pfizer	17
		Columbia Univ	14
		New York Univ	11
		N Shore Long Isl Jewish Hlth Syst	10
Montreal	Canada	McGill Univ	31
		Univ Montreal	26
San Francisco	USA	Univ Calif San Francisco	18
		Univ Calif Berkeley	7
		Roche Holding	4
		Pfizer	1

TABLE 8.5 FIVE JOURNAL SUBJECT CATEGORIES IN WHICH EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH PUBLISHED MOST FREQUENTLY, 2010-2015

Cluster	Country	Journal Subject Category	Publications
London	United Kingdom	Neurosciences	90
		Psychiatry	61
		Pharmacology & Pharmacy	51
		Clinical Neurology	40
		Biochemistry & Molecular Biology	27
Utrecht	Netherlands	Pharmacology & Pharmacy	78
		Rheumatology	62
		Immunology	31
		Neurosciences	27
		Public, Environmental & Occupational Health	24
Copenhagen	Denmark	Anesthesiology	20
		Pharmacology & Pharmacy	19
		Endocrinology & Metabolism	18
		Neurosciences	17
		Clinical Neurology	14
Stockholm	Sweden	Rheumatology	39
		Neurosciences	26
		Immunology	22
		Clinical Neurology	17
		Genetics & Heredity	15
Paris	France	Neurosciences	32
		Psychiatry	20
		Pharmacology & Pharmacy	17
		Biochemistry & Molecular Biology	12
		Chemistry, Multidisciplinary	11

TABLE 8.6 FIVE JOURNAL SUBJECT CATEGORIES IN WHICH NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH PUBLISHED MOST FREQUENTLY, 2010-2015

Cluster	Country	Journal Subject Category	Publications
Boston	USA	Neurosciences	14
		Genetics & Heredity	13
		Pharmacology & Pharmacy	12
		Psychiatry	10
		Oncology	8
Toronto	Canada	Neurosciences	15
		Psychiatry	15
		Biochemistry & Molecular Biology	9
		Genetics & Heredity	8
		Oncology	5
New York	USA	Pharmacology & Pharmacy	22
		Psychiatry	12
		Neurosciences	11
		Toxicology	9
		Public, Environmental & Occupational Health	8
Montreal	Canada	Neurosciences	16
		Psychiatry	14
		Biochemistry & Molecular Biology	6
		Genetics & Heredity	5
		Psychology, Developmental	4
San Francisco	USA	Genetics & Heredity	6
		Clinical Neurology	5
		Neurosciences	5
		Pharmacology & Pharmacy	4
		Psychiatry	4

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 (currently the IP & Science business of Thomson Reuters).[17]

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 Thomson Reuters 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 Thomson Reuters 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

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

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.

Thomson Reuters 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.

Thomson Reuters frequently uses the broader field categories in the InCites: Essential Science Indicators^{SM} 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 Thomson Reuters, 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.

