Bibliometric analysis of ongoing projects

10th Report September 2019

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1 EXECUTIVE SUMMARY

This report presents a bibliometric analysis of the Innovative Medicine Initiative Joint Undertaking's (IMI JU) research published between 2010 and 2018, using citations as an index of academic impact and co-authorship as an index of collaboration. This is the tenth report commissioned by IMI from Clarivate Analytics.

The data show that IMI continues to perform well and rapidly expand its research effort. The overall number of IMI research publications has increased rapidly since 2010, and the initiative continues to show an exceptionally high growth in output. Every year IMI produced more publication than in the previous year as the number of funded projects has increased over time. To date, IMI projects have produced 4,938 publications which have been matched to the Clarivate Web of Science™. This represents a 32% increase from the 3,737 publications matched to the Web of Science in the ninth report, which covered IMI project research published between 2010 and 2017.

The majority of IMI research (60%) has been published in high impact journals, i.e. those journals in the highest quartile (Q1) ranked by Journal Impact Factor, and the average Journal Impact Factor of all IMI project publications was 6.77. IMI research was wide-ranging from basic biological research to clinical practice. IMI project research has been published most frequently in the fields of Pharmacology & Pharmacy, Neurosciences and Biochemistry & Molecular Biology.

The impact of IMI project research (as indexed by citation impact) has remained high, with only a slight decrease in citation impact since last year. The field-normalised citation impact of IMI project research (1.84) is nearly twice the world average (1.00), which indicates the research was internationally influential. Between 2010 and 2018, the field-normalised citation impact of IMI papers was considerably higher (60%) than the European Union's (EU) average citation impact (1.10) in similar fields (journal categories). Nearly one quarter of papers from IMI projects were highly-cited - that is, the papers were in the world's top 10% of papers in the same journal category and year of publication, when ranked by number of citations.

The output of individual IMI projects has also increased between 2010 and 2018. BTCURE (Call 2) has remained the most prolific IMI project, with 645 publications as of this report. This is a 12.6% increase on the 573 publications attributed to BTCURE in the previous report. However, this growth is slower than the growth for all IMI projects in aggregate; most likely because the BTCURE project ended in early 2017.

Projects funded by IMI are highly collaborative. Since the ninth report, an increasing percentage of IMI publications involve collaboration between researchers in different sectors, institutions and countries. Nearly two-thirds (62.2%) of all IMI project papers were co-authored by researchers working in different sectors, more than three-quarters (84.3%) involved collaboration between institutions and more than half (61.3%) of all IMI project papers were internationally collaborative. Internationally collaborative IMI project research had a citation impact (2.62) well over twice the world average (1.0) and higher than non-internationally collaborative IMI project research (1.86).

Research in both Europe and North America tends to be clustered in major cities with an existing strong academic research base. It is clear that the citation impact of IMI papers within these clusters is higher than national averages and rates of international co-authorship are very high compared to the averages for EU-28 biomedical research. The cluster with the highest proportion of open access publications is Oxford, UK (75%).

IMI's field-normalised citation impact (1.84) is on a par with well-established funding bodies such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Medical Research Council (MRC) and the Wellcome Trust (WT) (1.57, 1.86 and 2.01 respectively). Its journal-normalised citation impact (1.19) and percentage of highly-cited papers (22.0%) are also similar to those of the comparator funders.

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

Summary of key findings

Since its first call for proposals in 2008, IMI has funded more than 135 projects from a total of 27 funding calls, a further three calls are currently open for proposals. Of the calls, 11 were from IMI's first phase, which ran from 2008 to 2013, and the rest from its second phase, which was launched in 2014 and is still in progress. It may take several months for a project to progress from inception to the point where it has generated sufficient data for a publication. It may take further months or years until it has produced its most valuable results. As some of the IMI projects analysed in this report are relatively young, the bibliometric indicators may not fully reflect their eventual impact.

