Bibliometric analysis of ongoing projects

6th report
June 2015

Prepared by Thomson Reuters on behalf of IMI Programme
Office under a public procurement procedure
Document reference: IMI2/INT/2015-01848

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1 EXECUTIVE SUMMARY

This report presents a bibliometric analysis of IMI project research published between 2009 and 2014 associated with Funding Calls 1 to 9, and 38 IMI funded projects, using citations as an index of research quality and co-authorship as an index of collaboration. This is the sixth report commissioned by IMI.

The overall volume of IMI project research has increased rapidly since 2009 and the initiative continues to show an exceptionally high growth rate. This is partly to be expected as the number of funded projects rises and those projects funded earliest in the program begin to publish. To date, IMI projects have produced 1 134 publications which have been matched to the Thomson Reuters Web of Science™. This represents a 53.1% increase from the 658 publications matched to the Web of Science in Report 5, which included IMI project research published between 2009 and 2013.

Around three quarters of IMI project research 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 6.09. 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 Pharmacology & Pharmacy, Rheumatology, and Neurosciences journals

The quality of IMI project research (as indexed by citation impact) has been maintained while output has grown. The citation impact of IMI project research (2.19) was more than twice the world average (1.00), which indicates the research was internationally influential. The citation impact for IMI project papers (2.19) was nearly twice the EU's citation impact (1.10), between 2010 and 2014 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 received.

The output of individual IMI projects has also increased. BTCure (Call 2) was the most prolific project in any of the Funding Calls, with 212 publications as of this report. This is 60.6% increase from the 132 publications attributed to BTCure in Report 5. Among more recent projects, EU-AIMS (Call 3) has shown substantial growth in output, from 41 publications in Report 5 to 73 publications in this report, and its research was cited more than three times (3.37) the world average.

Projects funded by IMI were highly collaborative. About 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 citation impact well above twice the world average with a clear margin over 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 the USA, Canada, and Europe.

Even though IMI is a 'young' funding agency its performance was on par with the well-established funding bodies such as the MRC and Wellcome Trust, as indicated by the citation impact, and percentage of highly-cited papers (24.0%). In terms of citation impact, IMI's performance was best among the funding organisations analysed.

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

As of December 2014, there were 50 IMI projects from Funding Calls 1 to 11, of which 23 were launched since 1 January 2012, and four since 1 January 2014. 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. Many 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 1 134 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 2014 (Figure 4.3.1).
- IMI project publications appeared most frequently in *PLoS One* (58 publications), followed by *Annals of the Rheumatic Diseases* (42 publications). The 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 project research was published is the *New England Journal of Medicine*, with a Journal Impact Factor of 54.42. IMI project research published five publications in *Nature*, which had a Journal Impact Factor of 42.35 (Table 4.4.2).
- IMI project research was most frequently published in Pharmacology & Pharmacy journals (Figure 4.5.1). Of the 173 papers published in this field, 24.3% of them were highly-cited, 1.7% appeared in open access journals, and the average citation impact of these papers is 1.81 (Table 4.5.3).
- IMI project research had a higher citation impact for the fields it most frequently published in than the European (EU-28) papers for the same research fields (journal subject categories) (Table 4.6.1).
- Nearly a quarter (24.0%) of IMI papers were highly-cited, that is, they belong to the world's top 10% of papers in that journal category and year of publication, when ranked by number of citations received (Table 4.7.1).
- The citation impact for IMI project papers was more than twice the world average (2.19) over the five-year period, 2010-2014. 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 156 publications, before falling in 2014. The number of publications for Calls 2, 3, and 4 increased every year preceding the initial set of publications for that call (Figure 5.1.1).
- Research associated with five of the projects in Call 1 (eTOX, NEWMEDS, PRO-Active, SAFE-T, U-BIOPRED) was cited over twice the world average. In particular, research associated with the NEWMEDS project was cited at a level approaching three times the world average (2.83) (Figure 5.2.1).
- IMI project research is collaborative at sector, institution and country level. More than half (59.7%) of all IMI project papers were published by researchers affiliated with more than one sector. More than three-quarters (78.8%) of IMI project papers were collaborative between institutions. More than half (53.4%) of all IMI project papers were internationally collaborative (Table 6.1.1).
- BTCure had the greatest number of cross-sector collaborative publications, 112 out of 212 (53%), as well as the most collaborative publications involving more than two countries (108 out of 212) (Table 6.2.1-6.2.3).
- IMI had the highest percentage increase (2142.1%) of its research paper output between 2010 and 2014 (Table 7.2.1.2).
- IMI had the highest average citation impact (2.19) of funding organisations analysed (Table 7.3.1).

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 bi-annual reports focusing on research publications and patents produced by IMI funded researchers. This report is the sixth evaluation in the series. Since the number of applications and awards specifically generated by IMI projects to date is small, IMI personnel have advised that patent analyses are not required for this sixth 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 2014-2024. 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 with a budget of €2 billion equally shared between EU and EFPIA.

To date, IMI have announced eleven Calls for proposals from its first phase and another 4 Calls for proposals under its second phase to be funded. The first Funding Call was announced in 2008 and the latest, was launched on 17 December 2014. This report covers the research output (publications and papers) from Calls 1 to 9 of the first IMI phase (although no publications from Call 7 were found). This report covers 38 IMI projects which are from Calls 1 through 9.

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.
- Sections 4 presents analyses of IMI project publications overall, including trends in publications, frequently used journals, 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 output of individual project. Where possible the IMI projects are benchmarked to world output and overall IMI output.
- Section 6 presents collaboration analyses for IMI publication 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.

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℠ 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

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[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 JU project identified using grant acknowledgments, title and abstract text search, as well as other parameters developed in conjunction with JU staff. There are currently 50 active IMI JU projects. IMI JU staff validated the publications identified by this process and the list of projects to be analysed was provided by IMI JU 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 2014. The census point for inclusion of publications into the fifth report was December 2013. 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 2014.

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 which have Thomson Reuters citation data is outlined in Figure 4.1.1.

The IMI project dataset started with 764 publications which were previously identified by IMI. Separately, 1 065 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 1 232 unique publication records which were identified for IMI-supported projects. Of these 1 232 publications, 1 231 unique publications were matched to underlying Thomson Reuters Web of Science database, 50 were eliminated since they were published in 2015, and 47 were excluded by IMI on the basis that they were not IMI publications. Therefore, 1 134 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. Thirty-nine 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 end-2014. Normalised bibliometric indicators were calculated using standard methodology and the Thomson Reuters National Science Indicators (NSI) database for 2014.

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

IMI-identified publications

- There were 764 publications previously idenfitied as IMI publications.

Web of Science

- 1,065 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 to1,232 unique records in IMI dataset overall

Publications (total)

- 1,231 were matched in Thomson Reuters database
- 50 records are not used because they were published in 2015
- IMI reviewed and removed another 47 non-IMI publications

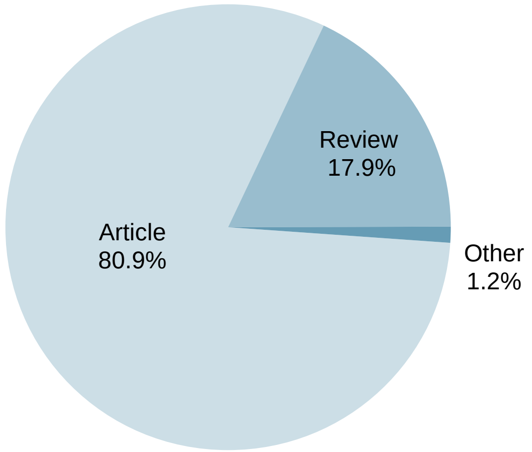
IMI project dataset

- 1,134 unique Web of Science publications linked to Thomson Reuters citation databases; all publications were published before end-2014 and so have 2014 citation data
- 1,121 papers (articles and reviews; 98.8%); 13 other document types (9 editorials, 2 meeting abstracts, 1 letter, and 1 news-item; 1.2%)

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.

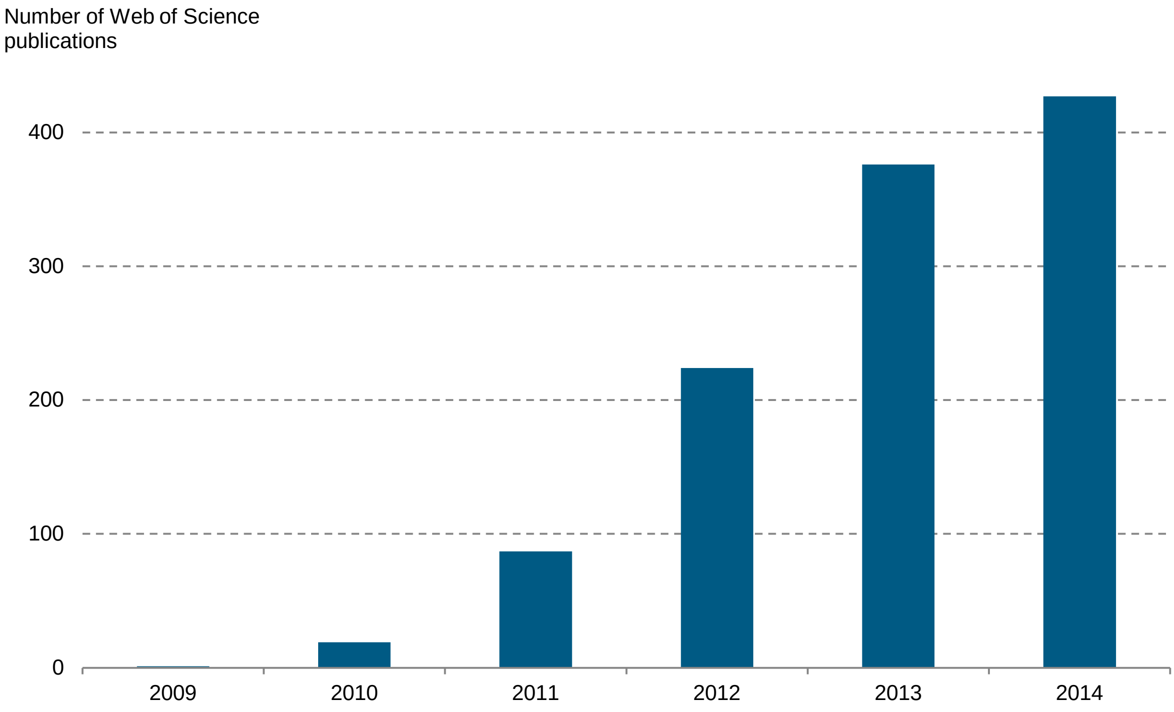


IMI project research comprised 1 134 unique Web of Science publications. Of these publications 98.8% were substantive articles and reviews with only thirteen 13 documents not falling into this grouping. These documents (classified as 'Other') comprised nine editorials, two meeting abstracts, one letter, 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 2014.

FIGURE 4.3.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS FOR IMI PROJECTS BY YEAR, 2009-2014

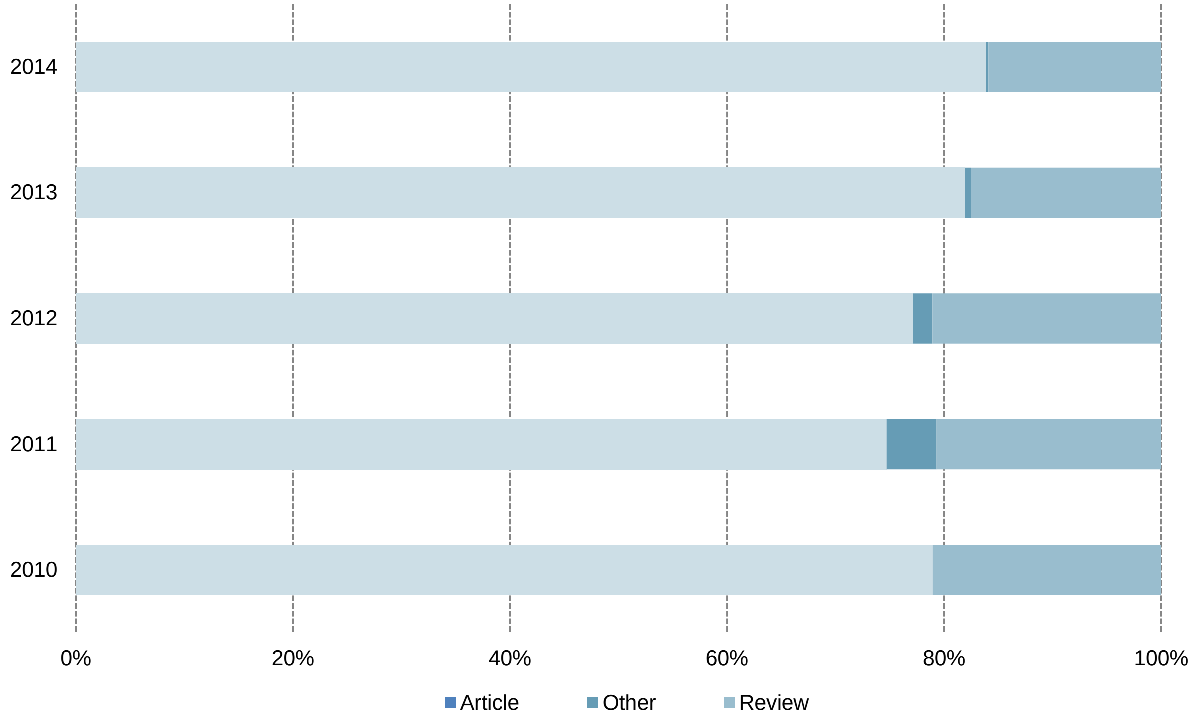


IMI project research continued to show substantial growth with publication count increasing every year between 2009 and 2014:

- The percentage change in the output of IMI project-supported publications between 2013 and 2014 was 12.7%, and the percentage change of publications between 2012 and 2014 was 62.4%.
- IMI projects produced more than 400 publications in 2014 (427 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 2014.[4]

FIGURE 4.3.2 CATEGORISATION OF WEB OF SCIENCE PUBLICATIONS FOR IMI PROJECTS BY YEAR AND DOCUMENT TYPE, 2010-2014



- 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 2014. Review papers were approximately one-fifth of publications between 2010 and 2012, but decreased to 17.5% in 2013 and 15.9% in 2014.

[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 that appeared most frequently[5] (ranked by number of publications) in the IMI project publications dataset, 2009-2014, are listed in Table 4.4.1. Together, the 20 most frequently used journals cover 328 Web of Science publications - more than one-quarter (28.9%) of the total number of publications in the dataset.

IMI project publications appeared most frequently in *PLoS One* (58 publications), followed by *Annals of the Rheumatic Diseases* (42 publications). The publications from *Annals of the Rheumatic Diseases* were exclusively from the Call 2 project BTCure, and are associated with the Web of Science journal category of Rheumatology.

There was a strong focus on Rheumatology, as three of the top six journals fall into that category. However, the top 20 journals for IMI projects highlight the diversity of IMI-supported research. There are multidisciplinary titles (such as *PLoS One*, *PNAS*), as well as specialised titles in other disease areas such as diabetes (such as *Diabetologia*, *Diabetes*).

All but three of the journals in Table 4.4.1 (*Molecular Informatics*, *European Journal of Pharmaceutical Sciences*, *Pharmacoepidemiology* and *Drug Safety*) were in the top quartile when ranked by Journal Impact Factor. These three journals were in the second quartile by Journal Impact Factor.

IMI project publications were published in a total of 473 journals, of which 293 were ranked in the top quartile (by Journal Impact Factor) of journals in their specific journal category. A total of 830 publications (73.2% of IMI project publications) were published in these well regarded journals. The average Journal Impact Factor of all IMI project publications is 6.09.

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 54.42. IMI projects published five publications in *Nature*, which had a Journal Impact Factor of 42.35.

The 11 journals appearing most frequently (ranked by number of open access publications) in the IMI project publications dataset, 2009-2014, are listed in Table 4.4.3. Of all the open access journals in which IMI project research was published, *Genome Biology* had the highest impact factor (10.465). *PLoS One* is the open access journal with the highest number of IMI publications (58).

[5] Table 4.4.1 uses a frequency threshold of at least eight publications. This is a change from the fourth report where this threshold was at least five publications.