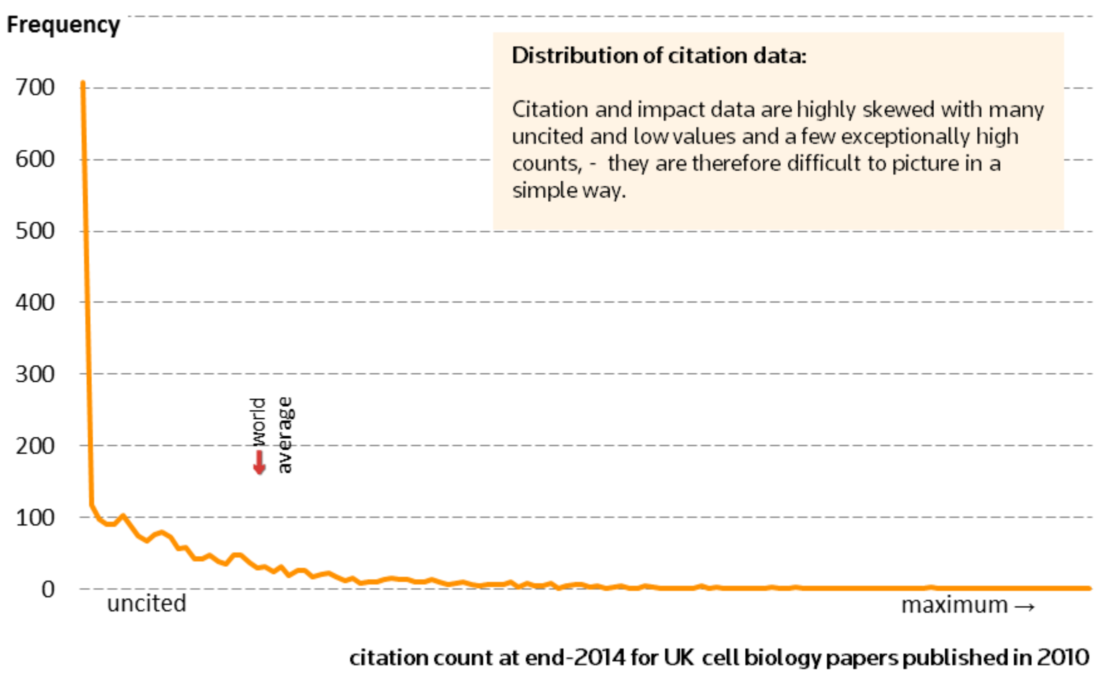
Citation counts

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.

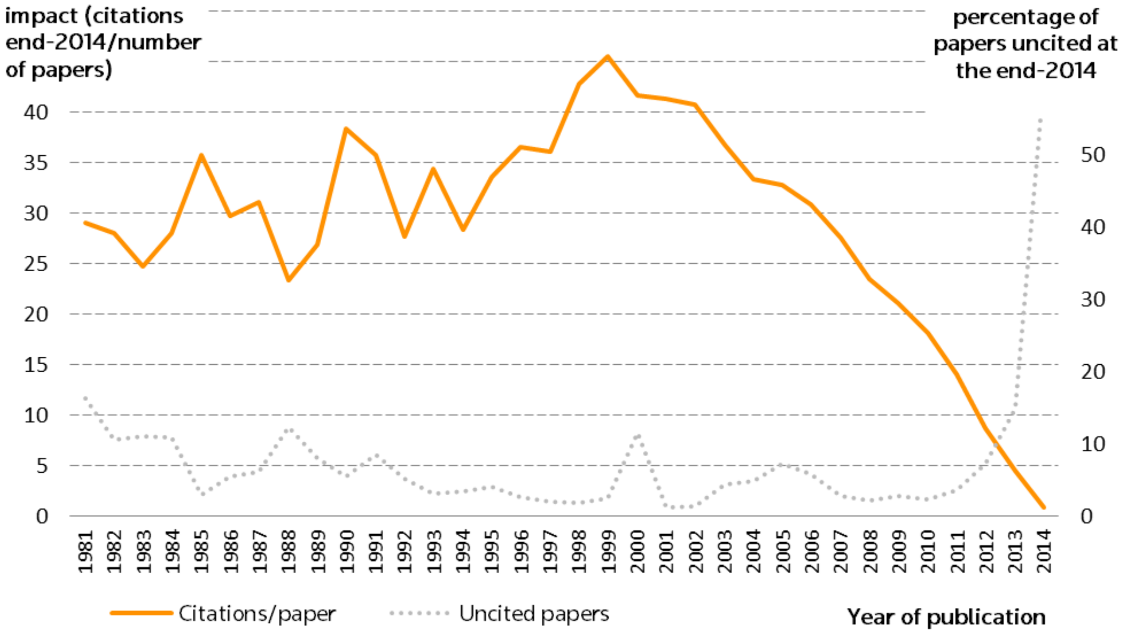
We do not seek to account separately for the effect of self-citation. If the citation count is significantly affected by self-citation then the paper is likely to have been infrequently cited. This is therefore only of consequence for low impact activity. Studies show that for large samples at national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