- IMI projects have published a total of 4,938 unique Web of Science publications (Figure 4.1.1). IMI project research continues to show substantial growth, with the research publication count increasing every year since its inception (Figure 4.3.1).
- Nearly a quarter (22.1%) of IMI papers were in the world's top 10% of most highly-cited papers in the relevant field and year of publication, suggesting very strong performance (Table 4.6.1).
- The field-normalised citation impact of IMI project papers was nearly twice the world average (1.84) between 2010 and 2018. This indicates that the impact of IMI-associated research (as indicated by citations) has been maintained while output has continued to grow (Table 4.6.1).
- More IMI project publications appeared in *PLOS One* than in any other journal (162 publications), followed by *Annals of the Rheumatic Diseases* (153 publications). Of the 20 journals in which IMI-funded project published most frequently, more than two-thirds (14) rank in the top quartile by Journal Impact Factor (Table 4.7.1).
- The highest Impact Factor journal in which IMI research was published is the *New England Journal of Medicine*, which has a Journal Impact Factor of 70.670. IMI project research published 11 times in *Nature* and nine times in *Science*, which have Journal Impact Factors of 43.070 and 41.037 respectively (Table 4.7.2).
- IMI project research had a citation impact well above the European (EU-28) average in all 10 journal subject categories to which most IMI publications are assigned (Figure 4.9.1 and Table 4.9.1).
- IMI project research was most frequently published in Pharmacology & Pharmacy journals (Figure 4.8.1). Of the 595 papers published in this field, 17.5% were highly-cited, 39.5% were open access, and the average citation impact of these papers was 1.5 times the world average for the field to which they relate (Tables 4.8.2 and 4.8.3).
- The number of publications from IMI 1 Call 1 increased from 2010 to 2013 to a peak of 177, before falling to less than 100 publications in 2018. Other early calls follow a similar pattern of initial growth followed by a decline as projects come to a close (Figure 5.1.1).
- Research associated with three projects in IMI 1 Call 1 (EUROPAIN, NEWMEDS, U-BIOPRED) received more than twice the world average number of citations for research published in the same field and year (Figure 5.2.1).
- IMI project research is collaborative across sectors, institutions and countries. Nearly two-thirds (62.2%) of IMI project papers were co-authored by researchers from different sectors. More than three-quarters (84.3%) of IMI project papers involved collaboration between different institutions. And more than half (61.3%) of all IMI project papers were internationally collaborative (Table 7.1.1).
- BTCURE had the most cross-sector collaborative papers, 380 out of a total of 603 (63.0%), as well as the most internationally collaborative papers (350 out of 603) (Tables 7.2.1 to 7.2.3).
- IMI's research output grew faster (20.9%) between 2017 and 2018 than any of the seven selected comparators (Table 8.2.1.1).

- IMI's field-normalised citation impact approached twice the world average (1.84) was around the same as those of the MRC (1.86), CSIRO (1.57) and the Wellcome Trust (2.01) (Table 8.2.2.1).
- The largest geographic clusters of research supported by IMI in Europe are London (983 publications), Amsterdam (794 publications), Stockholm (464 publications), Paris (403 publications) and Copenhagen (342 publications). The largest clusters in North America are Boston (194 publications), Toronto (187 publications), Bethesda (116 publications), Montreal (83 publications) and New York (81 publications) (Tables 6.1 and 6.3).
- Typically, around 35-40% of EU-28 biomedical research involves international co-authorship whereas the lowest rate of international co-authorship for IMI's European clusters was 66.9% (Madrid). In addition, more than two thirds of the European clusters have rates of international co-authorship of at least 75%. The North American clusters have the highest rates of international collaboration because IMI is a European funding organisation (Tables 6.1 and 6.3).

2 INTRODUCTION

2.1 OVERVIEW

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

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

2.2 INNOVATIVE MEDICINES INITIATIVE (IMI) JOINT UNDERTAKING

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

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

To date, IMI has announced 11 calls for proposals under its first phase and a further 19 calls for proposals under its second phase. The first funding call was announced in 2008 and the latest, was launched in June 2019. This report covers the research output (publications and papers) of a total of 62 projects from IMI phase one and 60 projects from IMI phase two.