TABLE 4.4.1 JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP TWENTY RANKED BY NUMBER OF WEB OF SCIENCE PUBLICATIONS, 2009-2014

Journal	Number of Web of Science Publications	Number of Papers	Journal Impact Factor (2013)	Web of Science Journal Categories
PLoS One	58	58	3.534	Multidisciplinary Sciences
Annals of the Rheumatic Diseases	42	41	9.27	Rheumatology
Drug Safety	21	21	2.62	Public, Environmental & Occupational Health
Pain	21	21	5.836	Anaesthesiology Clinical Neurology Neurosciences
Arthritis and Rheumatism	20	19	7.871	Rheumatology
Arthritis Research & Therapy	18	18	4.117	Rheumatology
Molecular Informatics	16	16	2.013	Chemistry, Medicinal Mathematical & Computational Biology
Psychopharmacology	14	14	3.988	Pharmacology & Pharmacy Psychiatry
Diabetologia	13	13	6.88	Endocrinology & Metabolism
European Journal of Pharmaceutical Sciences	12	11	3.005	Pharmacology & Pharmacy
Proceedings of the National Academy of Sciences of the United States of America	12	12	9.809	Multidisciplinary Sciences
Neuroimage	11	11	6.132	Neurosciences Radiology, Nuclear Medicine & Medical Imaging
Diabetes	11	11	8.474	Endocrinology & Metabolism
Pharmacoepidemiology and Drug Safety	10	10	3.172	Pharmacology & Pharmacy
Journal of Clinical Investigation	10	10	13.765	Medicine, Research & Experimental
European Journal of Immunology	9	8	4.518	Immunology
BMC Bioinformatics	8	8	2.672	Mathematical & Computational Biology
Toxicological Sciences	8	8	4.478	Toxicology
Bioinformatics	8	8	4.621	Mathematical & Computational Biology Statistics & Probability
European Neuropsychopharmacology	8	8	5.395	Neurosciences Pharmacology & Pharmacy Psychiatry

TABLE 4.4.2 JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP TWENTY RANKED BY JOURNAL IMPACT FACTOR, 2009-2014

Journal	Number of Web of Science Publications	Number of Papers	Journal Impact Factor (2013)	Web Of Science Journal Categories
New England Journal of Medicine	1	1	54.42	Clinical Neurology
Nature	5	5	42.351	Psychiatry Genetics & Heredity
Lancet	1	1	39.207	Psychiatry
Nature Biotechnology	1	0	39.08	Biotechnology & Applied Microbiology
Nature Reviews Cancer	1	1	37.912	Oncology
Nature Reviews Drug Discovery	2	0	37.231	Biotechnology & Applied Microbiology
Science	1	1	31.477	Neurosciences
JAMA-Journal of the American Medical Association	1	1	30.387	Medicine, General & Internal
Nature Genetics	4	2	29.648	Genetics & Heredity
Nature Medicine	2	2	28.054	Medicine, Research & Experimental
Nature Methods	1	1	25.953	Biochemical Research Methods
Nature Immunology	2	2	24.973	Immunology
Lancet Neurology	4	4	21.823	Clinical Neurology
Immunity	3	3	19.748	Immunology
Lancet Infectious Diseases	1	1	19.446	Infectious Diseases
Pharmacological Reviews	1	1	18.551	Pharmacology & Pharmacy
Alzheimer's & Dementia	3	3	17.472	Clinical Neurology
BMJ-British Medical Journal	2	2	16.378	Oncology Public, Environmental & Occupational Health
Clinical Microbiology Reviews	2	2	16	Microbiology
Neuron	2	2	15.982	Neurosciences

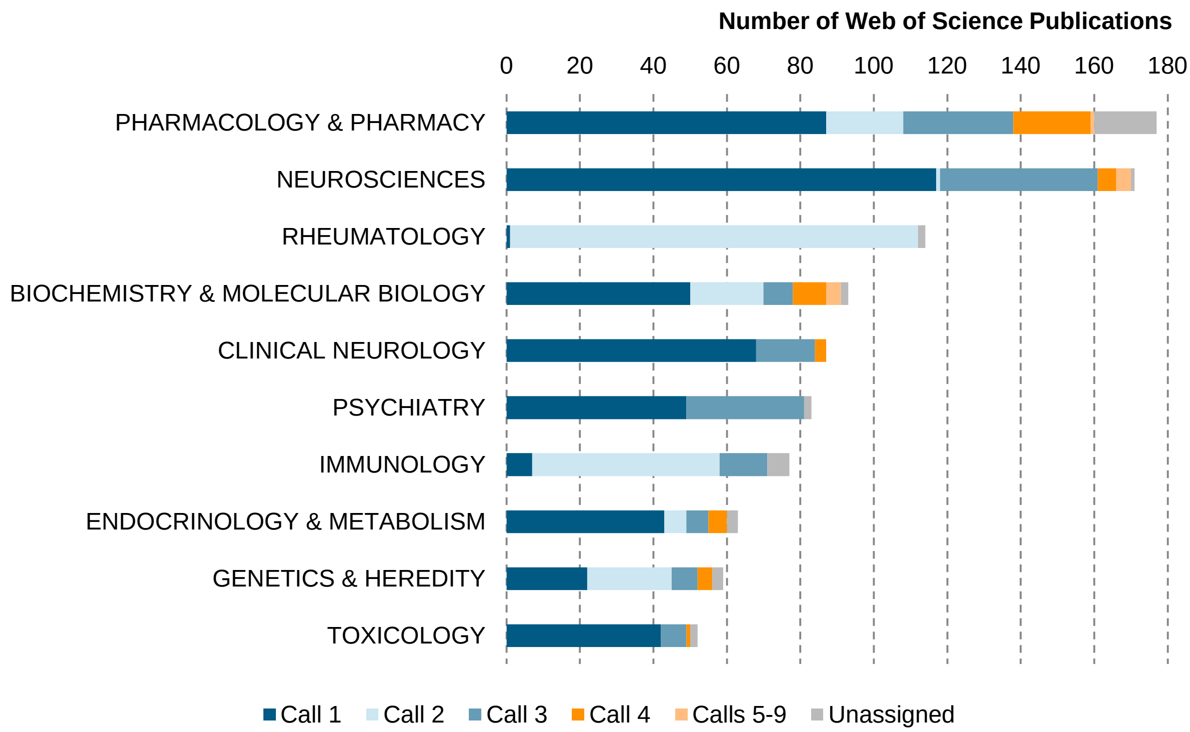
TABLE 4.4.3 OPEN ACCESS JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP ELEVEN RANKED BY NUMBER OF WEB OF SCIENCE PUBLICATIONS, 2009-2014

Open Access Journal	**Number of Web of Science Publications**	**Number of Papers**	**Journal Impact Factor (2013)**	**Web of Science Journal Categories**
PLOS One	58	58	3.534	Multidisciplinary Sciences
BMC Bioinformatics	8	8	2.672	Biochemical Research Methods Biotechnology & Applied Microbiology Mathematical & Computational Biology
Genome Biology	7	6	10.465	Biotechnology & Applied Microbiology Genetics & Heredity
Nucleic Acids Research	7	7	8.808	Biochemistry & Molecular Biology
International Journal of Molecular Sciences	6	6	2.339	Biochemistry & Molecular Biology Chemistry, Multidisciplinary
Mediators Of Inflammation	4	4	2.417	Cell Biology Immunology
Cell Reports	3	3	7.207	Cell Biology
Health And Quality of Life Outcomes	3	3	2.099	Health Care Sciences & Services Health Policy & Services
PLOS Computational Biology	3	3	4.829	Biochemical Research Methods Mathematical & Computational Biology
PLOS Genetics	3	3	8.167	Genetics & Heredity
Frontiers in Aging Neuroscience	3	3	2.843	Geriatrics & Gerontology Neurosciences
PLOS Medicine	3	3	14	Medicine, General & Internal Pharmacology & Pharmacy Psychiatry

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

Figure 4.5.1 shows the top ten Web of Science journal categories[6] by rank associated with IMI project research[7]. Calls 5-9 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, 2009-2014



- IMI projects generated more publications in Pharmacology and Pharmacy than in other journal categories, followed by Neurosciences, and Rheumatology. This has changed from Report 4 in which Rheumatology had the highest number of publications.
- The majority of publications (97.3%) in Rheumatology were from Call 2, and from project BTCure.
- The publications assigned to Pharmacology and Pharmacy, and Neurosciences were predominantly from Calls 1 and 2.

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[6] Journals can be associated with more than one Web of Science category. This analysis is based on the best-performing category (i.e. that in which it ranks highest in terms of overall citations relative to journal category and year).

[7] It should be noted that there are some publications which appear in 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, 2009-2014

	Number of publications by IMI Call								
Journal Category	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**9**	**Unassigned**
Pharmacology & Pharmacy	87	21	30	21		1			17
Neurosciences	117	1	43	5			2	2	1
Rheumatology	1	111							2
Biochemistry & Molecular Biology	50	20	8	9	1	3			2
Clinical Neurology	68		16	3					
Psychiatry	49		32						2
Immunology	7	51	13						6
Endocrinology & Metabolism	43	6	6	5					3
Genetics & Heredity	22	23	7	4					3
Toxicology	42		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, 2009-2014

		Citation Impact		
Journal category	**Number of Papers**	**Normalised at field level**	**Normalised at journal level**	**Raw citation impact**
Pharmacology & Pharmacy	173	1.81	1.30	5.27
Neurosciences	169	2.44	1.45	11.55
Rheumatology	112	2.28	0.99	6.84
Biochemistry & Molecular Biology	91	2.25	1.21	9.04
Clinical Neurology	87	2.46	1.32	14.39
Psychiatry	83	3.60	1.36	9.45
Immunology	76	1.94	1.23	7.62
Endocrinology & Metabolism	63	1.64	1.15	6.59
Genetics & Heredity	55	4.16	1.66	18.13
Toxicology	51	1.69	1.55	4.02

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, 2009-2014

Journal Category	Number of Web of Science publications	% of Open Access publications	Number of papers	% of Highly Cited Papers
Pharmacology & Pharmacy	176	1.7%	173	24.3%
Neurosciences	169	8.9%	169	18.9%
Rheumatology	114	9.6%	112	27.7%
Biochemistry & Molecular Biology	91	19.8%	91	27.5%
Clinical Neurology	87	8.0%	87	26.4%
Psychiatry	83	7.2%	83	25.3%
Immunology	77	14.3%	76	26.3%
Endocrinology & Metabolism	63	6.3%	63	31.7%
Genetics & Heredity	58	27.6%	55	23.6%
Toxicology	52	9.6%	51	21.6%

- IMI project research was most frequently published in Pharmacology & Pharmacy journals. Of the 173 papers published in this field, 24.3% of them were highly-cited, 1.7% appeared in open access journals, and the average citation impact of these papers was 1.81.
- There were 114 publications (102 papers) in the journal category of Rheumatology, and this was the category with the highest percentage of highly-cited papers (27.7%).
- The highest percentage of publications in open access journals was in Genetics & Heredity with 27.6% of publications in open access journals. This field also had the highest average citation impact (4.16).

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, 2010-2014

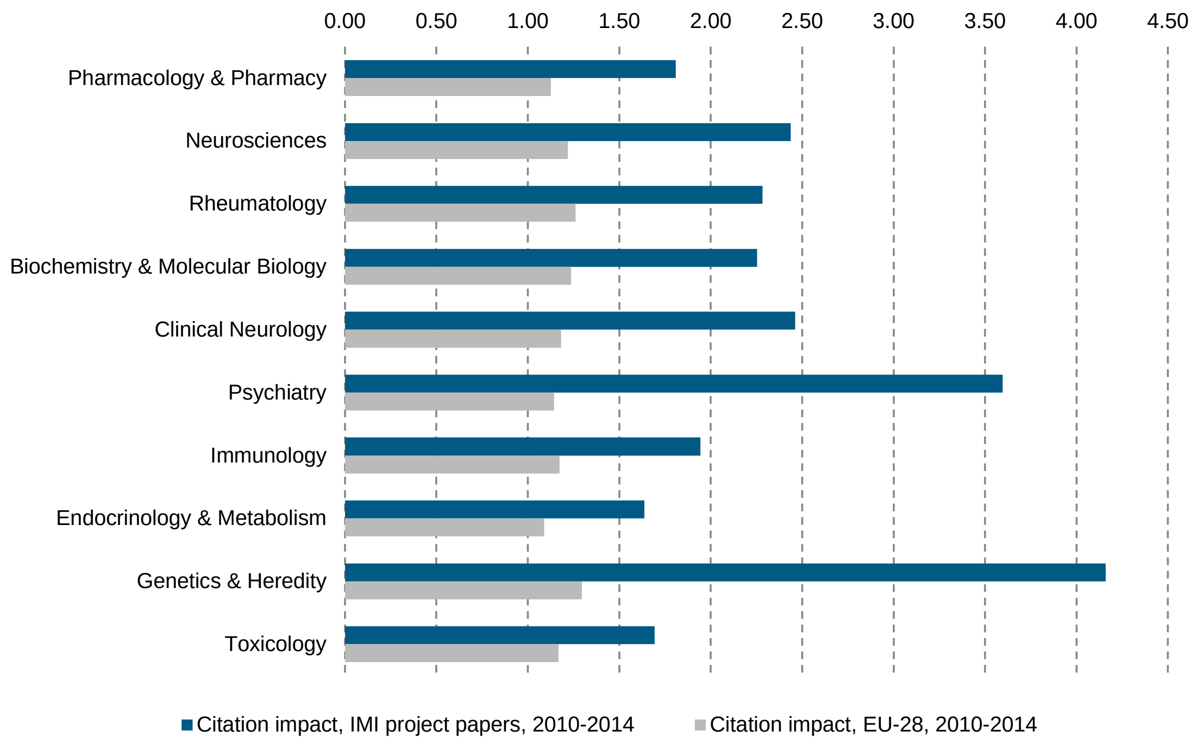


TABLE 4.6.1 CITATION IMPACT AND PERCENTAGE OF PAPERS IN TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED, BENCHMARKED AGAINST EU-28 PAPERS IN THE SAME JOURNAL CATEGORIES, 2010-2014

			Citation impact normalised at field level	
Journal category	**% of IMI papers**	**% of EU-28 papers**	**IMI papers**	**EU-28**
Pharmacology & Pharmacy	15.4%	2.5%	1.81	1.13
Neurosciences	15.1%	3.2%	2.44	1.22
Rheumatology	10.0%	0.5%	2.28	1.26
Biochemistry & Molecular Biology	8.1%	4.1%	2.25	1.24
Clinical Neurology	7.8%	2.1%	2.46	1.18
Psychiatry	7.4%	1.5%	3.60	1.14
Immunology	6.8%	1.8%	1.94	1.17
Endocrinology & Metabolism	5.6%	1.5%	1.64	1.09
Genetics & Heredity	4.9%	1.6%	4.16	1.30
Toxicology	4.5%	0.7%	1.69	1.17

IMI project research had a higher citation impact for the fields it most frequently published in than the EU-28 papers for the same research fields (journal subject categories).

- The journal category with the highest citation impact for EU-28 paper was Genetics & Heredity (1.30); this was also the journal category for which IMI-supported papers had the highest citation impact (4.19).

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, 2009-2014

		Citation Impact			
	Number of Papers	**Normalised at field level**	**Normalised at journal level**	**Average Percentile**	**% Highly cited papers**
IMI projects	1 121	2.19	1.26	42.43	24.0%

TABLE 4.7.2 SUMMARY OF IMI SUPPORTED RESEARCH PUBLICATIONS, 2009-2014

	Number of Publications	**% Open access journals**	**Number of papers**	**Citations**	**Raw citation impact**
IMI Projects	1 134	14.6%	1,121	9 359	8.35

SUMMARY OF KEY FINDINGS

- The citation impact of IMI project papers was 2.19 (where world average is 1.0) for the 5-year period, 2010-2014. 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 (2.19) was nearly twice the EU's average citation impact (1.10)[8,9] relative to the world baseline (1.00) for 2010-2014, in the same group of journal categories.
- Nearly a quarter (24.0%) of IMI papers were highly-cited, that is, they were in the world's top 10% of most highly-cited papers in the relevant journal category and year of publication.

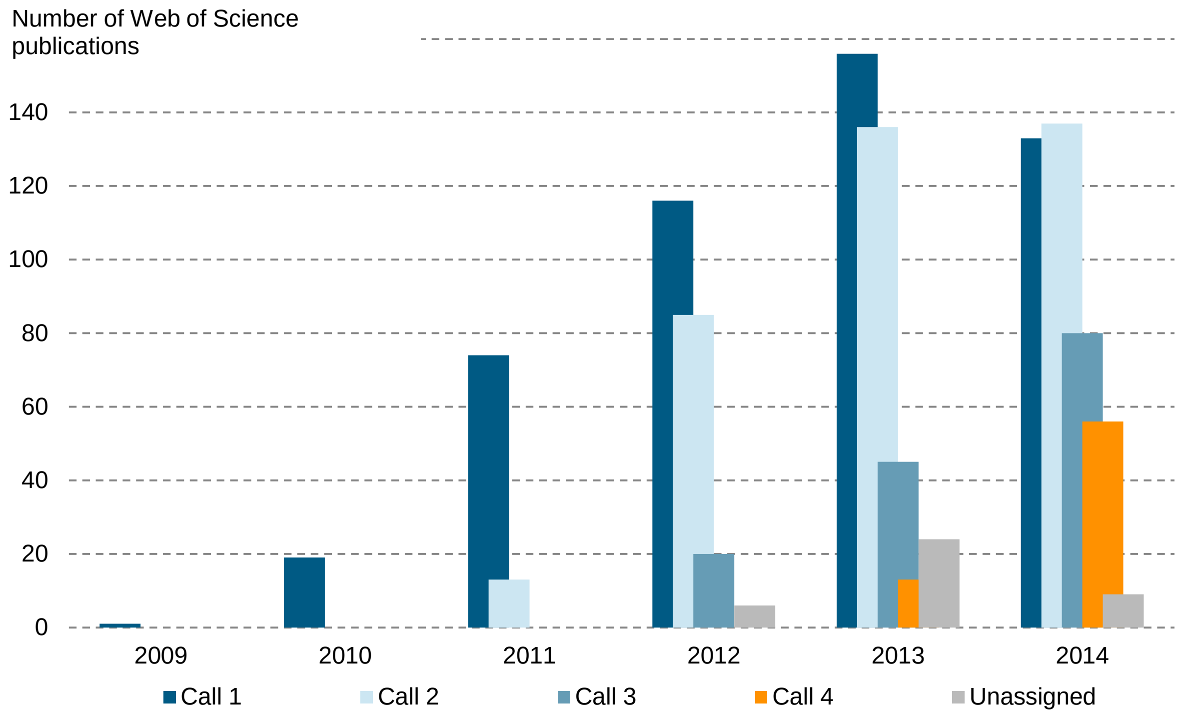
[8] EU-27 grouping of countries: Thomson Reuters National Science Indicators 2013 database; similar research has been defined as including the same journal categories as in the IMI project dataset.
[9] For this analysis, only papers are considered since only these publication types have normalised citation 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 2014 for IMI Calls 1-4. Calls 5-9 were more recently introduced and have a smaller number of publications relative to Calls 1-4. For clarity, the publications from Calls 5-9 are shown separately in Figure 5.1.2. Table 5.1.1 presents summary bibliometric data of number of publications, papers, and citation impact for all IMI Calls.

FIGURE 5.1.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL, 2009-2014



- The number of publications from Call 1 increased from 2009 to a peak of 156 in 2013. In 2014 Call 2 had the highest number of publications (137).
- The number of publications from Calls 2, 3, and 4 increased every year preceding the initial set of publications for that call.