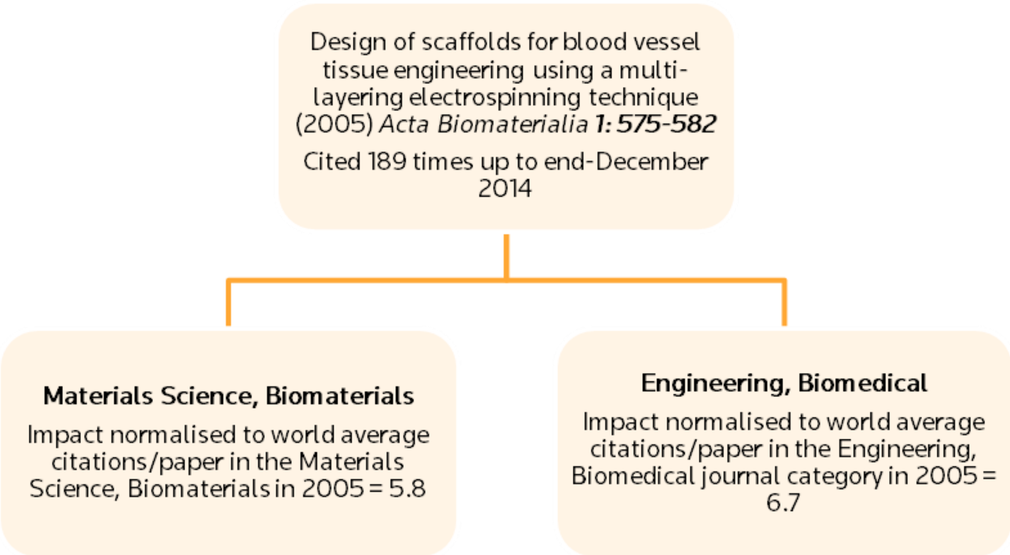
Papers are allocated according to the journal in which the paper is published. Some journals may be considered to be part of the publication record for more than one research field. As the example below illustrates, the journal *Acta Biomaterialia* is assigned to two journal categories: ***Materials 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 Thomson Reuters 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 Thomson Reuters 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 Thomson Reuters National Science Indicators baseline data for 2014.

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®

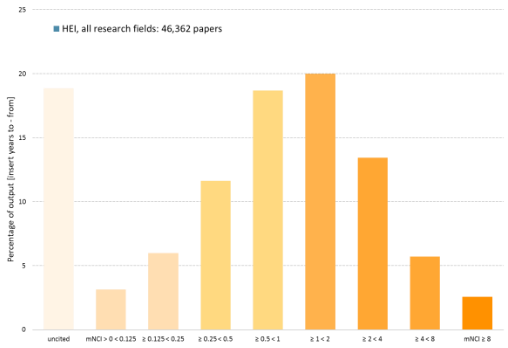
We have developed a bibliometric methodology[18] that shows the proportion of papers that are uncited and the proportion that lie in each of eight categories of relative citation rates, normalised (rebased) to world average. An Impact Profile® enables an examination and analysis of the strengths and 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 Thomson Reuters 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.

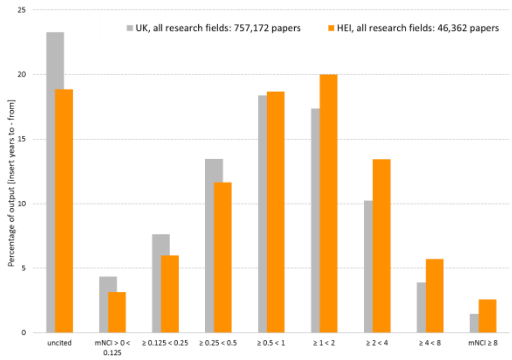
[18] Adams J, Gurney K & Marshall S (2007) Profiling citation impact: A new methodology. *Scientometrics* **72**: 325-344.