2.3 CLARIVATE ANALYTICS

Clarivate Analytics, formerly the IP & Science business of Thomson Reuters, provides reporting and consultancy services to enable customers to understand and interpret their research performance and to inform strategic decision-making. We have extensive experience with databases of research inputs, activity and outputs and have developed innovative analytical approaches for benchmarking, interpreting and visualising research impact.

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

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

Visit Clarivate Analytics or our Professional Research Data Services team online for more information.

2.4 SCOPE OF THIS REPORT

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

- To provide bibliometric indicators to identify excellence in IMI-supported research and to benchmark this research, where possible, overall and at individual call or 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.

Bibliometrics

- Section 4 presents analyses of IMI project publications overall, including trends in publications, frequently used journals, and top research fields. Where possible IMI research is benchmarked to EU-28 research.[1]
- Section 5 presents citation analyses of IMI publications at the call level, examining trends in publications, citation impact and outputs of individual project. Where possible the IMI projects are benchmarked to world output and overall IMI output.
- Section 6 presents geographic clusters where IMI research activity occurs, including bibliometric data, the constituent institutions and top five journal subject categories within the clusters.

Collaboration

- Section 7 presents collaboration analyses for IMI publications overall and at the project level, examining collaboration between different sectors, institutions and countries.

Benchmarking

- Section 8 presents analysis of IMI publications, benchmarked to similar organisations. The organisations are: Commonwealth Scientific and Industrial Research Organisation (CSIRO), Critical Path Institute (C-Path), Foundation for the National Institutes of Health (FNIH), Grand Challenges in Global Health (GCGH), Indian Council of Medical Research (ICMR), Medical Research Council (MRC), and the Wellcome Trust (WT).

[1] At time of publication, September 2019, the United Kingdom was still a member of the European Union and is included in the EU-28.

3 DATA SOURCES, INDICATORS AND INTERPRETATION

3.1 BIBLIOMETRICS AND CITATION ANALYSIS

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

Research publications accumulate citation counts when they are referred to by more recent publications. Citations to prior work are a normal part of publication and reflect the value placed on a work by later researchers. Some papers get cited frequently and many remain uncited. Highly cited work is recognised as having a greater impact and Clarivate Analytics has shown that high citation rates are correlated with other qualitative evaluations of research performance, such as peer review.[2] This relationship holds across most science and technology areas and, to a limited extent, in social sciences and even in some humanities subjects.

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

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

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

3.2 DATA SOURCE

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

The **Web of Science Core Collection** is part of the Web of Science and focuses on research published in journals and conferences in science, medicine, arts, humanities and social sciences. The authoritative, multidisciplinary content covers over 34,000 of the highest impact journals worldwide, including open access and over 205,000 conference proceedings. Coverage is both current and

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

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

3.3 METHODOLOGY

Publications: Many different document types are indexed in the Web of Science, including editorials, meeting abstracts, book reviews as well as research journal articles and reviews. In this report all documents regardless of type are referred to as 'publications'.

Article: Reports of research on original works. Includes research papers, features, brief communications, case reports, technical notes, chronology, and full papers that were published in a journal and/or presented at a symposium or conference.

Review: A renewed study of material previously studied. Includes review articles and surveys of previously published literature. Usually will not present any new information on a subject.

Papers: The terms 'paper' and 'publication' are often used interchangeably to refer to printed and electronic outputs of many types. However in this report the term 'paper' is used exclusively to refer to articles and reviews - a subset of 'publications' that excludes all other document types.

Articles and reviews are the main way researchers communicate their results to the wider community and standards in methodology and interpretation are ensured by pre-publication peer-review by experts in the same field. Therefore citation data for papers is the most informative for bibliometric evaluations and only citations to papers are used in calculations of the citation impact indicators presented in this report.

Citations: Papers mention earlier papers to acknowledge their intellectual contribution to a field of research. A paper receives a citation when it is mentioned or cited by another, usually more recent paper.

Citation count: The number of citations received by a paper since it was published reflects the impact it has had on later research. Not all citations are necessarily recorded as not all the citing papers are indexed in the Web of Science. The material indexed by Clarivate Analytics, however, is estimated to attract about 95% of global citations.