FIGURE 5.1.2 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL, 2012-2014

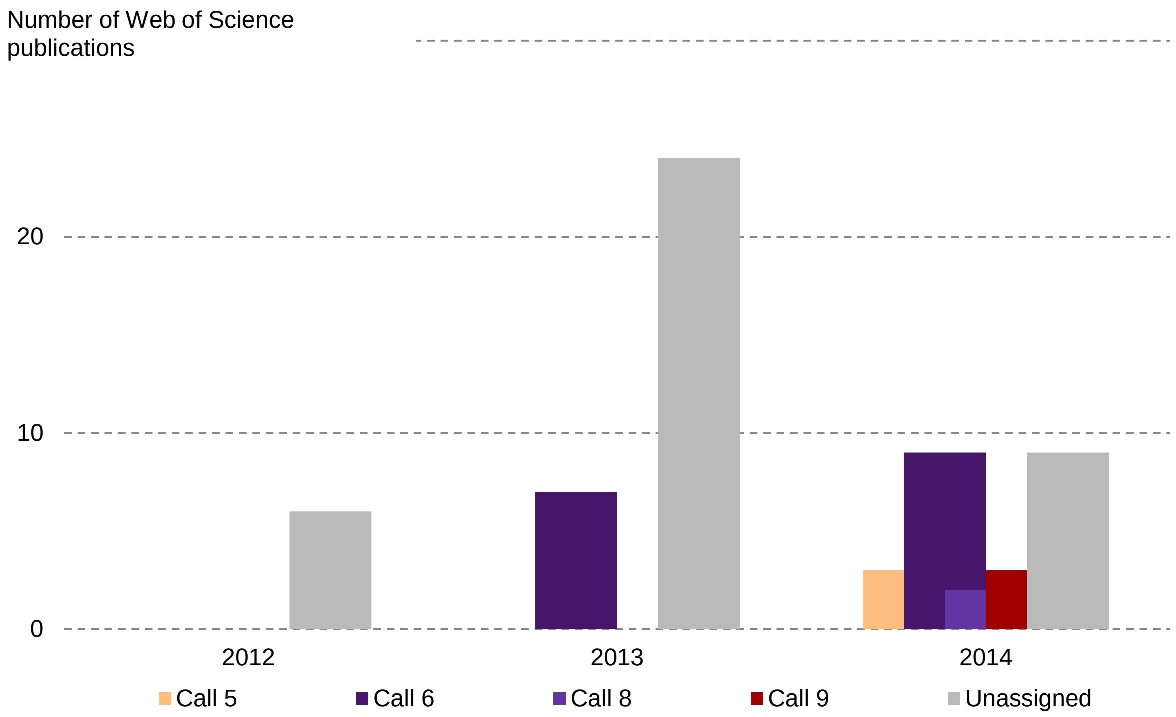


TABLE 5.1.1 SUMMARY BIBLIOMETRIC ANALYSES OF IMI PROJECTS AGGREGATED BY FUNDING CALL, 2009-2014

IMI Call	Number of Publications	% Open access journals	Number of Papers	Citation Impact: Raw citation impact	Citation Impact: Normalised at field level	Citation Impact: Normalised at journal level
Unassigned	39	10.30%	39	7.72	3.55	1.9
1	499	15.40%	495	10.34	2.02	1.32
2	371	16.20%	365	6.95	2.18	1.18
3	145	13.80%	142	8.54	2.77	1.25
4	69	5.80%	69	2.25	1.76	1.04
5	3	0.00%	3	0	0	0
6	16	12.50%	16	2.19	1.38	0.97
8	2	0.00%	2	1	1.47	0.91
9	3	66.70%	3	1	1.46	2.78

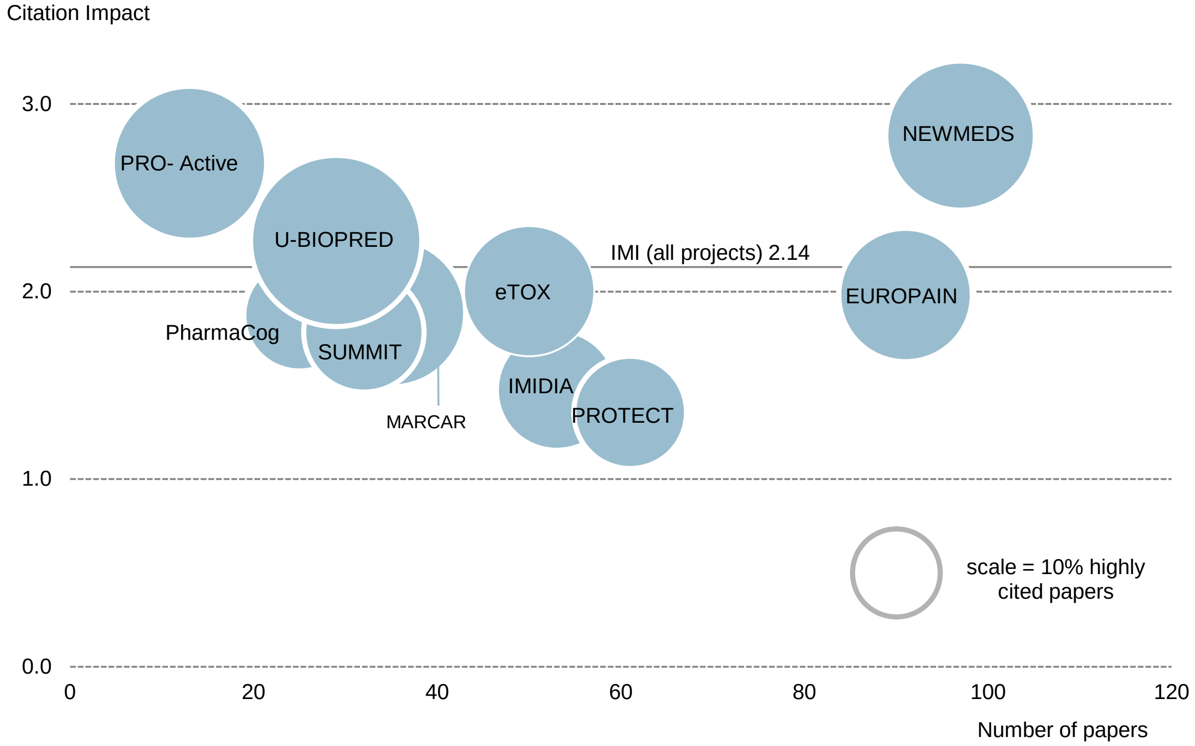
- IMI Call 1 generated the highest number of Web of Science publications (499), and papers (495). Of the publications in Call 1, 15.56% were published in open access journals. The publications generated by IMI Call 1 also had the highest raw citation impact (10.34).
- The papers which were not assigned to any IMI call had the highest field normalised citation impact (3.73)[10].

[10] This is 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 (2009-2014) 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, 2009-2014



The data in Figure 5.2.1 show 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 five of the projects (eTOX, NEWMEDS, PRO-Active, SAFE-T, U-BIOPRED) in Call 1 was cited over twice the world average. In particular, research associated with the NEWMEDS project was cited at a level approaching three times the world average (2.83).
- Three of twelve projects (NEWMEDS, PRO-Active, U-BIOPRED) in Call 1 had papers with an average citation impact greater than the average citation impact of all IMI project papers (2.14).

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, 2009-2014

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level**	**Normalised at journal level**	**Average Percentile**	**% Highly cited papers**
eTOX	50	2.00	1.81	30.35	22.00%
EUROPAIN	91	1.98	1.53	36.69	23.08%
IMIDIA	53	1.47	1.04	47.09	18.87%
MARCAR	35	1.89	1.53	41.62	28.57%
NEWMEDS	97	2.83	1.21	35.22	28.87%
PharmaCog	25	1.87	0.90	39.12	16.00%
PRO-Active	13	2.68	1.59	30.41	30.77%
PROTECT	61	1.36	1.16	42.43	16.39%
SafeSciMET	2	0.46	0.20	66.97	0.00%
SAFE-T	7	2.12	1.31	39.06	28.57%
SUMMIT	32	1.78	1.04	43.19	18.75%
U-BIOPRED	29	2.27	1.37	36.65	37.93%
Overall (IMI projects)	**1 082**	**2.14**	**1.24**	**42.74**	**23.48%**

TABLE 5.2.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 1, 2009-2014

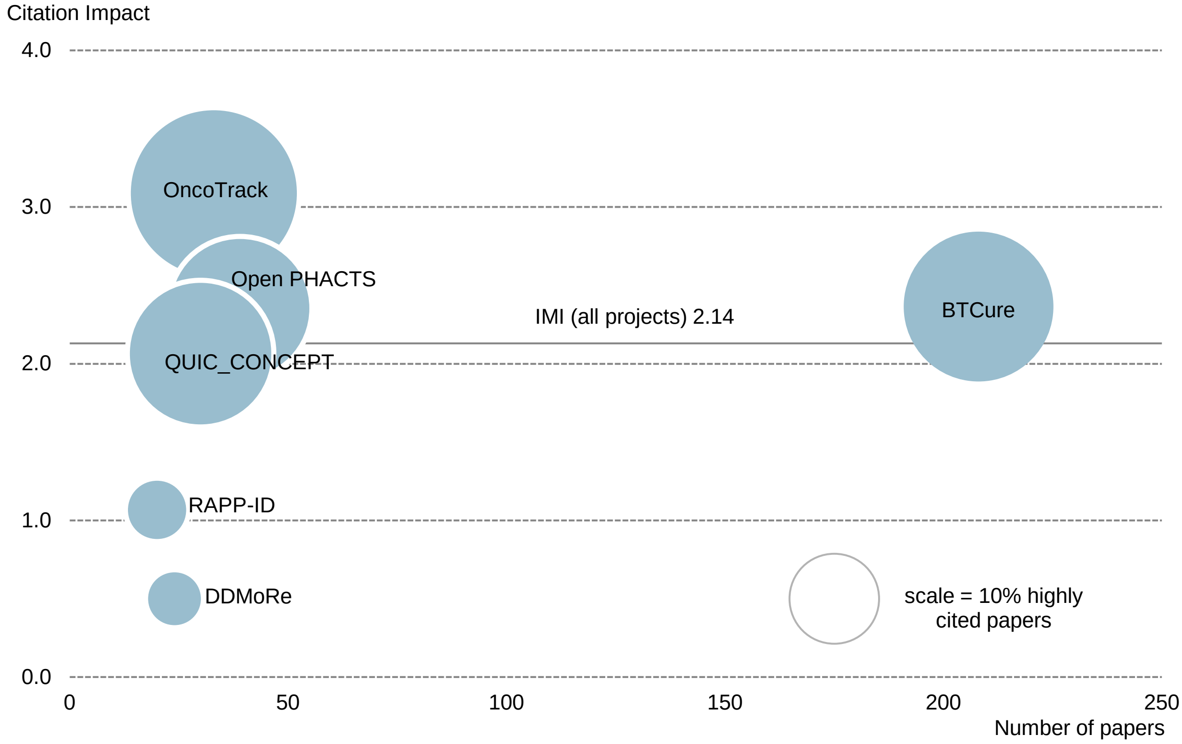
Project	**Number of Publications**	**Number of Papers**	**% Open access journals**	**Citations**	**Raw citation impact**
eTOX	51	50	35.3%	496	9.73
EUROPAIN	91	91	11.0%	1 130	12.42
IMIDIA	53	53	7.5%	402	7.58
MARCAR	36	35	44.4%	187	5.19
NEWMEDS	97	97	5.2%	1 205	12.42
PharmaCog	25	25	4.0%	483	19.32
PRO- Active	13	13	53.8%	116	8.92
PROTECT	61	61	6.6%	298	4.89
SafeSciMET	3	2	0.0%	4	1.33
SAFE-T	8	7	25.0%	38	4.75
SUMMIT	32	32	25.0%	351	10.97
U-BIOPRED	29	29	6.9%	413	14.24

- PRO-Active had the largest percentage of open access publications (53.8%) with 13 publications.

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 (2009-2014) 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, 2009-2014



The data in Figure 5.3.1 show that:

- The average citation impact of most Call 2 projects was above world average. DDMore was the exception with a citation impact of half world average (0.50).
- BTCure was by far the most prolific IMI Call 2 project with 208 papers at the end of 2014. The citation impact of this research is more than twice the world average (2.36).
- Research associated with OncoTrack was very well-cited with a citation impact of more than three times (3.09) the world average.
- Quic-Concept and Open PHACTS were also very well-cited with a citation impact of more than twice the world average at 2.06 and 2.35 respectively.
- Three of the eight 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 indicators citation impact normalised against world average values 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, 2009-2014

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level**	**Normalised at journal level**	**Average Percentile**	**% Highly cited papers**
BTCure	208	2.36	1.03	42.90	27.88%
DDMoRe	24	0.50	0.45	73.93	4.17%
EHR4CR	5	1.89	1.30	24.36	20.00%
OncoTrack	33	3.09	1.67	27.44	36.36%
Open PHACTS	39	2.35	1.84	46.86	25.64%
PREDECT	6	1.13	0.41	43.15	0.00%
QUIC-CONCEPT	30	2.06	1.60	41.23	26.67%
RAPP-ID	20	1.07	1.00	42.50	5.00%
Overall (IMI projects)	**1 082**	**2.14**	**1.24**	**42.74**	**23.48%**

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

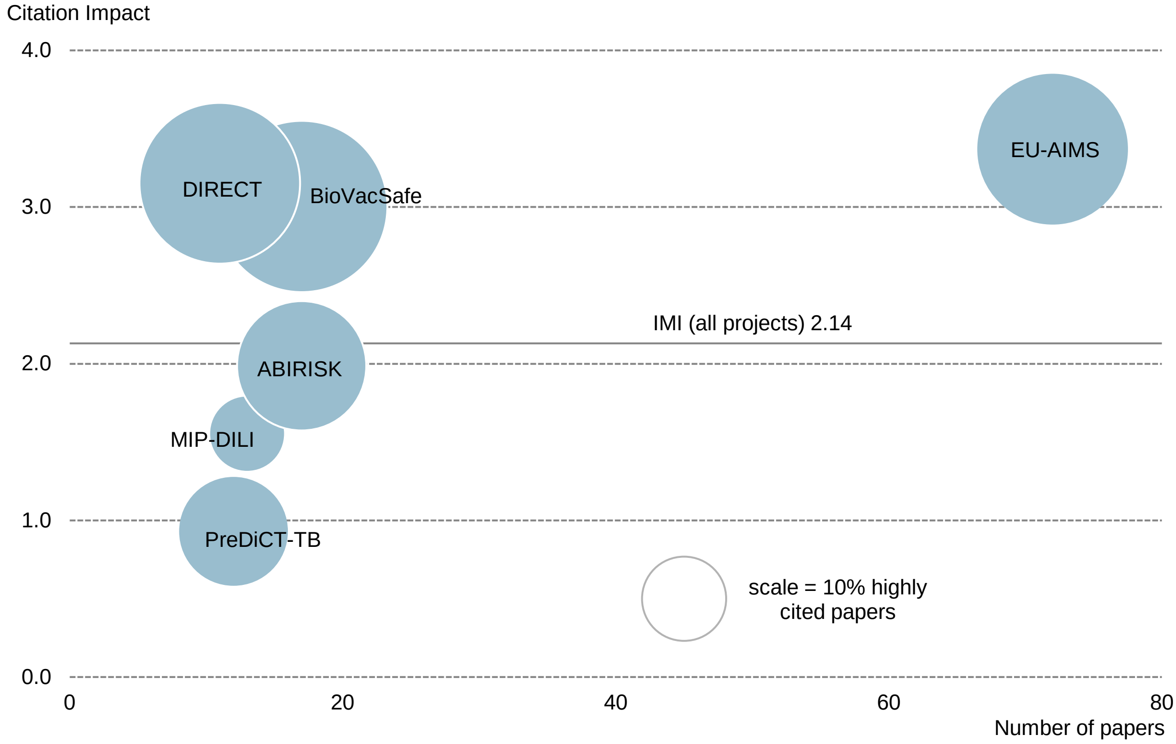
Project	**Number of Publications**	**Number of papers**	**% Open access journals**	**Citations**	**Raw citation impact**
BTCure	212	208	12.3%	1 493	7.04
DDMoRe	24	24	20.8%	32	1.33
EHR4CR	5	5	20.0%	12	2.40
OncoTrack	33	33	21.2%	421	12.76
Open PHACTS	41	39	29.3%	340	8.29
PREDECT	6	6	0.0%	20	3.33
QUIC-CONCEPT	30	30	20.0%	234	7.80
RAPP-ID	20	20	15.0%	88	4.40

- BTCure is the project with the highest number of open access publications (25), but OncoTrack had the highest percentage of publications in open access journals (21.2%).

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 (2009-2014) 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, 2009-2014



The data in Figure 5.4.1 show that:

- Except for one project, the average citation impact of most of these projects was above world average. The exception was project PreDiCT-TB with a citation impact of 0.93. This might be expected since publications for this project are from 2013 onwards.
- EU-AIMS was by far the most prolific IMI and Call 3 project with 72 publications at end-2014. The citation impact of this research was more than three times world average (3.37).
- Research associated with DIRECT, and BioVacSafe was also very well-cited with a citation impact that is three times world average.
- Three of the six projects in this Call had an average citation impact greater than the citation impact of all IMI related projects.