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

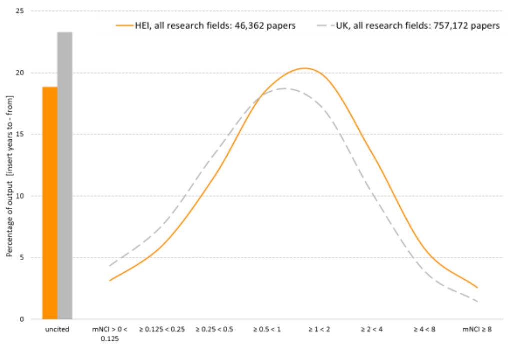
A



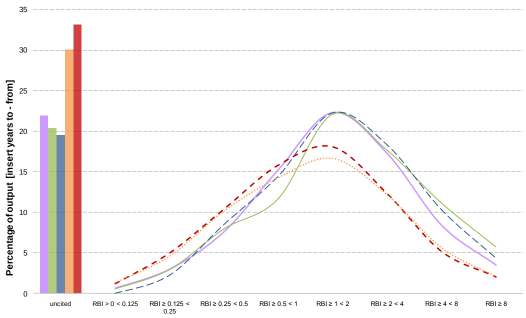
B



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'?

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

ESSENTIAL SCIENCE INDICATORS

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

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	0.63	0.47	0.87	1.97	283	1.91
NEWMEDS	0.61	0.57	1.00	2.18	133	2.17
EU-AIMS	0.66	0.62	1.00	2.29	122	2.65
EUROPAIN	0.37	0.29	0.69	1.36	113	1.93
PROTECT	0.96	0.64	1.00	2.59	72	1.13
IMIDIA	0.51	0.40	1.00	1.91	69	1.69
eTOX	0.28	0.37	0.49	1.14	57	1.79
EMIF	0.77	0.66	1.00	2.43	56	3.18
SUMMIT	0.52	0.49	1.00	2.01	50	1.66
QUIC-CONCEPT	0.74	0.59	0.94	2.27	47	2.38
Open PHACTS	0.66	0.55	0.83	2.04	47	2.06
MARCAR	0.48	0.37	0.40	1.25	42	1.66
OncoTrack	0.67	0.28	0.59	1.53	39	3.06
CHEM21	0.11	0.28	0.11	0.50	36	1.56
TRANSLOCATION	0.42	0.41	0.33	1.16	36	0.97
U-BIOPRED	0.56	0.47	1.00	2.02	36	2.09
PreDiCT-TB	0.65	0.52	0.84	2.01	31	1.98
DDMoRe	0.70	0.43	0.67	1.79	30	0.93
OrBiTo	0.67	0.50	0.30	1.47	30	2.14
PHARMA-COG	0.87	0.69	1.00	2.56	30	1.83
ELF	0.55	0.49	0.28	1.32	29	2.13
BioVacSafe	0.75	0.38	0.64	1.77	28	2.62
RAPP-ID	0.65	0.44	0.33	1.42	26	1.06
ABIRISK	0.54	0.42	1.00	1.97	24	1.71
MIP-DILI	0.57	0.39	0.81	1.77	23	1.34
StemBANCC	0.62	0.30	1.00	1.92	21	1.51
PRO- Active	0.52	0.75	1.00	2.27	21	2.33
DIRECT	1.00	0.52	1.00	2.52	16	2.26
COMBACTE	0.86	0.46	0.69	2.01	14	1.13
Compact	0.77	0.50	0.83	2.10	13	2.43
PREDECT	0.17	0.39	0.55	1.10	12	1.44
SAFE-T	0.55	0.48	0.80	1.82	11	1.20
AETIONOMY	1.00	0.31	1.00	2.31	10	0.38
EHR4CR	0.78	0.72	1.00	2.50	9	2.00
eTRIKS	0.89	0.96	1.00	2.85	9	2.92
K4DD	0.83	0.29	1.00	2.13	6	2.20
PRECISESADS	0.50	0.88	0.67	2.04	6	2.03
SPRINTT	0.83	0.42	0.17	1.42	6	1.18
ULTRA-DD	0.50	0.67	0.83	2.00	6	0.49
SafeSciMET	0.50	1.00	1.00	2.50	6	1.05

Project	X-sector Score	IntlScore	Metric 3	Collaboration Index	Total Project publications	Citation impact (normalised at field level)
FLUCOP	1.00	0.92	0.00	1.92	3	0.00
ENABLE	1.00	0.00	0.00	1.00	3	0.46
EBOVAC1	0.00	0.00	0.00	0.00	3	0.00
CANCER-ID	0.00	0.50	1.00	1.50	2	0.65
ADVANCE	0.50	0.00	0.00	0.50	2	5.20
DRIVE-AB	0.00	1.00	1.00	2.00	1	6.25
GetReal	1.00	0.00	1.00	2.00	1	1.78
EUPATI	1.00	1.00	1.00	3.00	1	1.78
PharmaTrain	1.00	1.00	1.00	3.00	1	0.00
WEB-RADR	1.00	0.75	0.00	1.75	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 22 papers that have been identified as hot papers and 390 papers that have been identified as highly-cited in the IMI project publication dataset.