Citation impact: Citations per paper is an index of academic or research impact (as compared with economic or social impact). for a single paper, raw citation impact is the same as its citation count. For a set of papers it is calculated by dividing the sum of citations by the total number of papers in any given dataset. 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).

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

Field-normalised citation impact (nci_F): Broadly the field normalised citation impact compares the citation impact of a paper or set of papers to the average citation impact of all similar papers published worldwide in the same field and year.

As citation rates vary between research fields and with time, 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.

As field-normalised citation impact is normalised to global averages the performance of papers in different fields can be directly compared as the world average always equals 1.00. Therefore a field-normalised citation impact exceeding 1.00 indicates papers have received more citations than the world average, conversely a value below 1.00 suggests papers are underperforming. See page 113 for a worked example of how field normalised citation impact is calculated.

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

Web of Science journal categories or Clarivate Analytics InCites: Essential Science Indicators℠ fields: Standard bibliometric methodology uses journal category or ESI fields as a proxy for research fields. ESI fields aggregate data at a higher level than the journal categories – there are only 22 ESI research fields compared to 254 journal categories. Journals are assigned to one or more categories, and every article within that journal is subsequently assigned to that category. Papers from prestigious, 'multidisciplinary' and general medical journals such as *Nature, Science*, *The Lancet*, *The BMJ*, *The New England Journal of Medicine* and the *Proceedings of the National Academy of Sciences* (PNAS) are assigned to specific categories based on the journal categories of the references cited in the article. The selection procedures for the journals included in the citation databases are documented here http://mjl.clarivate.com/.[4]

Journal-normalised citation impact (nci_J): Broadly the journal-normalised citation impact compares a papers or set of papers citation impact to all the other papers published in the same journal in the same year.

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

Like the field-normalised citation impact a value exceeding 1.00 indicates that a paper or set of papers is receiving more citations than other papers in the same journal, and a values less than 1.00 indicates that a paper or set of papers is underperforming, receiving fewer citations,

3.4 DATA COLLATION

This analysis used a dataset comprising publications arising from IMI-supported projects. This contained publications associated with each IMI project identified using grant acknowledgments, title and abstract text search, as well as other parameters developed in conjunction with IMI staff. There are

[4] 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.

currently 135 IMI projects. IMI staff validated the publications identified by this process and the list of projects to be analysed was provided by IMI staff.

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 in this, the tenth report, include IMI-supported publications identified in Clarivate Analytics Web of Science up to 31st December 2018. The census point for inclusion of publications into the ninth report was 31st December 2017. Therefore, this report reflects changes in IMI activity between these points. Citations to these publications were counts up to June 2019. Unless otherwise specified metrics are for all IMI-supported documents from all calls in IMI 1 and IMI 2, in aggregate.

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

4.1 PUBLICATIONS FROM IMI-SUPPORTED PROJECTS

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

The IMI project dataset started with 3,737 publications which were previously identified as IMI publications. Separately, 2,004 new publications were identified as IMI-associated through keyword searches of funding acknowledgement text in databases which underlie Clarivate Analytics Web of Science. The combination of these two datasets led to a total of 5,741 unique publication records associated with IMI-supported projects. Of these 5,741 publications, 803 were eliminated as they were either published in 2019 or could not be distinguished as IMI from a manual review of the dataset. Therefore, 4,938 Web of Science publications remained.

The citation counts for this report were sourced from the citation databases which underlie Clarivate Analytics Web of Science and were extracted in June 2019. Normalised bibliometric indicators were calculated using standard methodology and the Clarivate Analytics National Science Indicators (NSI) database for 2018.