Table 5.4.1 shows indicators where citation impact has been normalised against world average values 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, 2009-2014

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level**	**Normalised at journal level**	**Average Percentile**	**% Highly cited papers**
ABIRISK	17	1.99	0.87	53.78	23.53%
BioVacSafe	17	3.00	1.91	26.51	41.18%
DIRECT	11	3.15	1.43	54.35	36.36%
EU-AIMS	72	3.37	1.29	38.28	31.94%
MIP-DILI	13	1.55	0.98	44.94	7.69%
PreDiCT-TB	12	0.93	0.80	64.41	16.67%
Overall (IMI projects)	**1 082**	**2.14**	**1.24**	**42.74**	**23.48%**

TABLE 5.4.2 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 3, 2009-2014

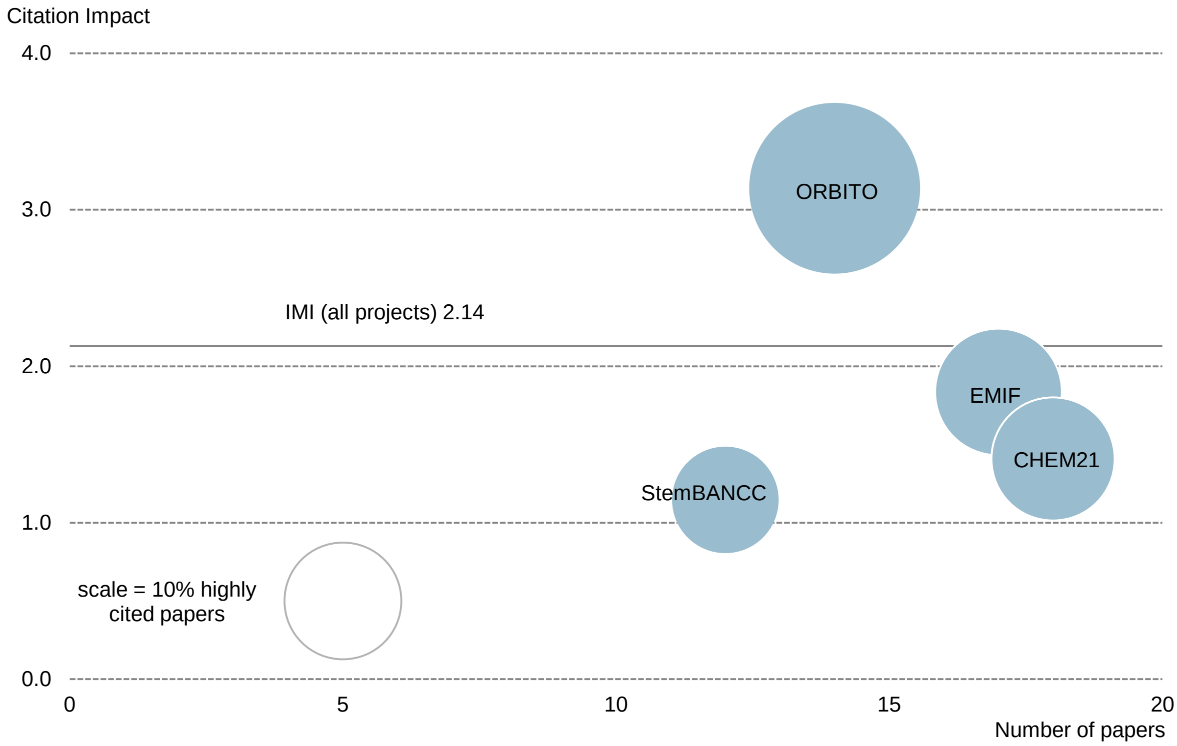
Project	**Number of Publications**	**Number of papers**	**% Open access journals**	**Citations**	**Raw citation impact**
ABIRISK	17	17	23.5%	78	4.59
BioVacSafe	18	17	5.6%	126	7.00
DIRECT	11	11	18.2%	53	4.82
EU-AIMS	73	72	12.3%	896	12.27
MIP-DILI	14	13	14.3%	58	4.14
PreDiCT-TB	12	12	16.7%	21	1.75

- EU-AIMS is the project with the highest number of publications in open access journals (9), but ABIRISK had the highest percentage of publications in open access journals (23.5%).

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 (2009-2014) 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, 2009-2014



The data in Figure 5.5.1 show that:

- The average citation impact of these projects was above world average though none have more than 18 papers.
- CHEM21 and EMIF produced the highest number of papers in Call 3, with 18 and 17 respectively.
- Research associated with ORBITO was very well-cited with a citation impact of more than three times the world average (3.14).
- ORBITO was the only one of the seven projects in this call, with an average citation impact greater than the average of all IMI-project papers.

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, 2009-2014

		Citation Impact			
Project	**Number of Papers**	**Normalised at field level**	**Normalised at journal level**	**Average Percentile**	**% Highly cited papers**
CHEM21	18	1.41	0.98	60.76	11.11%
Compact	5	0.67	0.80	82.61	0.00%
EMIF	17	1.84	0.86	59.80	11.76%
eTRIKS	2	0.84	0.42	65.36	0.00%
K4DD	1	1.88	1.77	18.57	0.00%
ORBITO	14	3.14	2.07	51.86	21.43%
StemBANCC	12	1.15	0.34	76.62	8.33%
Overall (IMI projects)	**1 082**	**2.14**	**1.24**	**42.74**	**23.48%**

TABLE 5.5.2 BIBLIOMETRIC INDICATORS FOR IMI PROJECTS IN CALL 4, 2009-2014

Project	Number of Publications	Number of Papers	% Open access journals	Citations	Raw citation impact
CHEM21	18	18	0.0%	48	2.67
Compact	5	5	0.0%	2	0.40
EMIF	17	17	11.8%	54	3.18
eTRIKS	2	2	50.0%	1	0.50
K4DD	1	1	0.0%	5	5.00
ORBITO	14	14	0.0%	31	2.21
StemBANCC	12	12	8.3%	14	1.17

- Four out of the seven projects in Call 4 had no publications in open access journals. This is expected since Call 4 is relatively new and so does not have as many publications.

6 COLLABORATION ANALYSIS FOR IMI RESEARCH

6.1 COLLABORATION ANALYSIS FOR IMI RESEARCH

International research collaboration is a rapidly growing element of research activity.[11] 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.[12] 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, other[13]. A paper is defined as cross-sector if the listed addresses are from more than one sector. For example, if a paper has the two addresses: University of Copenhagen and Novartis, it would be classified as cross-sector. If a paper has the two addresses: 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 sector, institution and country level.

TABLE 6.1.1 CROSS-SECTOR, CROSS-INSTITUTION AND INTERNATIONAL OUTPUT – IMI PROJECT RESEARCH, 2009-2014

	Number of papers	Percentage of Papers	Citation impact (normalised at field level)
Cross-sector	667	59.6%	2.50
Single-sector	453	40.4%	1.72
Cross-institution	883	78.8%	2.31
Single-institution	237	21.2%	1.71
International	598	53.4%	2.54
Domestic	522	46.6%	1.78

- More than half (59.7%) of all IMI project papers were published by researchers affiliated with different sectors.
- More than three-quarters (78.8%) of IMI project papers involved collaboration between institutions.
- More than half (53.4%) of all IMI project papers were internationally collaborative.
- Collaborative IMI project research was internationally influential with citation impact well over twice world average (1.0) and a clear margin over non-collaborative IMI project research.

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

[12] 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.

[13] 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 the 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).
- NEWMEDS had the second highest number of papers with authors from more than one country and institution, but PROTECT had the second highest number of papers with authors from more than one sector.
- 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 projects BTCure, NEWMEDS, and EUROPAIN, there was also a substantial collaboration with China and Australia (Figure 6.2.1, 6.2.3). NEWMEDS and EU-AIMS had collaborations in South America (Figure 6.2.1, 6.2.4).

TABLE 6.2.1 NUMBER, PERCENTAGE AND CITATION IMPACT[14] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE COUNTRY, 2009-2014

Project	Number of papers	Number of internationally collaborative papers	Percentage of internationally collaborative papers	Citation impact (normalised at field level)
BTCURE	208	107	51.4%	2.83
NEWMEDS	97	60	61.9%	3.23
EUROPAIN	91	30	33.0%	1.67
EU-AIMS	72	50	69.4%	3.64
PROTECT	61	43	70.5%	1.50
IMIDIA	53	22	41.5%	1.77
eTOX	50	20	40.0%	1.59
Open PHACTS	39	22	56.4%	2.51
MARCAR	35	15	42.9%	2.76
OncoTrack	33	12	36.4%	5.04
SUMMIT	32	14	43.8%	3.01
QUIC-CONCEPT	30	20	66.7%	2.39
U-BIOPRED	29	15	51.7%	3.46
PharmaCog	25	17	68.0%	2.35
DDMoRe	24	12	50.0%	0.58
RAPP-ID	20	12	60.0%	1.01
CHEM21	18	7	38.9%	0.00
ABIRISK	17	8	47.1%	1.74
BioVacSafe	17	8	47.1%	2.11
EMIF	17	13	76.5%	1.82
ORBITO	14	11	78.6%	3.84
MIP-DILI	13	5	38.5%	1.07
PRO- Active	13	10	76.9%	3.35
PreDiCT-TB	12	8	66.7%	1.33
StemBANCC	12	5	41.7%	0.58
DIRECT	11	5	45.5%	4.70
COMBACTE	8	4	50.0%	0.55
TRANSLOCATION	8	3	37.5%	0.98
SAFE-T	7	4	57.1%	2.70
PREDECT	6	3	50.0%	0.69
Compact	5	4	80.0%	0.84
EHR4CR	5	3	60.0%	2.57
EUCLID	3	3	100.0%	0.00
SPRINTT	3	1	33.3%	2.92
SafeSciMET	2	2	100.0%	0.46
eTRIKS	2	2	100.0%	0.84
AETIONOMY	2	1	50.0%	1.47
K4DD	1	1	100.0%	1.88

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

TABLE 6.2.2 NUMBER, PERCENTAGE AND CITATION IMPACT[15] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE INSTITUTION, 2009-2014

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	208	151	72.6%	2.48
NEWMEDS	97	80	82.5%	2.90
EUROPAIN	91	56	61.5%	2.03
EU-AIMS	72	69	95.8%	3.41
PROTECT	61	60	98.4%	1.38
IMIDIA	53	41	77.4%	1.64
eTOX	50	29	58.0%	2.32
Open PHACTS	39	32	82.1%	2.58
MARCAR	35	25	71.4%	2.05
OncoTrack	33	26	78.8%	3.58
SUMMIT	32	22	68.8%	2.36
QUIC-CONCEPT	30	26	86.7%	2.18
U-BIOPRED	29	23	79.3%	2.56
PharmaCog	25	23	92.0%	1.95
DDMoRe	24	19	79.2%	0.47
RAPP-ID	20	16	80.0%	1.16
CHEM21	18	8	44.4%	0.00
ABIRISK	17	13	76.5%	2.19
BioVacSafe	17	14	82.4%	2.89
EMIF	17	14	82.4%	2.14
ORBITO	14	13	92.9%	3.25
MIP-DILI	13	9	69.2%	1.15
PRO- Active	13	13	100.0%	2.68
PreDiCT-TB	12	12	100.0%	0.93
StemBANCC	12	7	58.3%	0.48
DIRECT	11	10	90.9%	3.42
COMBACTE	8	5	62.5%	0.91
TRANSLOCATION	8	5	62.5%	1.73
SAFE-T	7	7	100.0%	2.12
PREDECT	6	3	50.0%	0.69
Compact	5	5	100.0%	0.67
EHR4CR	5	5	100.0%	1.89
EUCLID	3	3	100.0%	0.00
SPRINTT	3	2	66.7%	1.46
SafeSciMET	2	2	100.0%	0.46
eTRIKS	2	2	100.0%	0.84
AETIONOMY	2	2	100.0%	1.47
K4DD	1	1	100.0%	1.88

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

TABLE 6.2.3 NUMBER, PERCENTAGE AND CITATION IMPACT[16] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE SECTOR, 2009-2014

Project	Number of papers	Number of cross sector papers	Percentage of cross sector papers	Citation impact (normalised at field level)
BTCure	208	111	53.4%	2.74
NEWMEDS	97	58	59.8%	3.37
EUROPAIN	91	32	35.2%	2.63
EU-AIMS	72	48	66.7%	3.73
PROTECT	61	59	96.7%	1.38
IMIDIA	53	23	43.4%	2.04
eTOX	50	15	30.0%	1.49
Open PHACTS	39	25	64.1%	2.16
MARCAR	35	20	57.1%	2.37
OncoTrack	33	21	63.6%	4.06
SUMMIT	32	13	40.6%	2.46
QUIC-CONCEPT	30	20	66.7%	2.26
U-BIOPRED	29	17	58.6%	3.14
PharmaCog	25	22	88.0%	1.98
DDMoRe	24	18	75.0%	0.42
RAPP-ID	20	13	65.0%	1.18
CHEM21	18	2	11.1%	0.00
ABIRISK	17	8	47.1%	2.71
BioVacSafe	17	14	82.4%	2.89
EMIF	17	11	64.7%	1.72
ORBITO	14	11	78.6%	3.75
MIP-DILI	13	8	61.5%	1.29
PRO- Active	13	13	100.0%	2.68
PreDiCT-TB	12	10	83.3%	0.87
StemBANCC	12	6	50.0%	0.49
DIRECT	11	9	81.8%	3.79
COMBACTE	8	5	62.5%	0.91
Translocation	8	3	37.5%	1.91
SAFE-T	7	7	100.0%	2.12
PREDECT	6	3	50.0%	0.69
Compact	5	1	20.0%	0.00
EHR4CR	5	4	80.0%	2.06
EUCLID	3	2	66.7%	0.00
SPRINTT	3	1	33.3%	2.92
SafeSciMET	2	2	100.0%	0.46
eTRIKS	2	1	50.0%	1.68
AETIONOMY	2	1	50.0%	1.46
K4DD	1	1	100.0%	1.88

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

FIG 6.2.1 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: BTCURE, 2009-2014

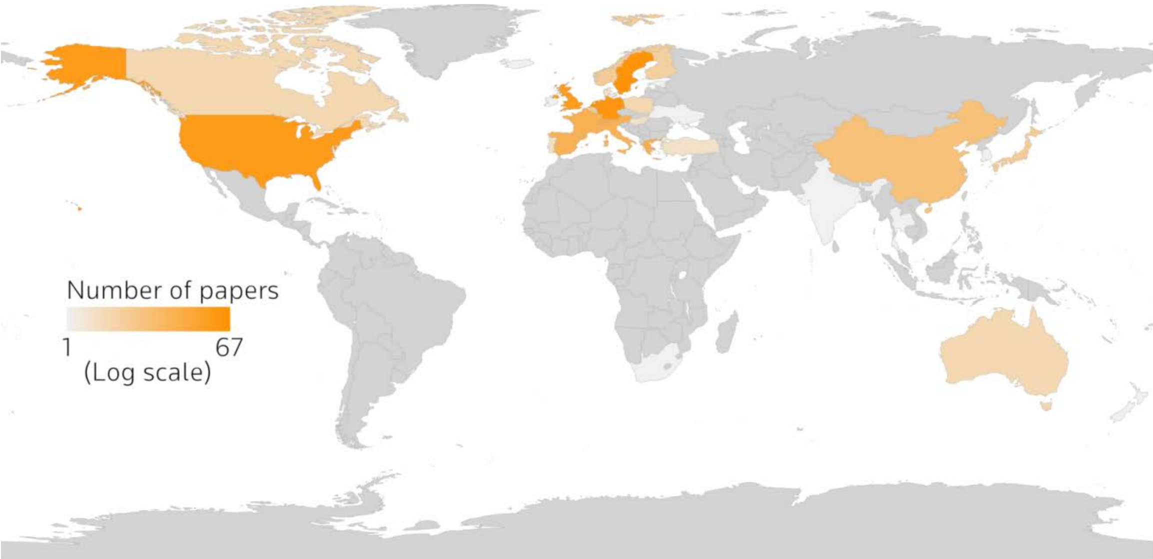


FIG 6.2.2 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: NEWMEDS, 2009-2014

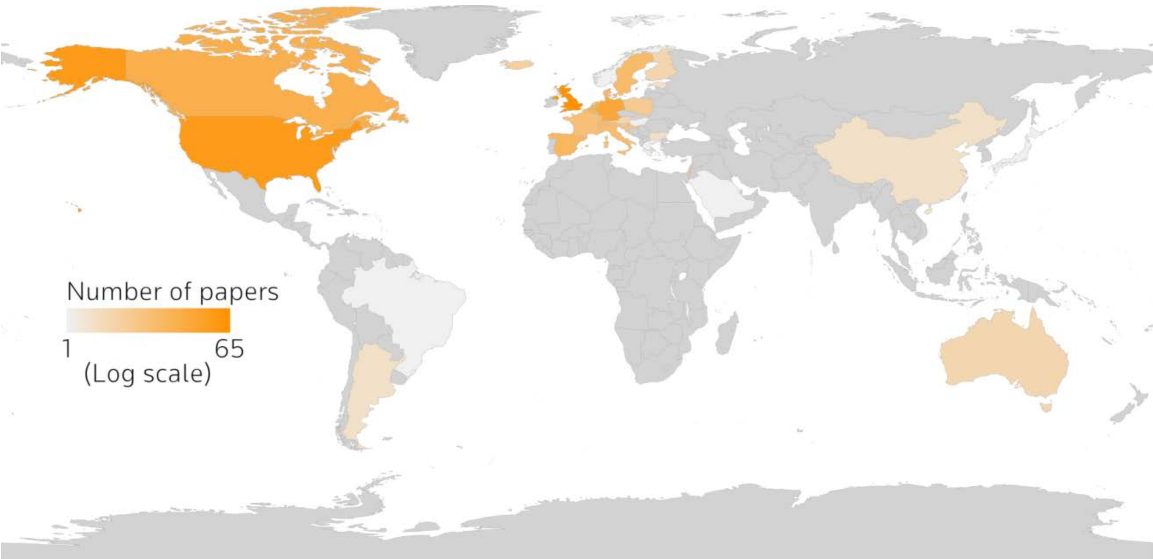


FIG 6.2.3 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: EUROPAIN, 2009-2014

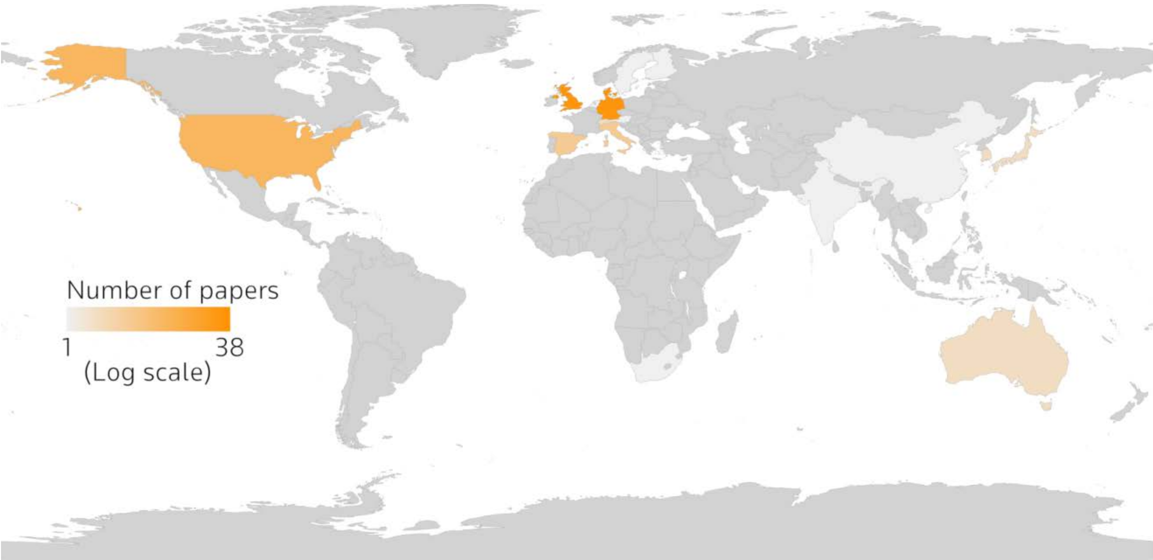


FIG 6.2.4 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: EU-AIMS, 2009-2014