HOT PAPERS ASSOCIATED WITH IMI PROJECTS

- BTCURE: HARRE, U et al. (2012) Induction of osteoclastogenesis and bone loss by human autoantibodies against citrullinated vimentin, Journal Of Clinical Investigation, 122: 1791-1802, doi:10.1172/JCI60975
- BTCURE: OKADA, Y et al. (2014) Genetics of rheumatoid arthritis contributes to biology and drug discovery, NATURE, 506: 376-+, 10.1038/nature12873
- EMIF: VOS, SJB et al. (2013) Preclinical Alzheimers disease and its outcome: a longitudinal cohort study, LANCET NEUROL, 12: 957-965, 10.1016/S1474-4422(13)70194-7
- eTOX: ARIGHI, CN et al. (2011) Overview of the BioCreative III Workshop, BMC Bioinformatics, 12: , doi:10.1186/1471-2105-12-S8-S1
- EU-AIMS: BAUDOUIN, SJ et al. (2012) Shared Synaptic Pathophysiology in Syndromic and Nonsyndromic Rodent Models of Autism, SCIENCE, 338: 128-132, 10.1126/science.1224159
- EU-AIMS: KONG, A et al. (2012) Rate of de novo mutations and the importance of fathers age to disease risk, NATURE, 488: 471-475, 10.1038/nature11396
- EU-AIMS: LAI, MC et al. (2014) Autism, LANCET, 383: 896-910, 10.1016/S0140-6736(13)61539-1
- EU-AIMS: LOTH, E et al. (2014) Oxytocin Receptor Genotype Modulates Ventral Striatal Activity to Social Cues and Response to Stressful Life Events, BIOL PSYCHIAT, 76: 367-376, 10.1016/j.biopsych.2013.07.043
- EUROPAIN: FINNERUP, NB et al. (2010) The evidence for pharmacological treatment of neuropathic pain, PAIN, 150: 573-581, 10.1016/j.pain.2010.06.019
- MARCAR: THOMSON, JP et al. (2012) Non-genotoxic carcinogen exposure induces defined changes in the 5-hydroxymethylome, Genome Biology, 13: , doi:10.1186/gb-2012-13-10-R93
- NEWMEDS: JACQUEMONT, S et al. (2011) Mirror extreme BMI phenotypes associated with gene dosage at the chromosome 16p11.2 locus, NATURE, 478: 97-U111, 10.1038/nature10406
- NEWMEDS: KAPUR, S et al. (2012) Why has it taken so long for biological psychiatry to develop clinical tests and what to do about it?, MOL PSYCHIATR, 17: 1174-1179, 10.1038/mp.2012.105
- NEWMEDS: KIROV, G et al. (2012) De novo CNV analysis implicates specific abnormalities of postsynaptic signalling complexes in the pathogenesis of schizophrenia, MOL PSYCHIATR, 17: 142-153, 10.1038/mp.2011.154
- NEWMEDS: STEFANSSON, H et al. (2014) CNVs conferring risk of autism or schizophrenia affect cognition in controls, NATURE, 505: 361-+, 10.1038/nature12818