FIGURE 4.1.1 PROCESS FOR IDENTIFYING PUBLICATIONS FROM IMI-SUPPORTED PROJECTS, 2010-2018

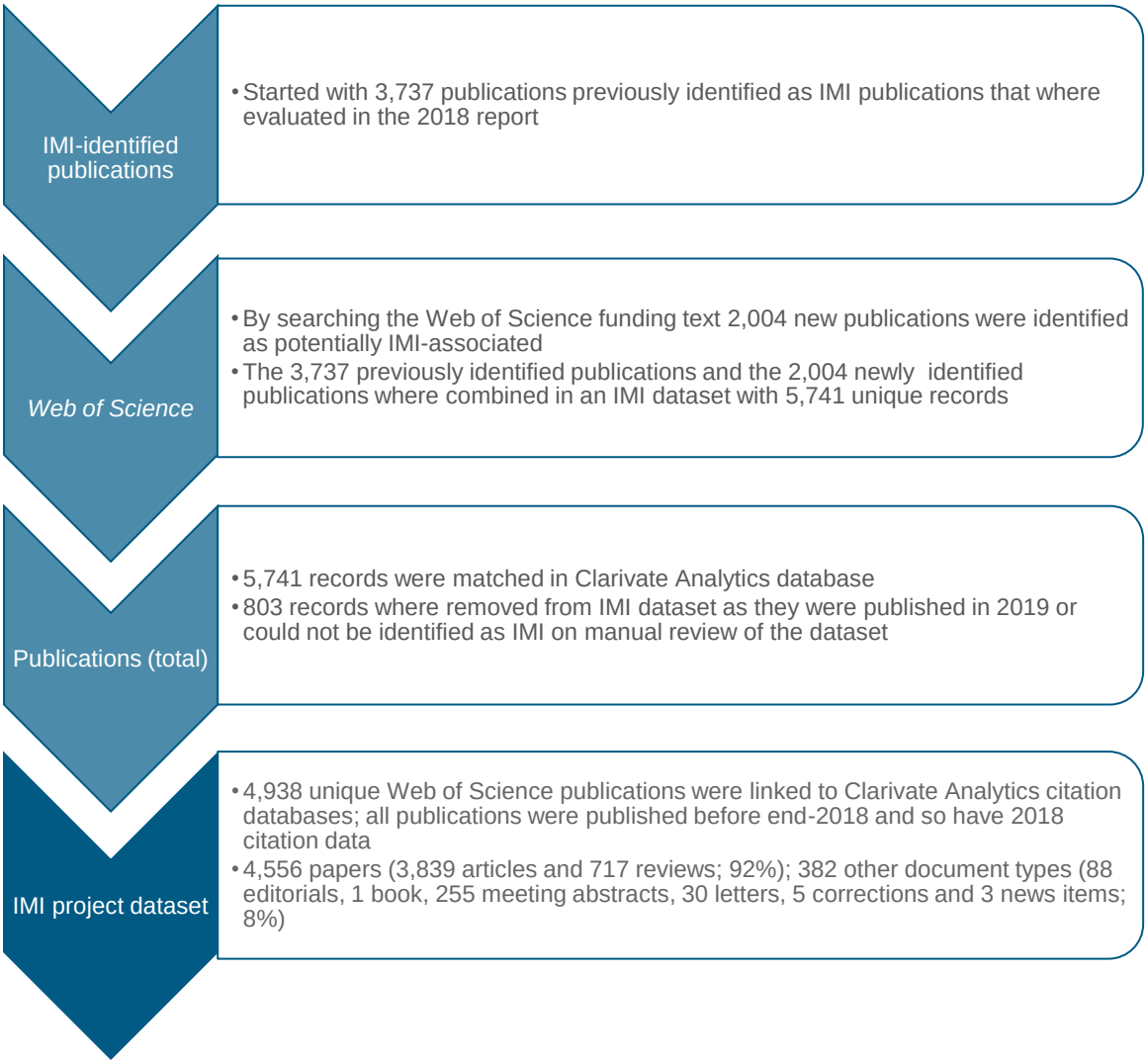


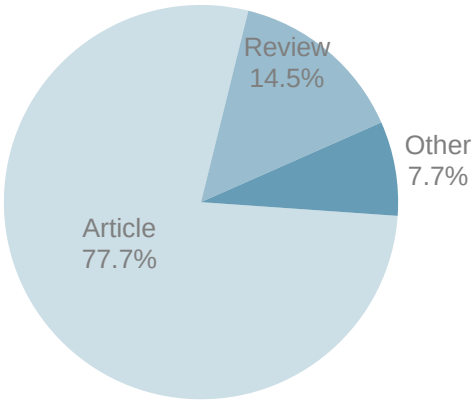
Table 4.1.1 NUMBER OF PUBLICATIONS FROM IMI PROJECTS, 2010-2018

	Number of publications	Number of paper
All IMI	4,938	4,556
IMI 1	4,608	4,297
IMI 2	326	257

4.2 PUBLICATIONS FROM IMI PROJECTS BY DOCUMENT TYPE

Figure 4.2.1**Error! Reference source not found.** shows the percentage of Web of Science publications by document type and the same data is shown in Table 4.2.1.