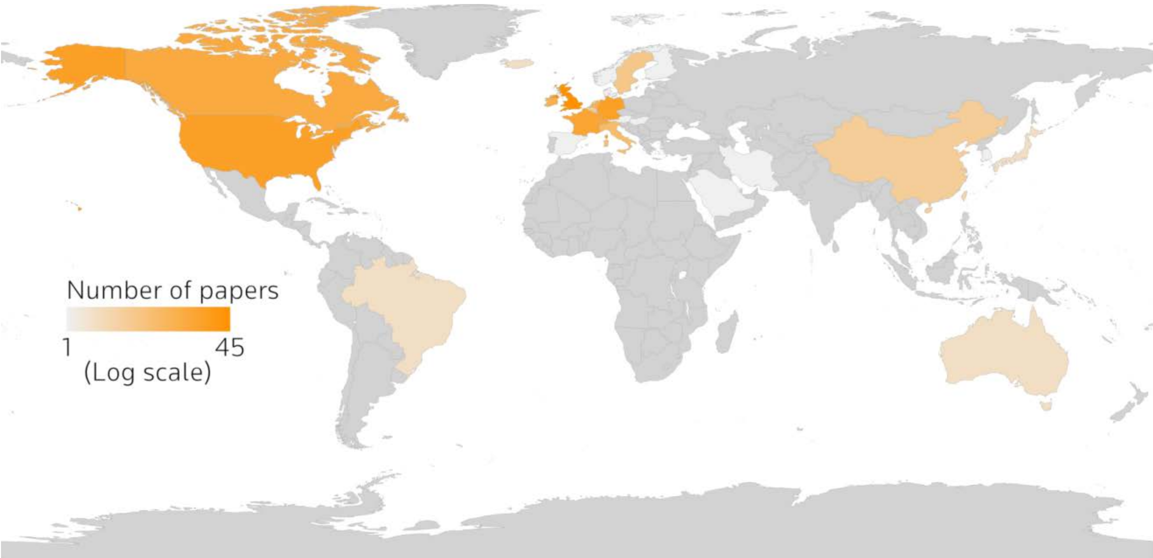
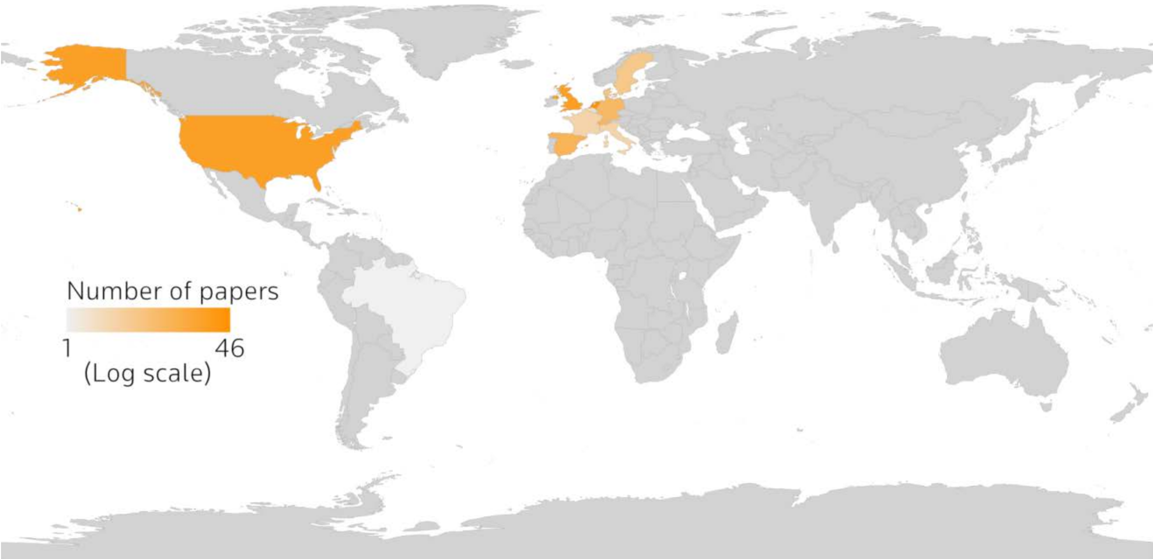


FIG 6.2.5 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: PROTECT, 2009-2014



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 2014. The results for all projects are shown in Annex 3.

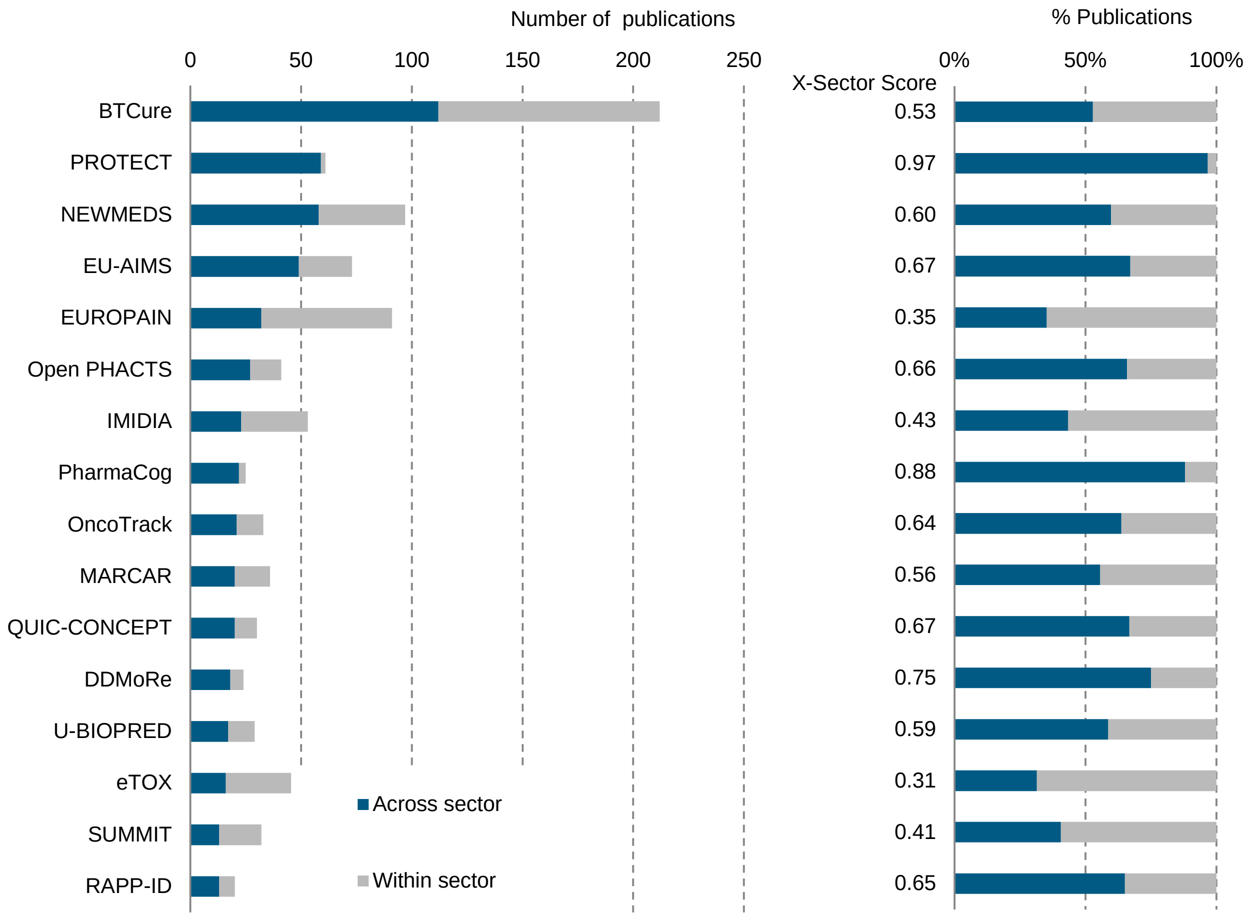
Three metrics were chosen to evaluate the collaborativeness of IMI projects:

- 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 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 number of publications or fraction of publications that include at least one cross sector collaboration. The fraction of publications in each project that are cross-sector collaboration 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, 2009-2014



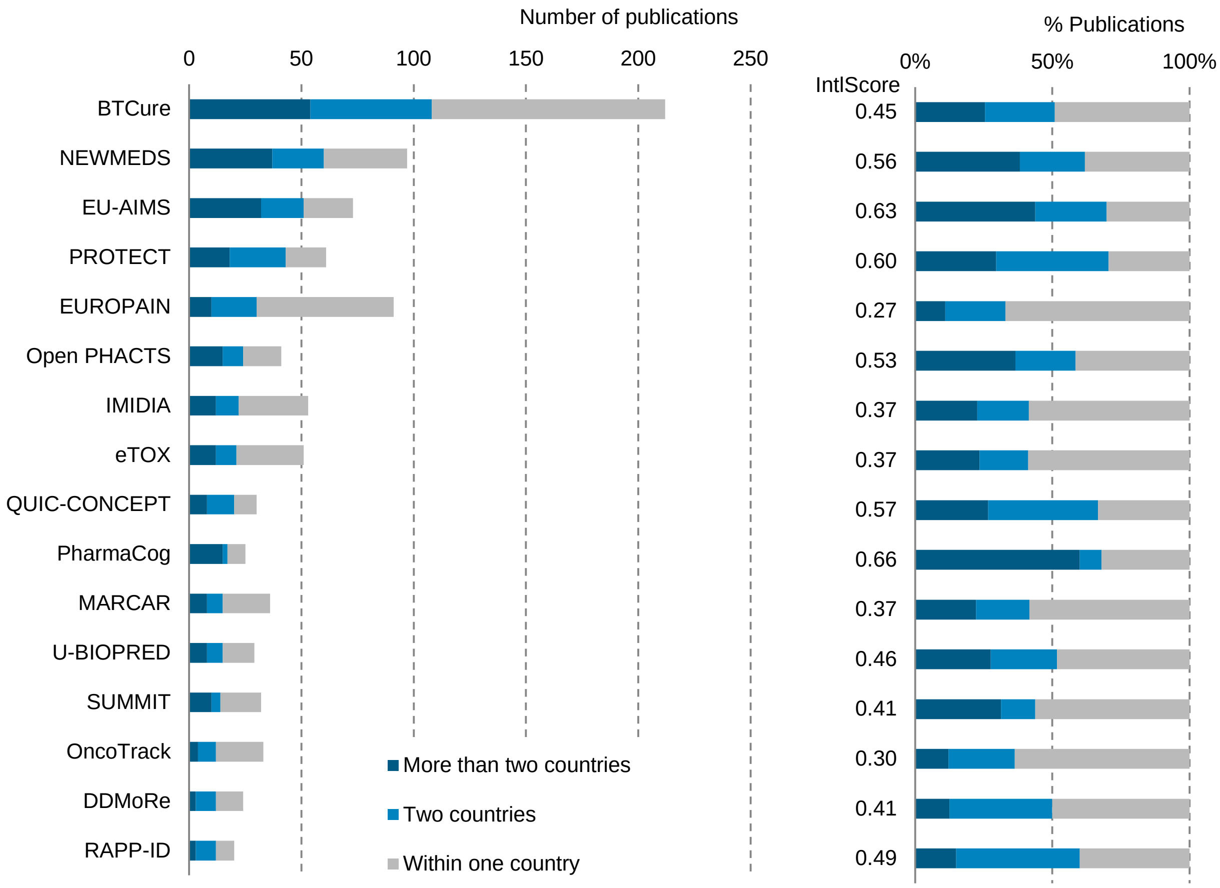
BTCure had the greatest number of cross-sector collaborative publications, 112 out of 212. PROTECT, PharmaCog, and DDMoRe had the highest percentage of cross-sector collaborative publications (97%, 88%, and 75% respectively).

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, 2009-2014

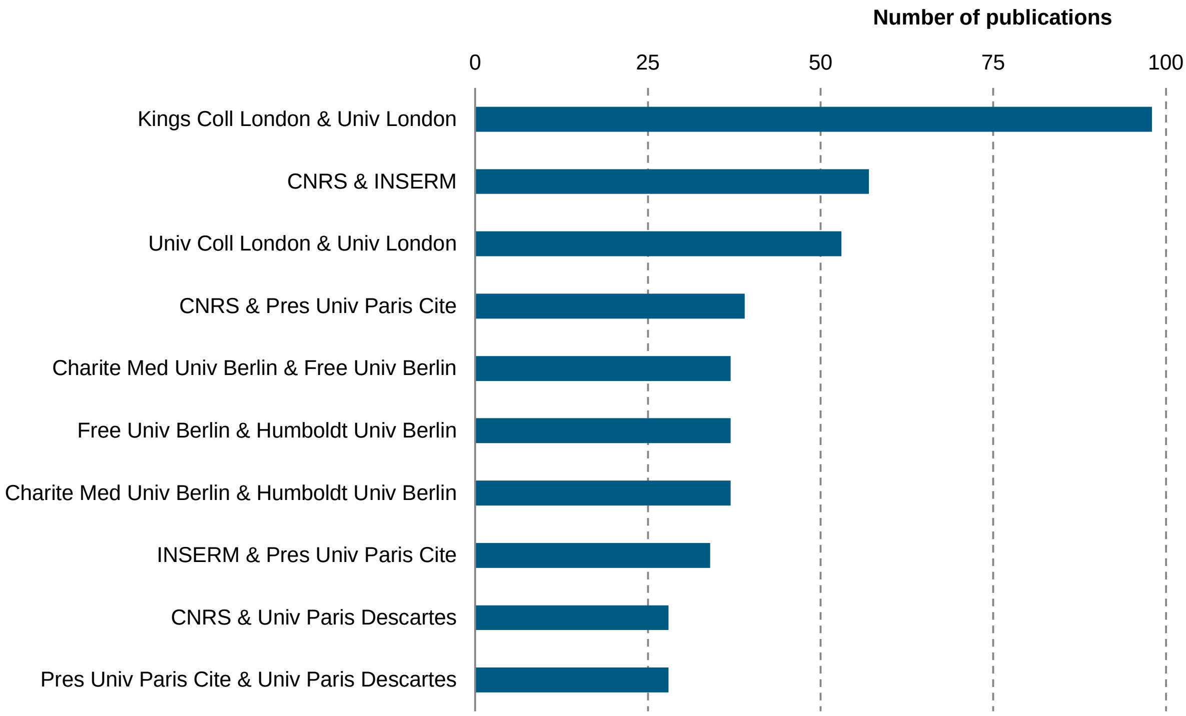


BTCure had the most internationally collaborative publications involving more than two countries (108 out of 212), with an International Score of 0.45. PharmaCog, EU-Aims, and PROTECT, had the highest International Score (0.66, 0.63, and 0.60 respectively).

6.3.3 METRIC 3: TOP COLLABORATING ORGANISATIONS PER PUBLICATION

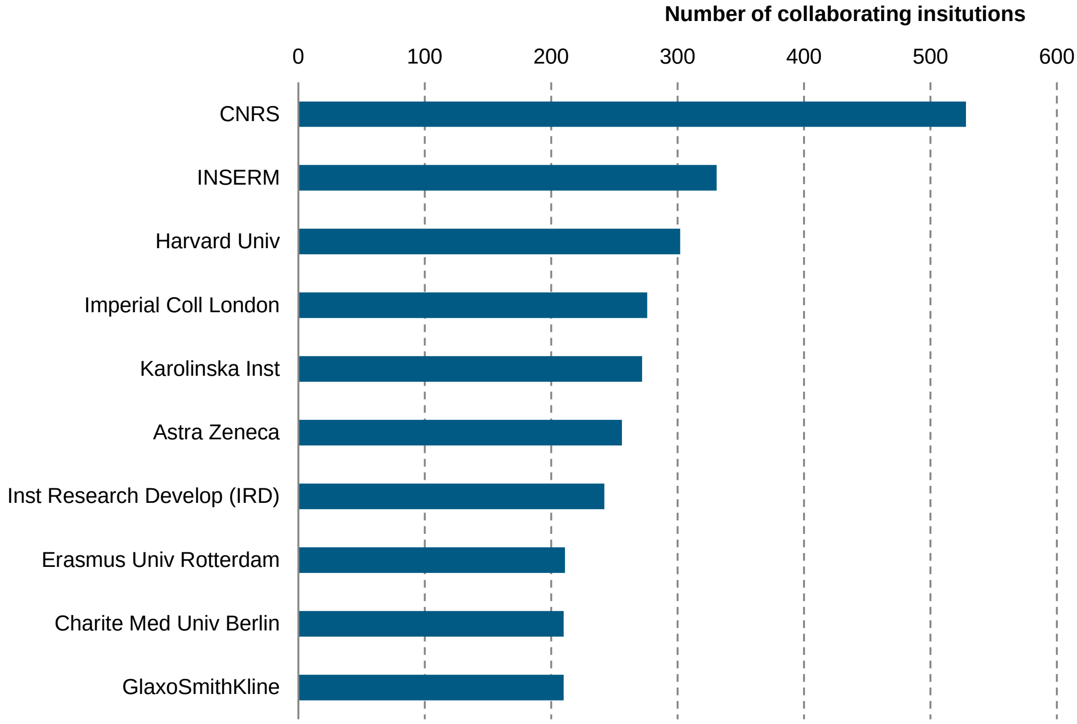
Metric 3 focuses on the top collaborating organisations and the number involved in publications associated with each project. Figure 6.3.3.1 shows the top ten collaborating organisation pairs and the total number of collaborating publications for each pair. Figure 6.3.3.2 shows the number of collaborating 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, 2009-2014



The organisations that collaborated together the most frequently in IMI project publications were King's College and the University of London.