- NEWMEDS: SULLIVAN, PF et al. (2013) A mega-analysis of genome-wide association studies for major depressive disorder, Molecular Psychiatry, 18: 497-511, doi:10.1038/mp.2012.21
- NEWMEDS: UHER, R et al. (2013) Common Genetic Variation and Antidepressant Efficacy in Major Depressive Disorder: A Meta-Analysis of Three Genome-Wide Pharmacogenetic Studies, American Journal Of Psychiatry, 170: 207-217, doi:10.1176/appi.ajp.2012.12020237
- OncoTrack: WEGNER, KD . (2015) Quantum dots: bright and versatile in vitro and in vivo fluorescence imaging biosensors, CHEM SOC REV, 44: 4792-4834, 10.1039/c4cs00532e
- Open PHACTS: WILLIAMS, AJ et al. (2012) Towards a gold standard: regarding quality in public domain chemistry databases and approaches to improving the situation, Drug Discovery Today, 17: 685-701
- PHARMA-COG: FRISONI, GB et al. (2010) The clinical use of structural MRI in Alzheimer disease, NAT REV NEUROL, 6: 67-77, 10.1038/nrneurol.2009.215
- PreDiCT-TB: ZUMLA, AI et al. (2014) New antituberculosis drugs, regimens, and adjunct therapies: needs, advances, and future prospects, LANCET INFECT DIS, 14: 327-340, 10.1016/S1473-3099(13)70328-1
- PROTECT: NOREN, GN et al. (2014) Zoo or Savannah? Choice of Training Ground for Evidence-Based Pharmacovigilance, DRUG SAFETY, 37: 655-659, 10.1007/s40264-014-0198-z
- SUMMIT: BOEKHOLDT, SM et al. (2012) Association of LDL Cholesterol, Non-HDL Cholesterol, and Apolipoprotein B Levels With Risk of Cardiovascular Events Among Patients Treated With Statins A Meta-analysis, Jama-Journal Of The American Medical Association, 307: 1302-1309, doi:10.1001/jama.2012.366
- Unassigned: ATKINSON, RW et al. (2013) Long-Term Exposure to Outdoor Air Pollution and Incidence of Cardiovascular Diseases, EPIDEMIOLOGY, 24: 44-53, 10.1097/EDE.0b013e318276ccb8

HIGHLY-CITED PAPERS ASSOCIATED WITH IMI PROJECTS

- ABIRISK: KIESEIER, BC et al. (2013) Disease Amelioration With Tocilizumab in a Treatment-Resistant Patient With Neuromyelitis Optica Implication for Cellular Immune Responses, JAMA NEUROL, 70: 390-393, 10.1001/jamaneurol.2013.668
- ABIRISK: UNGAR, B et al. (2014) The temporal evolution of antidrug antibodies in patients with inflammatory bowel disease treated with infliximab, GUT, 63: 1258-1264, 10.1136/gutjnl-2013-305259
- ABIRISK: WARNKE, C et al. (2013) Changes to anti-JCV antibody levels in a Swedish national MS cohort, J NEUROL NEUROSUR PS, 84: 1199-1205, 10.1136/jnnp-2012-304332
- ABIRISK: WARNKE, C et al. (2013) Natalizumab affects the T-cell receptor repertoire in patients with multiple sclerosis, NEUROLOGY, 81: 1400-1408, NULL
- ABIRISK: WENNIGER, LJMD et al. (2013) Immunoglobulin G4+clones identified by next-generation sequencing dominate the B cell receptor repertoire in immunoglobulin G4 associated cholangitis, HEPATOLOGY, 57: 2390-2398, 10.1002/hep.26232
- ADVANCE: STURKENBOOM, MCJM . (2015) The narcolepsy-pandemic influenza story: Can the truth ever be unraveled?, VACCINE, 33: B6-B13, 10.1016/j.vaccine.2015.03.026
- BioVacSafe: ANDERSEN, P et al. (2014) Tuberculosis vaccines - rethinking the current paradigm, TRENDS IMMUNOL, 35: 387-395, 10.1016/j.it.2014.04.006
- BioVacSafe: CLIFF, JM et al. (2015) The human immune response to tuberculosis and its treatment: a view from the blood, IMMUNOL REV, 264: 88-102, 10.1111/imr.12269
- BioVacSafe: KAUFMANN, SHE et al. (2014) Progress in tuberculosis vaccine development and host-directed therapies-a state of the art review, LANCET RESP MED, 2: 301-320, 10.1016/S2213-2600(14)70033-5
- BioVacSafe: KAUFMANN, SHE . (2014) Tuberculosis vaccine development at a divide, CURR OPIN PULM MED, 20: 294-300, 10.1097/MCP.0000000000000041