FIGURE 4.2.1 PERCENTAGE OF IMI PROJECT PUBLICATIONS BY DOCUMENT TYPE, 2010-2018



Articles + Reviews = Papers, 92.2%

- IMI project research resulted in 4,938 unique Web of Science publications.
- Of these publications 92% were articles (77.7%) and reviews (14.5%) which are collectively referred to as 'papers' in this report.
- A further 382 publications (7.7%) where not papers. These 'other' publications comprised of 88 editorials, one book, 255 meeting abstracts, 30 letters, five corrections, three news items and one publication that was not assigned a document type.

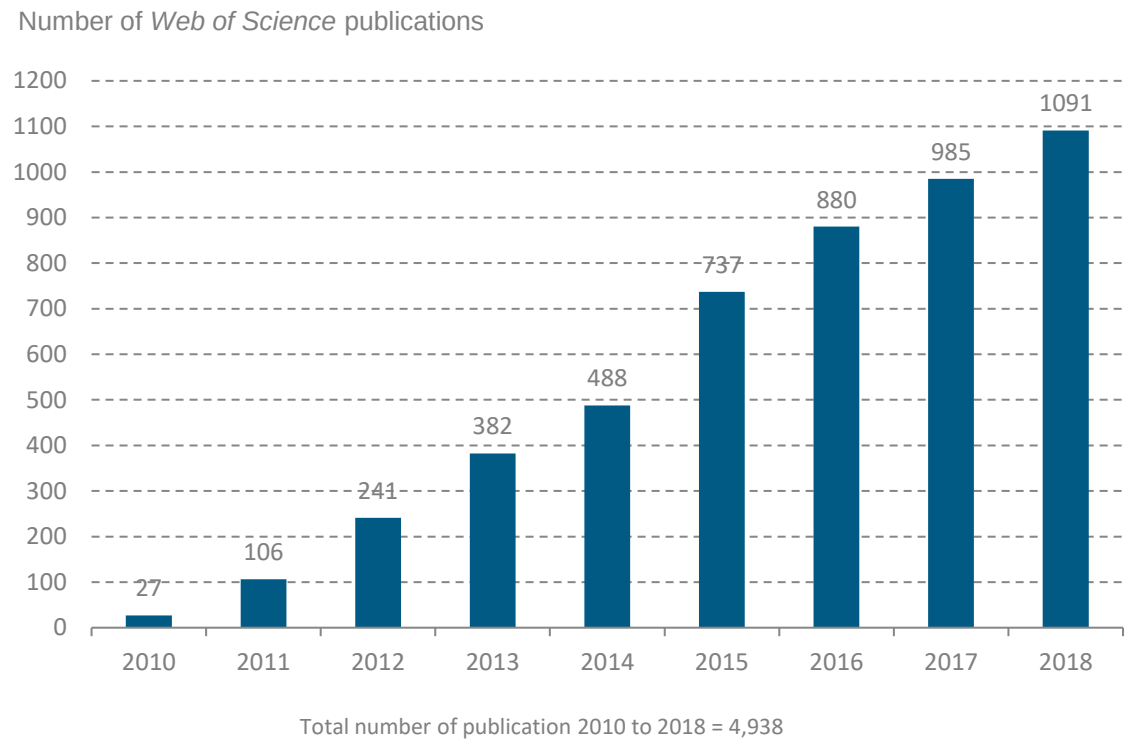
TABLE 4.2.1 NUMBER AND PERCENTAGE OF IMI PROJECT PUBLICATIONS BY DOCUMENT TYPE, 2010-2018

Document type		Number of publications	% of IMI publications
Papers	Articles	3,838	77.7%
	Reviews	717	14.5%
Other document types	Meeting abstracts	255	5.16%
	Editorials	88	1.78%
	Letters	30	0.61%
	Corrections	5	0.10%
	News items	3	0.06%
	Books	1	0.02%
	Not specified	1	0.02%

4.3 TRENDS IN PUBLICATION OUTPUT

Figure shows the annual number of Web of Science publications arising from IMI projects between 2010 and 2018.