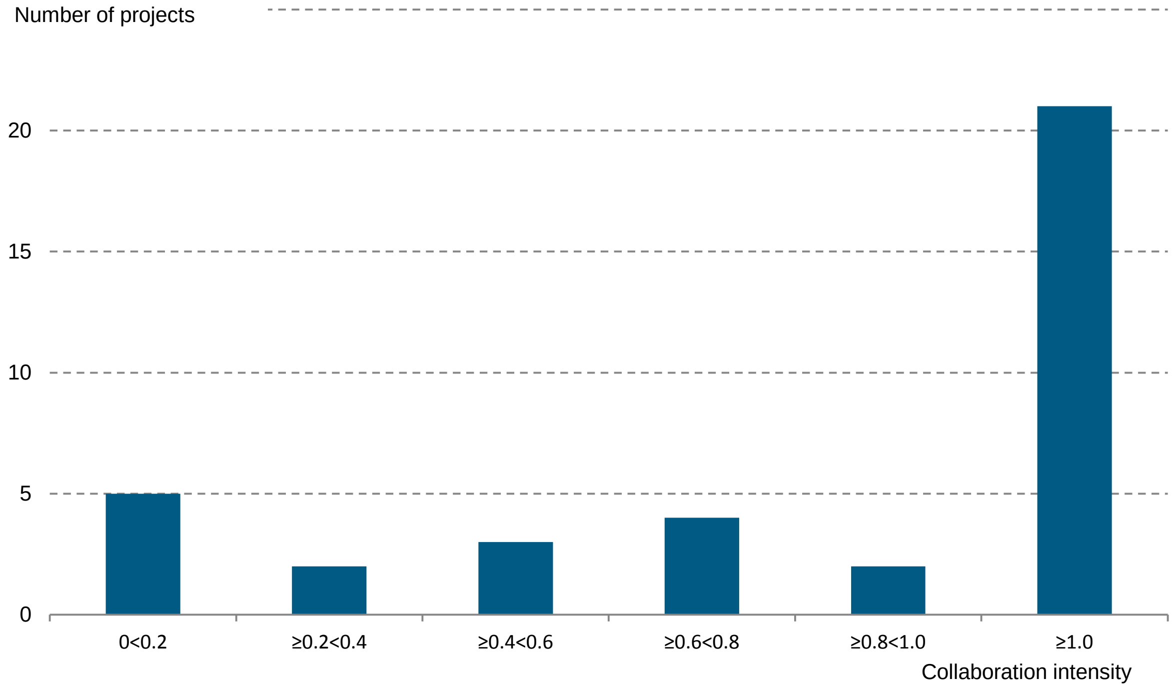
FIGURE 6.3.3.2 THE TEN MOST DIVERSE COLLABORATIVE ORGANISATIONS, 2009-2014



CNRS has collaborated with 528 different organisations within the IMI project publications.

The top 50 most diverse collaborating organisations were used to assign each project a score (metric 3. The top 50 most diverse collaborating organisations were used to assign each project a score (metric 3). For each project the number of author 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 BTCure had 220 author affiliations which belonged to the top 50 institutions, and 212 publications, so the result for metric 3 was 1.03 and this was set to 1.0.

FIGURE 6.3.3.3 METRIC 3 SCORE DISTRIBUTION, 2009-2014



6.4 COLLABORATION INDEX

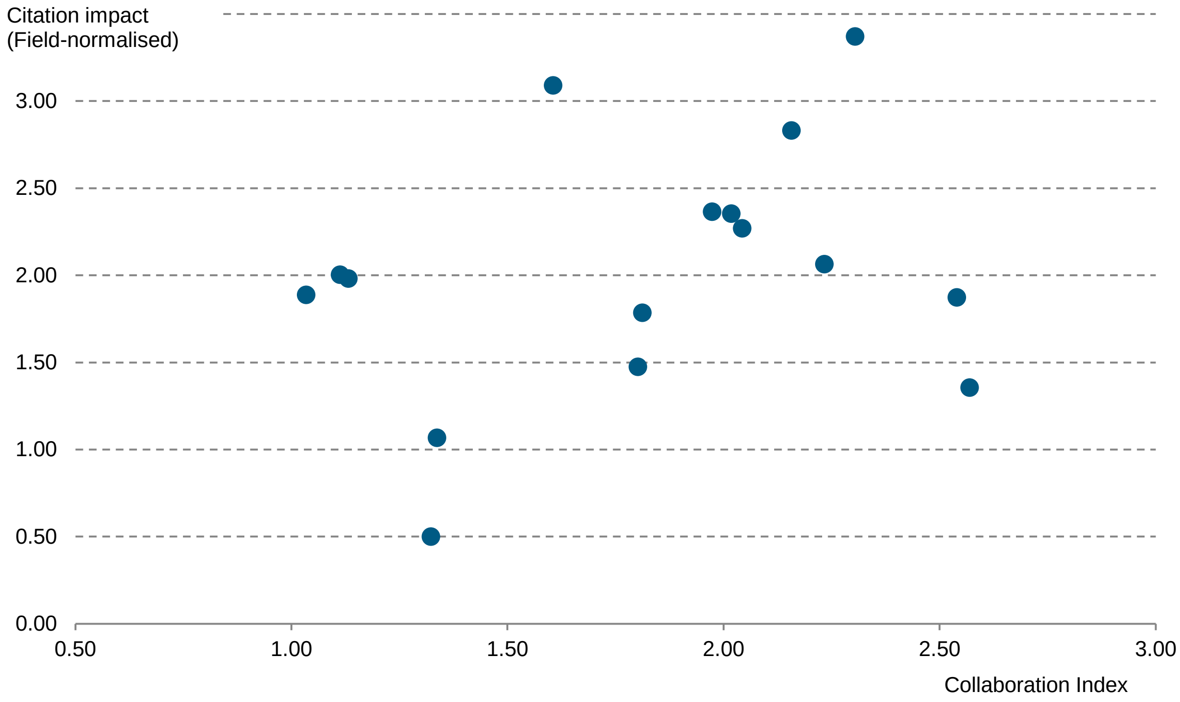
Metrics 1 and 2 (described above) measure different types of collaboration diversity. The first measures the fraction of publications that involve cross sector collaborations and the second measures the fraction of publications that involve international collaborations. Metric 3 is based on the average 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 (2.57), followed by PharmaCog, EU-AIMS and QUIC-CONCEPT (2.54, 2.30, and 2.23 respectively).

TABLE 6.4.1 SUMMARY SCORE FOR COLLABORATION METRICS, TOTAL NUMBER PUBLICATIONS, AND CITATION IMPACT FOR IMI PROJECTS, 2009-2014

Project	X-sector Score	IntlScore	Metric 3	Collaboration Index	Total Project publications	Citation impact (normalised at field level)
BTCure	0.53	0.45	1.00	1.97	212	2.36
NEWMEDS	0.60	0.56	1.00	2.16	97	2.83
EUROPAIN	0.35	0.27	0.51	1.13	91	1.98
EU-AIMS	0.67	0.63	1.00	2.30	73	3.37
PROTECT	0.97	0.60	1.00	2.57	61	1.36
IMIDIA	0.43	0.37	1.00	1.80	53	1.47
eTOX	0.31	0.37	0.43	1.11	51	2.00
Open PHACTS	0.66	0.53	0.83	2.02	41	2.35
MARCAR	0.56	0.37	0.11	1.03	36	1.89
OncoTrack	0.64	0.30	0.67	1.61	33	3.09
SUMMIT	0.41	0.41	1.00	1.81	32	1.78
QUIC-CONCEPT	0.67	0.57	1.00	2.23	30	2.06
U-BIOPRED	0.59	0.46	1.00	2.04	29	2.27
PharmaCog	0.88	0.66	1.00	2.54	25	1.87
DDMoRe	0.75	0.41	0.17	1.32	24	0.50
RAPP-ID	0.65	0.49	0.20	1.34	20	1.07

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 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

A total of eighty candidate comparators were reviewed by Thomson Reuters and seventeen were supplied to IMI for further verification prior to inclusion in the analyses.

Following discussion with IMI, seven comparators with sufficient publications to allow a robust analysis, were selected for this report (Table 7.1.1)[17].

TABLE 7.1.1 SUMMARY INFORMATION OF IMI-SELECTED COMPARATORS, 2010-2014

Comparator	Publications (2010-2014)	Papers (2010-2014)	Country	Region
Commonwealth Scientific and Industrial Research Organization (CSIRO)	158	158	Australia	Australia
Critical Path Institute (C-Path)	164	164	USA	North America
Foundation for the National Institutes of Health (FNIH)	615	615	USA	North America
Grand Challenges in Global Health (GCGH)	1 171	1 171	USA	North America
Indian Council of Medical Research (ICMR)	4 468	4 466	India	Asia
Medical Research Council (MRC)	21 081	21 046	UK	Europe
Wellcome Trust (WT)	28 403	28 370	UK	Europe

[17] The total publications for CSIRO between 2010 and 2014 was 2 644; 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 2014. 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, 2010-2014

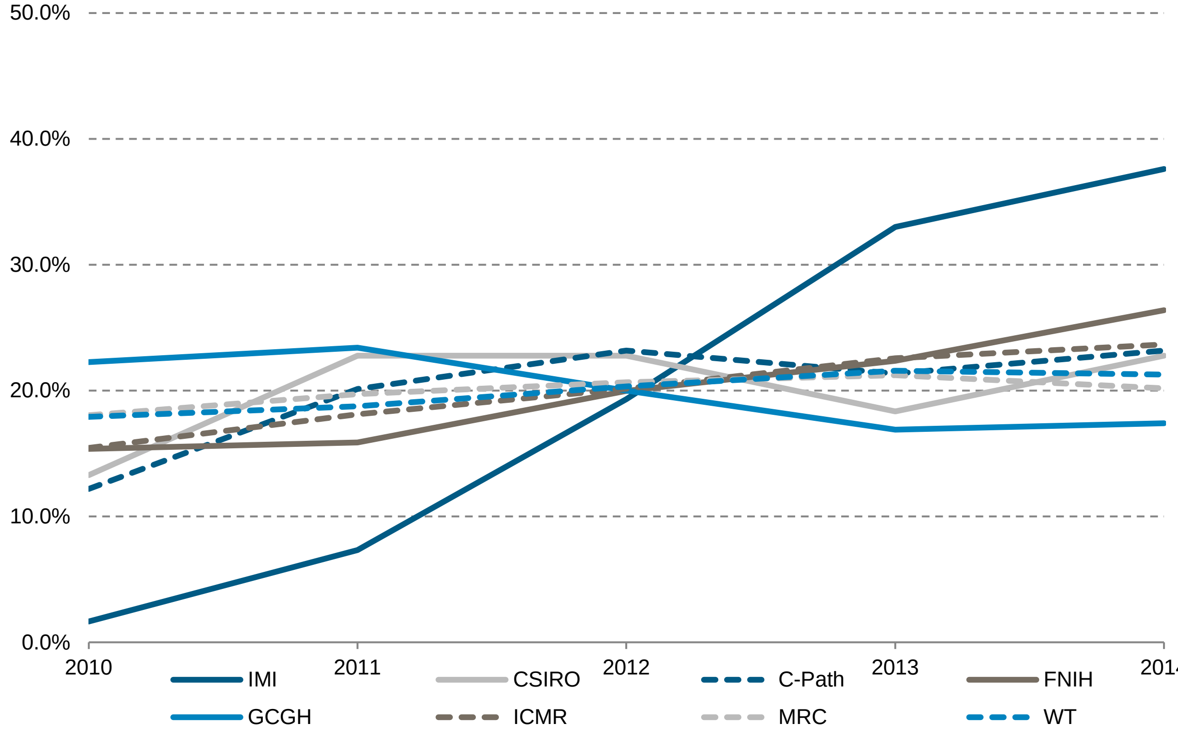


TABLE 7.2.1.1 SHARE OF OUPUT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2014

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	1.7%	13.3%	12.2%	15.4%	22.3%	15.4%	18.0%	17.9%
2011	7.3%	22.8%	20.1%	15.9%	23.4%	18.1%	19.7%	18.8%
2012	19.3%	22.8%	23.2%	20.0%	20.0%	20.1%	20.7%	20.3%
2013	33.0%	18.4%	21.3%	22.4%	16.9%	22.6%	21.2%	21.6%
2014	37.6%	22.8%	23.2%	26.4%	17.4%	23.7%	20.2%	21.3%

TABLE 7.2.1.2 NUMBER OF PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2014

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	19	21	20	180	137	690	3 805	5 092
2011	83	36	33	186	144	810	4 156	5 329
2012	219	36	38	234	123	900	4 357	5 775
2013	374	29	35	262	104	1 009	4 473	6 129
2014	426	36	38	309	107	1 057	4 255	6 045
Total	**1 121**	**158**	**164**	**1 171**	**615**	**4 465**	**21 046**	**28 370**

- GCGH was the only comparator which had a decrease in its share of output between 2010 and 2014.
- IMI had the highest percentage increase (2142.1%) of its research paper output between 2010 and 2014. The Wellcome Trust had the highest number of papers between 2010 and 2014.

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 2014. 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, 2010-2014

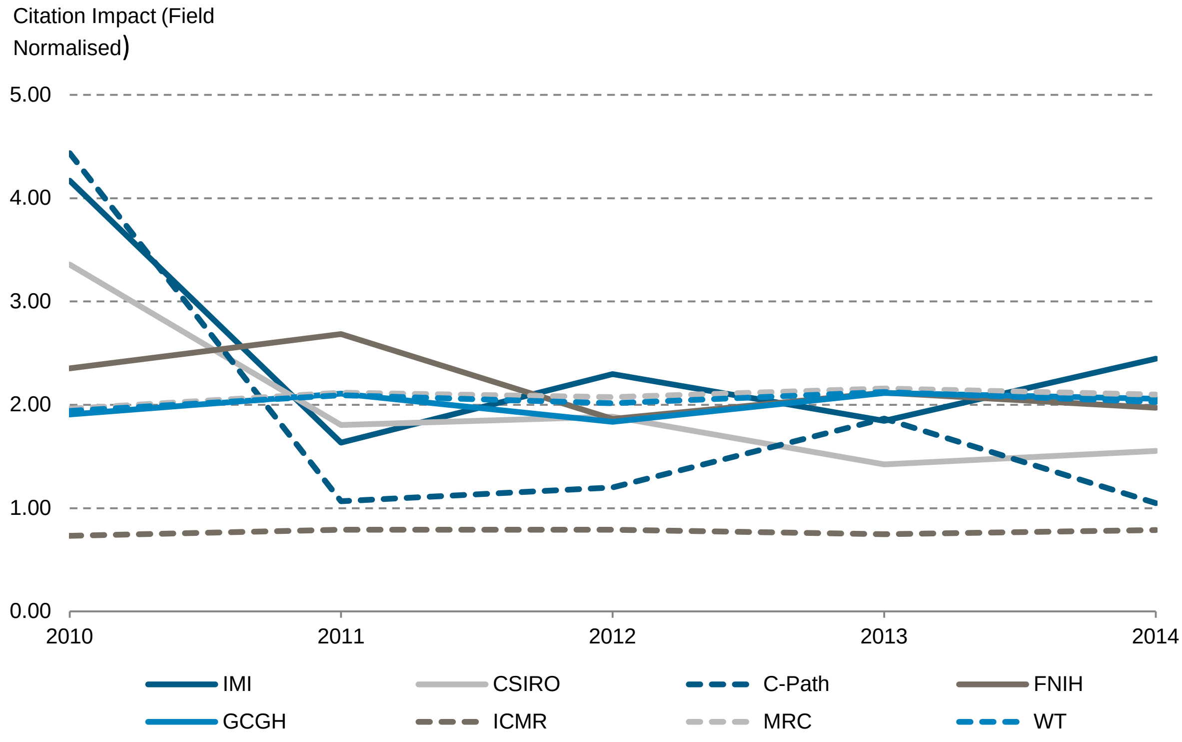


TABLE 7.2.2.1 FIELD NORMALISED CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2014

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	4.17	3.36	4.44	2.35	1.91	0.73	1.96	1.94
2011	1.63	1.80	1.07	2.69	2.11	0.79	2.12	2.09
2012	2.30	1.88	1.20	1.86	1.83	0.79	2.07	2.02
2013	1.85	1.42	1.87	2.12	2.12	0.75	2.16	2.12
2014	2.45	1.55	1.05	1.97	2.06	0.79	2.10	2.03
AVG	**2.19**	**1.90**	**1.68**	**2.16**	**2.00**	**0.77**	**2.08**	**2.04**

- In 2014 IMI had the highest citation impact of the organisations analysed (2.45).
- The citation impact of MRC and the Wellcome Trust were stable at around twice world average between 2010 and 2014, 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 papers 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 2014. 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, 2010-2014