- BioVacSafe: KAUFMANN, SHE . (2013) Tuberculosis vaccines: Time to think about the next generation, SEMIN IMMUNOL, 25: 172-181, 10.1016/j.smim.2013.04.006
- BioVacSafe: KAUFMANN, SHE et al. (2013) Inflammation in tuberculosis: interactions, imbalances and interventions, CURR OPIN IMMUNOL, 25: 441-449, 10.1016/j.coi.2013.05.005
- BioVacSafe: KAUFMANN, SHE . (2012) Tuberculosis vaccine development: strength lies in tenacity, TRENDS IMMUNOL, 33: 373-379, 10.1016/j.it.2012.03.004
- BioVacSafe: MAERTZDORF, J et al. (2012) Enabling biomarkers for tuberculosis control, INT J TUBERC LUNG D, 16: 1140-1148, 10.5588/ijtld.12.0246
- BioVacSafe: MAERTZDORF, J et al. (2015) Toward a Unified Biosignature for Tuberculosis, CSH PERSPECT MED, 5: NULL, 10.1101/cshperspect.a018531
- BioVacSafe: OLAFSDOTTIR, T et al. (2015) Molecular signatures of vaccine adjuvants, VACCINE, 33: 5302-5307, 10.1016/j.vaccine.2015.04.099
- BioVacSafe: RAPPUOLI, R et al. (2014) Vaccines, new opportunities for a new society, P NATL ACAD SCI USA, 111: 12288-12293, 10.1073/pnas.1402981111
- BioVacSafe: TRICOT, S et al. (2015) Evaluating the Efficiency of Isotope Transmission for Improved Panel Design and a Comparison of the Detection Sensitivities of Mass Cytometer Instruments, CYTOM PART A, 87A: 357-368, 10.1002/cyto.a.22648
- BioVacSafe: WEINER, J et al. (2014) Recent advances towards tuberculosis control: vaccines and biomarkers, J INTERN MED, 275: 467-480, 10.1111/joim.12212
- BTCURE: AKHMETSHINA, A et al. (2012) Activation of canonical Wnt signalling is required for TGF-beta-mediated fibrosis, NAT COMMUN, 3: NULL, 10.1038/ncomms1734
- BTCURE: ALBRECHT, A et al. (2013) The structural basis of MRI bone erosions: an assessment by microCT, ANN RHEUM DIS, 72: 1351-1357, 10.1136/annrheumdis-2012-201982
- BTCURE: AMARA, K et al. (2013) Monoclonal IgG antibodies generated from joint-derived B cells of RA patients have a strong bias toward citrullinated autoantigen recognition, J EXP MED, 210: 445-455, 10.1084/jem.20121486
- BTCURE: AMMARI, M et al. (2013) Impact of microRNAs on the understanding and treatment of rheumatoid arthritis, CURR OPIN RHEUMATOL, 25: 225-233, 10.1097/BOR.0b013e32835d8385
- BTCURE: BECKER, C et al. (2013) Complex Roles of Caspases in the Pathogenesis of Inflammatory Bowel Disease, GASTROENTEROLOGY, 144: 283-293, 10.1053/j.gastro.2012.11.035
- BTCURE: BLUML, S et al. (2015) Loss of phosphatase and tensin homolog (PTEN) in myeloid cells controls inflammatory bone destruction by regulating the osteoclastogenic potential of myeloid cells, ANN RHEUM DIS, 74: 227-233, 10.1136/annrheumdis-2013-203486
- BTCURE: BRINK, M et al. (2013) Multiplex Analyses of Antibodies Against Citrullinated Peptides in Individuals Prior to Development of Rheumatoid Arthritis, ARTHRITIS RHEUM-US, 65: 899-910, 10.1002/art.37835
- BTCURE: BURSKA, AN et al. (2014) Gene expression analysis in RA: towards personalized medicine, PHARMACOGENOMICS J, 14: 93-106, 10.1038/tpj.2013.48
- BTCURE: CHOI, IY et al. (2015) MRP8/14 serum levels as a strong predictor of response to biological treatments in patients with rheumatoid arthritis, ANN RHEUM DIS, 74: 499-505, 10.1136/annrheumdis-2013-203923
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