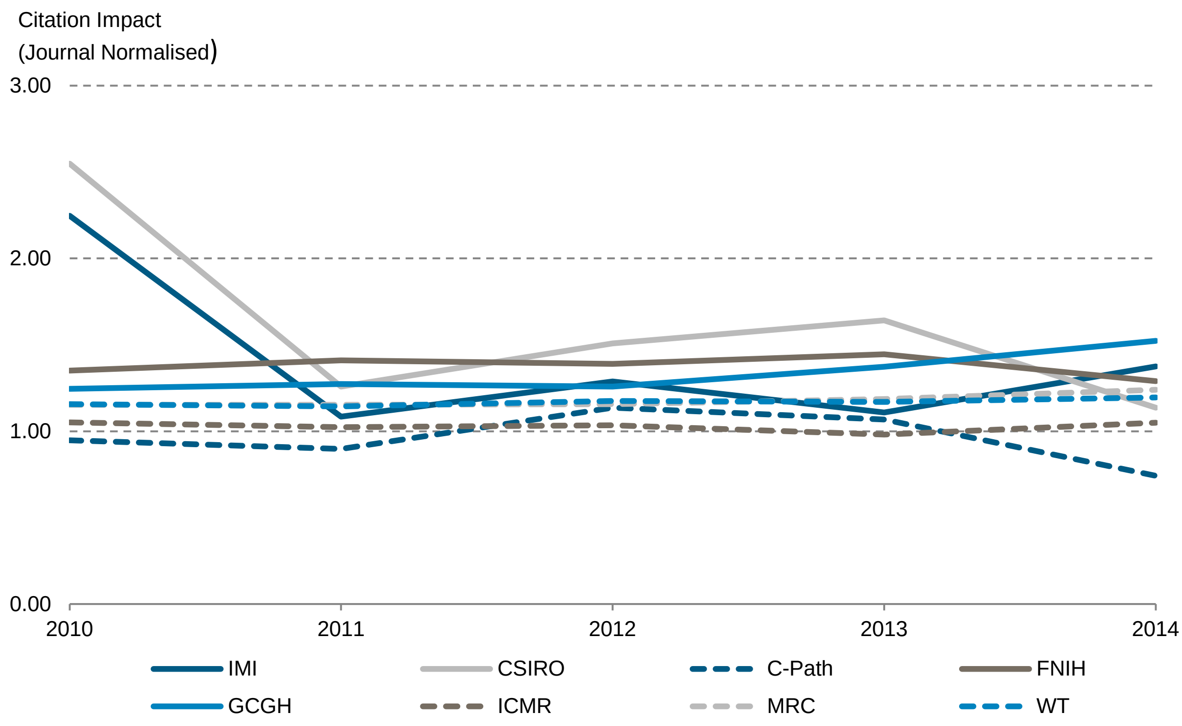


TABLE 7.2.3.1 JOURNAL NORMALISED CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2014

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	2.25	2.55	0.95	1.35	1.25	1.05	1.15	1.16
2011	1.09	1.26	0.90	1.41	1.27	1.02	1.15	1.14
2012	1.29	1.51	1.14	1.39	1.26	1.04	1.16	1.18
2013	1.11	1.64	1.07	1.45	1.37	0.98	1.19	1.17
2014	1.37	1.14	0.74	1.29	1.52	1.05	1.24	1.19
AVG	**1.26**	**1.53**	**0.96**	**1.37**	**1.33**	**1.03**	**1.18**	**1.17**

- As of 2014 IMI had the second highest journal normalised citation impact (1.37) of the organisations analysed, and GCGH had the highest (1.52).
- The journal normalised citation impact 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 its 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 2014. 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, 2010-2014

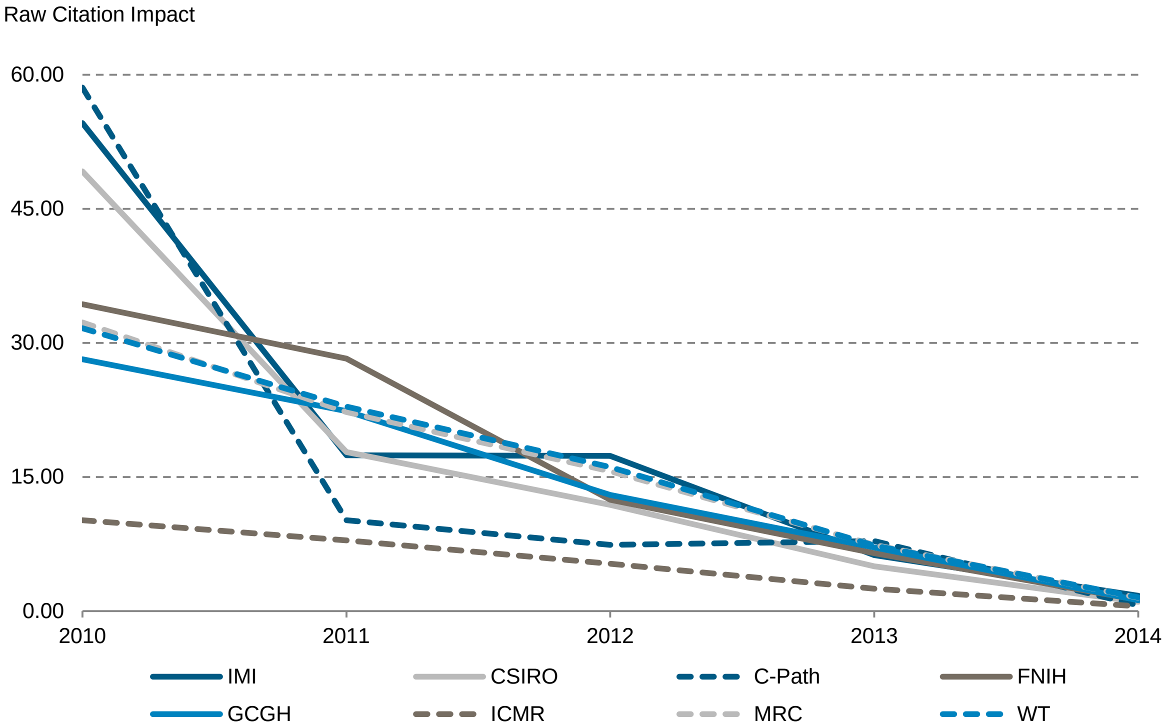


TABLE 7.2.4.1 RAW CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2014

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	54.58	49.19	58.55	34.32	28.18	10.16	32.29	31.62
2011	17.45	17.81	10.15	28.25	22.36	7.91	22.27	22.86
2012	17.36	11.89	7.42	12.45	13.00	5.30	15.64	16.11
2013	6.25	5.00	7.83	6.50	7.13	2.50	7.41	7.32
2014	1.73	1.06	0.63	1.25	1.23	0.54	1.52	1.53
AVG	**8.35**	**14.46**	**12.72**	**14.03**	**15.53**	**4.76**	**15.35**	**15.16**

- The raw citation impact of all organisations decreased from 2010 to 2014. 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 2014 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, 2010-2014

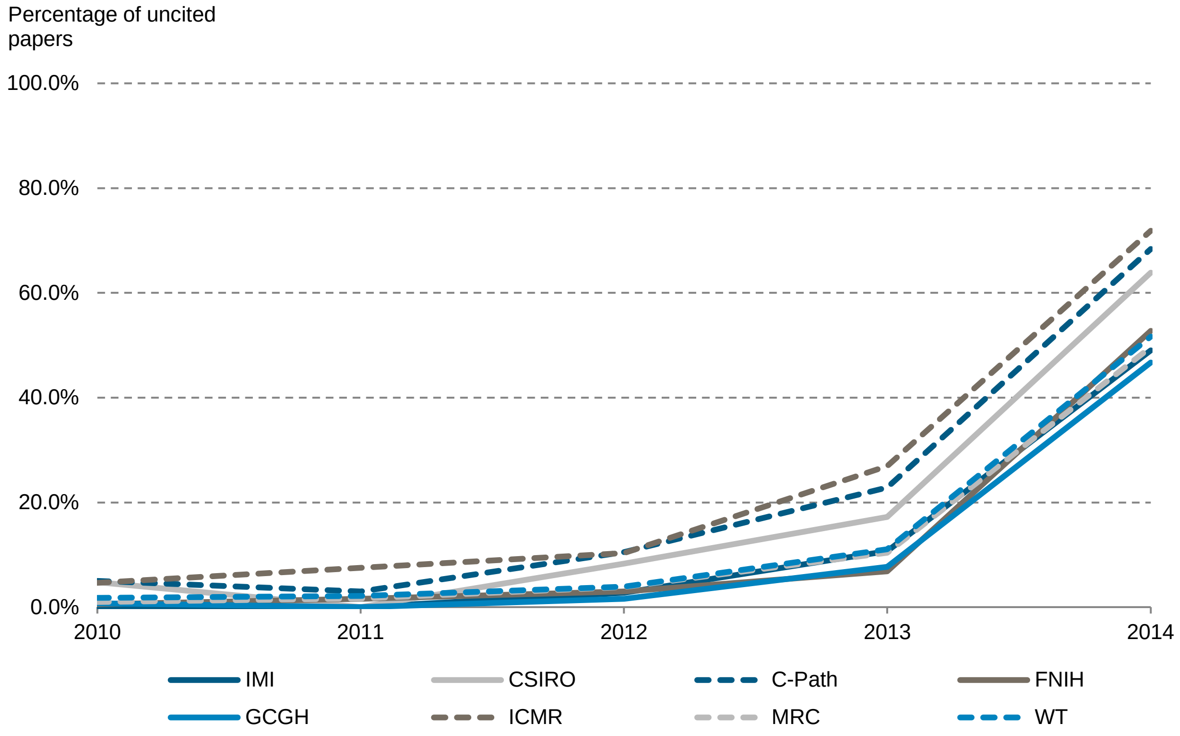


TABLE 7.2.5.1 PERCENTAGE OF UNCITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2014

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	0.0%	4.8%	5.0%	0.6%	0.7%	4.6%	1.0%	1.8%
2011	0.0%	0.0%	3.0%	1.6%	0.0%	7.5%	1.7%	2.1%
2012	2.7%	8.3%	10.5%	3.0%	1.6%	10.3%	3.9%	3.9%
2013	10.7%	17.2%	22.9%	6.9%	7.7%	27.0%	10.4%	11.1%
2014	49.1%	63.9%	68.4%	52.8%	46.7%	71.9%	49.6%	51.7%
Total	**22.7%**	**20.3%**	**24.4%**	**16.4%**	**9.9%**	**27.3%**	**13.5%**	**14.9%**

- IMI project research had a similar percentage of uncited research as the comparators between 2010 and 2014. 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. As more recent publications are less likely to be cited than older publications, so a higher percentage of uncited papers in 2013 and 2014 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 2014 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, 2010-2014

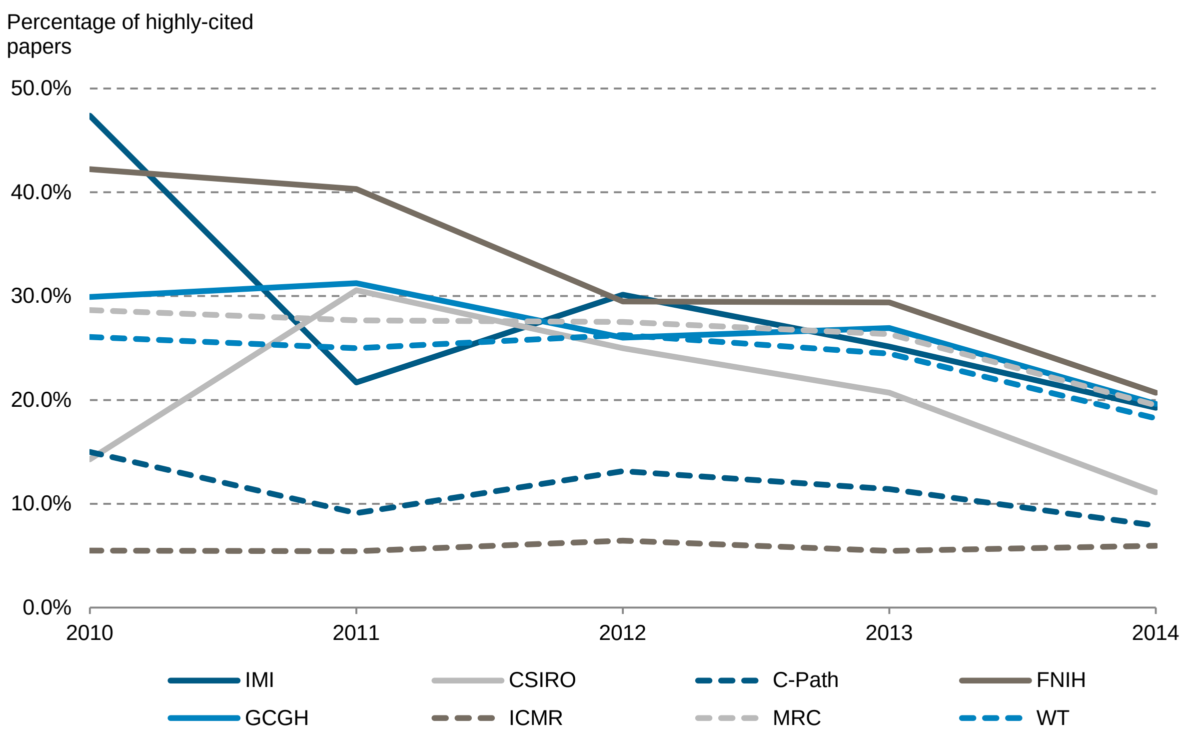


TABLE 7.2.6.1 PERCENTAGE OF HIGHLY CITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2014

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	47.4%	14.3%	15.0%	42.2%	29.9%	5.5%	28.7%	26.1%
2011	21.7%	30.6%	9.1%	40.3%	31.3%	5.4%	27.7%	25.0%
2012	30.1%	25.0%	13.2%	29.5%	26.0%	6.4%	27.5%	26.3%
2013	25.1%	20.7%	11.4%	29.4%	26.9%	5.5%	26.4%	24.5%
2014	19.2%	11.1%	7.9%	20.7%	19.6%	6.0%	19.5%	18.2%
Total	**24.0%**	**20.9%**	**11.0%**	**30.8%**	**27.2%**	**5.8%**	**25.9%**	**23.9%**

- The majority of organisations had a higher than expected percentage of highly-cited papers between 2010 and 2014. The exceptions were C-Path and ICMR.
- As of 2014, IMI had more highly-cited papers than CSIRO, C-Path, ICMR, and the Wellcome Trust.

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

Even though IMI is a 'young' funding agency its performance was 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). In terms of citation impact alone, IMI's performance was best among the funding organisations analysed.

TABLE 7.3.1 SUMMARY OF BIBLIOMETRIC INDICATORS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2014

	Number of papers	Citation impact (normalised at field level)	Percentage of uncited papers	Percentage of highly-cited papers
IMI	1121	2.19	22.7%	24.0%
CSIRO	158	1.90	20.3%	20.9%
C-Path	164	1.68	24.4%	11.0%
FNIH	1 171	2.16	16.4%	30.8%
GCGH	615	2.00	9.9%	27.2%
ICMR	4 465	0.77	27.3%	5.8%
MRC	21 046	2.08	13.5%	25.9%
WT	28 370	2.04	14.9%	23.9%

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).[18]

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

Data source

The data we use come from the 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

[18] 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.

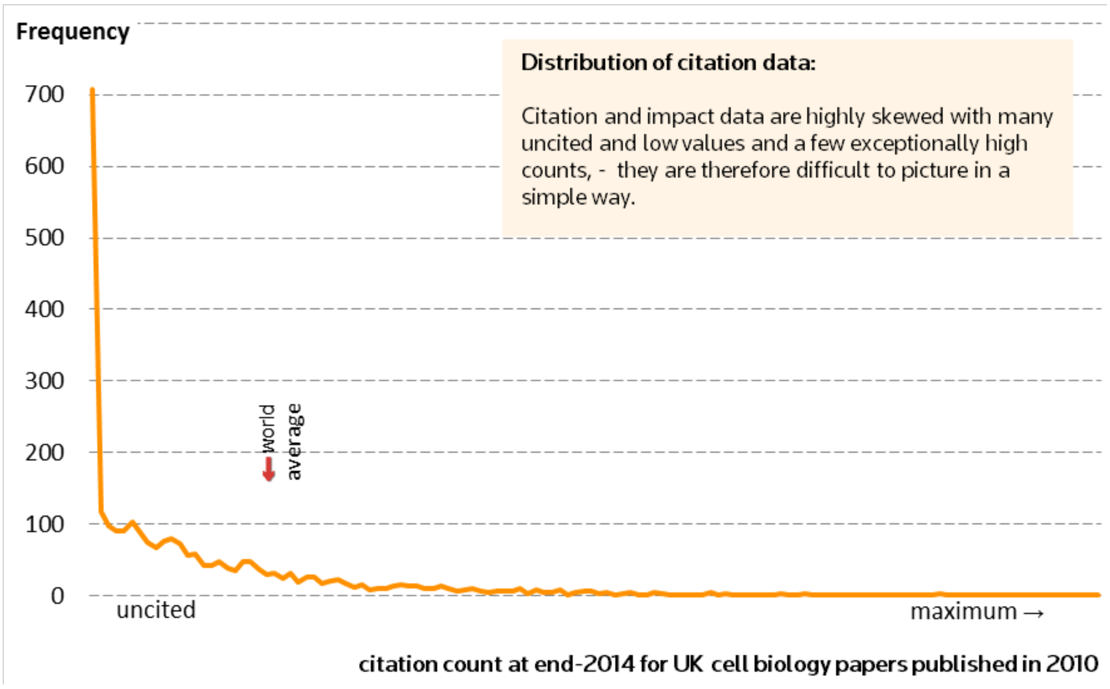
Citation counts

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.

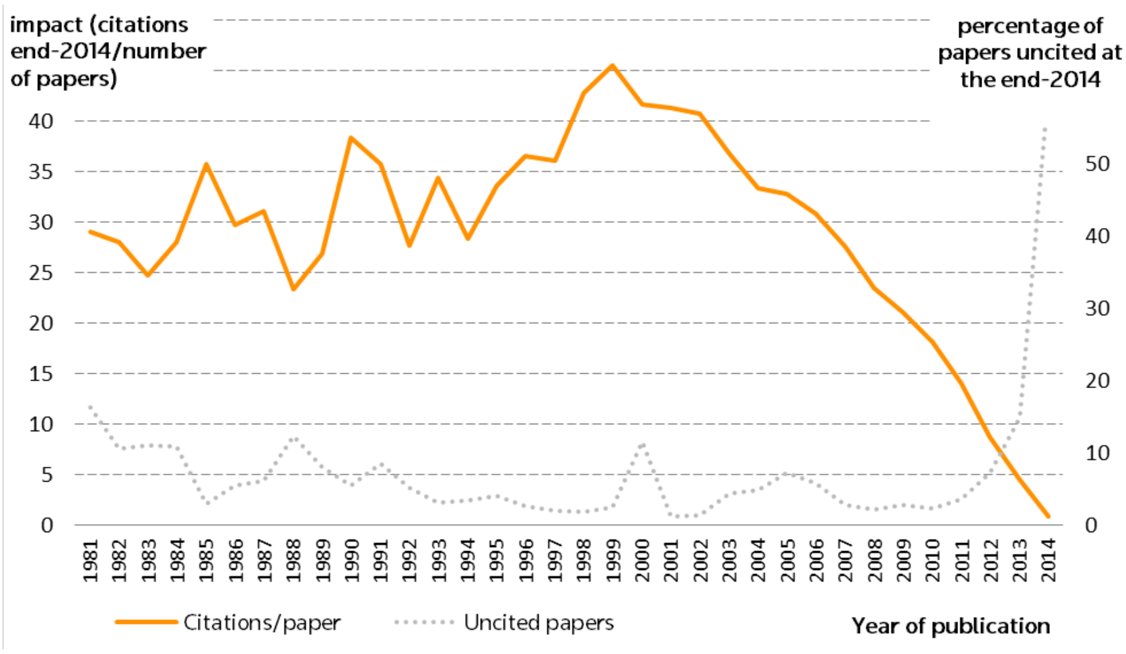
We do not seek to account separately for the effect of self-citation. If the citation count is significantly affected by self-citation then the paper is likely to have been infrequently cited. This is therefore only of consequence for low impact activity. Studies show that for large samples at national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

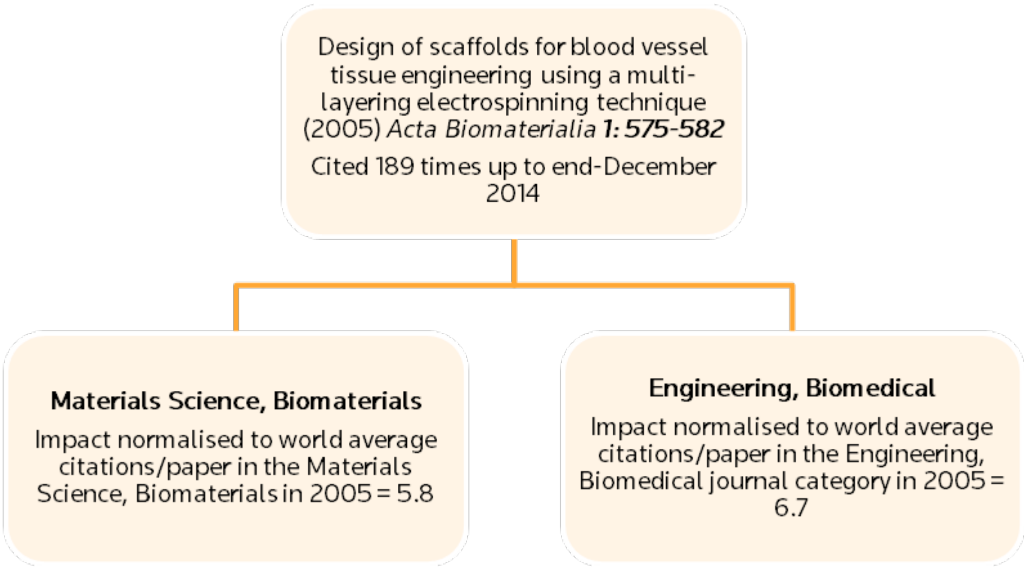
Papers are allocated according to the journal in which the paper is published. Some journals may be considered to be part of the publication record for more than one research field. As the example below illustrates, the journal *Acta Biomaterialia* is assigned to two journal categories: ***Materials 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[19] that shows the proportion of papers that are uncited and the proportion that lie in each of eight categories of relative citation rates, normalised (rebased) to world average. An Impact Profile® enables an examination and analysis of the strengths and weaknesses of published outputs relative to world average and relative to a reference profile. This provides much more information about the basis and structure of research performance than conventionally reported averages in citation indices.

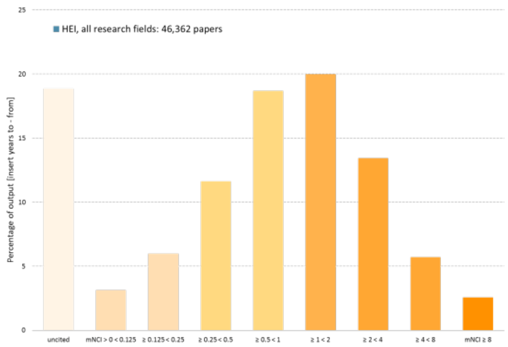
Papers which are "highly-cited" are often defined in our reports as those with an average citation impact (NCI_F) greater than or equal to 4.0, i.e. those papers which have received greater than or equal to four times the world average number of citations for papers in that subject published in that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

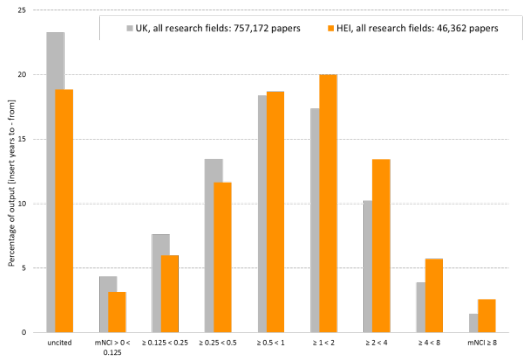
[19] Adams J, Gurney K & Marshall S (2007) Profiling citation impact: A new methodology. *Scientometrics* **72**: 325-344.

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

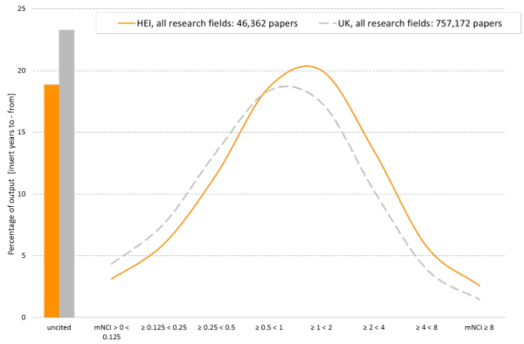
A



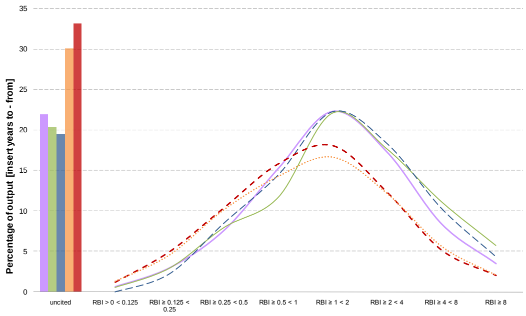
B



C



D



A: is used to represent the total output of an individual country, institution or researcher with no benchmark data. Visually it highlights the numbers of uncited papers (weaknesses) and highly cited papers (strengths).

B & **C**: are used to represent the total output of an individual country, institution or researcher (**client**) against an appropriate benchmark dataset (**benchmark**). The data are displayed as either histograms (B) or a combination of histogram and profile (C). Version C prevents the 'travel' which occurs in histograms where the eye is drawn to the data most offset to the right, but can be less easy to interpret as categorical data.

D: illustrates the complexity of data which can be displayed using an Impact Profile®. These data show research output in defined journal categories against appropriate benchmarks: **client, research field X**; **client, research field Y**; **client, research field Z**; **benchmark, research field X+Y**; **benchmark, research field, Z**.

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

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

Attention should be paid to:

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

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

What are uncited papers?

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

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

What is the threshold for 'highly cited'?

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

Chemistry, multidisciplinary
Chemistry, organic
Chemistry, physical
International relations
Language & linguistics
Language & linguistics theory
Law
Limnology
Linguistics
Literary reviews
Literary theory & criticism
Literature
Literature, African, Australian, Canadian
Literature, American
Literature, British Isles
Literature, German, Dutch, Scandinavian
Literature, romance
Literature, Slavic
Management
Marine & freshwater biology
Materials science, biomaterials
Materials science, ceramics
Materials science, characterization & testing
Materials science, coatings & films
Materials science, composites
Materials science, multidisciplinary
Materials science, paper & wood
Materials science, textiles
Math & computational biology
Mathematics
Mathematics, applied
Mathematics, interdisciplinary applications
Mechanics
Medical ethics
Medical informatics
Medical laboratory technology
Medicine, general & internal
Medicine, legal
Medicine, research & experimental
Medieval & renaissance studies

Engineering, manufacturing
Engineering, marine
Engineering, mechanical
Mining & mineral processing
Multidisciplinary sciences
Music
Mycology
Nanoscience & nanotechnology
Neuroimaging
Neurosciences
Nuclear science & technology
Nursing
Nutrition & dietetics
Obstetrics & gynecology
Oceanography
Oncology
Operations research & management science
Ophthalmology
Optics
Ornithology
Orthopedics
Otorhinolaryngology
Paleontology
Parasitology
Pathology
Pediatrics
Peripheral vascular disease
Pharmacology & pharmacy
Philosophy
Physics, applied
Physics, atomic, molecular & chemical
Physics, condensed matter
Physics, fluids & plasmas
Physics, mathematical
Physics, multidisciplinary
Physics, nuclear
Physics, particles & fields
Physiology
Planning & development

Information & library science
Instruments & instrumentation
Integrative & complementary medicine
Psychology
Psychology, applied
Psychology, biological
Psychology, clinical
Psychology, developmental
Psychology, educational
Psychology, experimental
Psychology, mathematical
Psychology, multidisciplinary
Psychology, psychoanalysis
Psychology, social
Public administration
Public, environmental & occupational health
Radiology, nuclear medicine & medical imaging
Rehabilitation
Religion
Remote sensing
Reproductive biology
Respiratory system
Rheumatology
Robotics
Social issues
Social sciences, biomedical
Social sci, interdisciplinary
Social sci, mathematical methods
Social work
Sociology
Soil science
Spectroscopy
Sport sciences
Statistics & probability
Substance abuse
Surgery
Telecommunications
Theater
Thermodynamics
Toxicology

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

ESSENTIAL SCIENCE INDICATORS

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

ANNEX 2: MEDICALLY RELATED JOURNAL CATEGORIES

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

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

ANNEX 3: COLLABORATION INDEX FOR ALL IMI SUPPORTED RESEARCH PROJECTS

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

Project	X-sector Score	IntlScore	Metric 3	Collaboration Index	Total Project publications	Citation impact (normalised at field level)
BTCure	0.53	0.45	1.04	2.01	212	2.36
NEWMEDS	0.60	0.56	1.78	2.94	97	2.83
EUROPAIN	0.35	0.27	0.51	1.13	91	1.98
EU-AIMS	0.67	0.63	2.90	4.21	73	3.37
PROTECT	0.97	0.60	1.20	2.77	61	1.36
IMIDIA	0.43	0.37	1.02	1.82	53	1.47
eTOX	0.31	0.37	0.43	1.11	51	2.00
Open PHACTS	0.66	0.53	0.83	2.02	41	2.35
MARCAR	0.56	0.37	0.11	1.03	36	1.89
OncoTrack	0.64	0.30	0.67	1.61	33	3.09
SUMMIT	0.41	0.41	2.09	2.91	32	1.78
QUIC-CONCEPT	0.67	0.57	1.23	2.47	30	2.06
U-BIOPRED	0.59	0.46	2.38	3.42	29	2.27
PharmaCog	0.88	0.66	2.04	3.58	25	1.87
DDMoRe	0.75	0.41	0.17	1.32	24	0.50
RAPP-ID	0.65	0.49	0.20	1.34	20	1.07
CHEM21	0.11	0.31	0.11	0.53	18	1.41
BioVacSafe	0.83	0.46	2.50	3.79	18	3.00
EMIF	0.65	0.69	2.00	3.34	17	1.84
ABIRISK	0.47	0.41	1.71	2.59	17	1.99
ORBITO	0.79	0.68	0.79	2.25	14	3.14
MIP-DILI	0.57	0.29	1.00	1.86	14	1.55
PRO- Active	1.00	0.73	0.69	2.42	13	2.68
PreDiCT-TB	0.83	0.54	0.17	1.54	12	0.93
StemBANCC	0.50	0.31	0.92	1.73	12	1.15
DIRECT	0.82	0.43	2.55	3.80	11	3.15
COMBACTE	0.63	0.44	0.75	1.81	8	1.56
SAFE-T	1.00	0.59	2.50	4.09	8	2.12
Translocation	0.38	0.34	0.38	1.09	8	1.19
PREDECT	0.50	0.46	0.17	1.13	6	1.13
Compact	0.20	0.70	0.40	1.30	5	0.67
EHR4CR	0.80	0.55	2.80	4.15	5	1.89
EUCLID	0.67	1.00	0.00	1.67	3	0.00
SPRINTT	0.33	0.25	1.00	1.58	3	1.46
SafeSciMET	0.67	0.67	1.00	2.33	3	0.46
eTRIKS	0.50	0.88	4.00	5.38	2	0.84
AETIONOMY	0.50	0.38	1.00	1.88	2	1.47
K4DD	1.00	0.75	1.00	2.75	1	1.88

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 hot papers in the IMI project publication dataset. This section lists 274 papers in the IMI project publications dataset that have been identified as highly-cited.

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-+, doi:10.1038/nature12873
- EMIF: VOS, SJB et al. (2013) Preclinical Alzheimers disease and its outcome: a longitudinal cohort study, Lancet Neurology, 12: 957-965, doi: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, doi: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, doi:10.1038/nature11396
- EU-AIMS: LAI, MC et al. (2014) Autism, Lancet, 383: 896-910, doi: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, Biological Psychiatry, 76: 367-376, doi: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, doi: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, doi: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?, Molecular Psychiatry, 17: 1174-1179, doi: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, Molecular Psychiatry, 17: 142-153, doi: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-+, doi: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
- 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
- PharmaCog: FRISONI, GB et al. (2010) The clinical use of structural MRI in Alzheimer disease, Nature Reviews Neurology, 6: 67-77, doi:10.1038/nrneurol.2009.215
- PROTECT: NOREN, GN et al. (2014) Zoo or Savannah? Choice of Training Ground for Evidence-Based Pharmacovigilance, Drug Safety, 37: 655-659, doi: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, doi:10.1097/EDE.0b013e318276ccb8
- Unassigned: ZUMLA, AI et al. (2014) New antituberculosis drugs, regimens, and adjunct therapies: needs, advances, and future prospects, Lancet Infectious Diseases, 14: 327-340, doi:10.1016/S1473-3099(13)70328-1

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 Neurology, 70: 390-393, doi: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, doi:10.1136/gutjnl-2013-305259
- ABIRISK: WARNKE, C et al. (2013) Changes to anti-JCV antibody levels in a Swedish national MS cohort, Journal Of Neurology Neurosurgery And Psychiatry, 84: 1199-1205, doi:10.1136/jnnp-2012-304332
- 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, doi:10.1002/hep.26232
- BioVacSafe: ANDERSEN, P et al. (2014) Tuberculosis vaccines - rethinking the current paradigm, Trends In Immunology, 35: 387-395, doi:10.1016/j.it.2014.04.006
- BioVacSafe: KAUFMANN, SHE et al. (2012) Tuberculosis vaccine development: strength lies in tenacity, Trends In Immunology, 33: 373-379, doi:10.1016/j.it.2012.03.004
- BioVacSafe: KAUFMANN, SHE et al. (2013) Tuberculosis vaccines: Time to think about the next generation, Seminars In Immunology, 25: 172-181, doi:10.1016/j.smim.2013.04.006
- BioVacSafe: KAUFMANN, SHE et al. (2014) Progress in tuberculosis vaccine development and host-directed therapies-a state of the art review, Lancet Respiratory Medicine, 2: 301-320, doi:10.1016/S2213-2600(14)70033-5
- BioVacSafe: KAUFMANN, SHE et al. (2014) Tuberculosis vaccine development at a divide, Current Opinion In Pulmonary Medicine, 20: 294-300, doi:10.1097/MCP.0000000000000041

- BioVacSafe: MAERTZDORF, J et al. (2012) Enabling biomarkers for tuberculosis control, International Journal Of Tuberculosis And Lung Disease, 16: 1140-1148, doi:10.5588/ijtld.12.0246
- BioVacSafe: WEINER, J et al. (2014) Recent advances towards tuberculosis control: vaccines and biomarkers, Journal Of Internal Medicine, 275: 467-480, doi:10.1111/joim.12212
- BTCURE: AKHMETSHINA, A et al. (2012) Activation of canonical Wnt signalling is required for TGF-beta-mediated fibrosis, Nature Communications, 3: , doi:10.1038/ncomms1734
- BTCURE: ALBRECHT, A et al. (2013) The structural basis of MRI bone erosions: an assessment by microCT, Annals Of The Rheumatic Diseases, 72: 1351-1357, doi: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, Journal Of Experimental Medicine, 210: 445-455, doi:10.1084/jem.20121486
- BTCURE: BECKER, C et al. (2013) Complex Roles of Caspases in the Pathogenesis of Inflammatory Bowel Disease, Gastroenterology, 144: 283-293, doi:10.1053/j.gastro.2012.11.035
- BTCURE: BOUCHERON, N et al. (2014) CD4(+) T cell lineage integrity is controlled by the histone deacetylases HDAC1 and HDAC2, Nature Immunology, 15: 439-+, doi:10.1038/ni.2864
- BTCure: BRINK, M et al. (2013) Multiplex Analyses of Antibodies Against Citrullinated Peptides in Individuals Prior to Development of Rheumatoid Arthritis, Arthritis And Rheumatism, 65: 899-910, doi:10.1002/art.37835
- BTCURE: BURGERS, LE et al. (2014) Long-term outcome of Rheumatoid Arthritis defined according to the 2010-classification criteria, Annals Of The Rheumatic Diseases, 73: 428-432, doi:10.1136/annrheumdis-2013-203402
- BTCURE: BURSKA, AN et al. (2014) Gene expression analysis in RA: towards personalized medicine, Pharmacogenomics Journal, 14: 93-106, doi:10.1038/tpj.2013.48
- BTCure: COPE, A et al. (2011) The Th1 life cycle: molecular control of IFN-gamma to IL-10 switching, Trends In Immunology, 32: 278-286, doi:10.1016/j.it.2011.03.010
- BTCURE: CUI, J et al. (2013) Genome-Wide Association Study and Gene Expression Analysis Identifies CD84 as a Predictor of Response to Etanercept Therapy in Rheumatoid Arthritis, PloS Genetics, 9: , doi:10.1371/journal.pgen.1003394
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