FIGURE 4.3.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS FOR IMI PROJECTS BY YEAR, 2010-2018

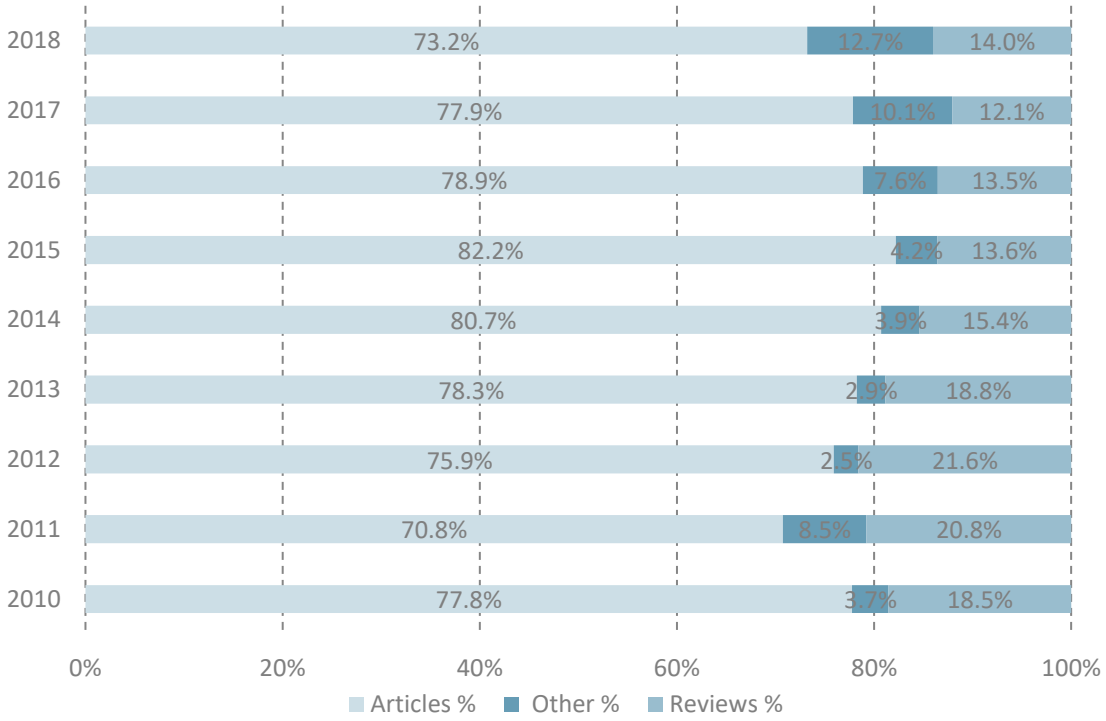


IMI project research continued to show substantial growth, with publication count increasing every year between 2010 and 2018:

- The 2017-2018 period has shown growth in IMI output in line with previous years.
- The percentage change in the output of IMI project-supported publications between 2017 and 2018 was 10.8%, compared with a growth of 11.9% between 2016 and 2017.

Figure 4.2.3 shows the proportion of papers (articles and reviews) relative to other document types for IMI project research between 2010 and 2018.

FIGURE 4.3.1 PERCENTAGE OF IMI PROJECT PUBLICATIONS EACH YEAR BY DOCUMENT TYPE, 2010-2018



- IMI project research continued to generate a high proportion of papers relative to other document types. Articles accounted for around 73.2% of all publication in 2018, slightly lower than in recent years. This small drop has been countered by a slight increase in reviews and a larger increase in the number of editorials and conference abstracts, both of which are represented in ‘other’ document types.

4.4 PUBLICATION OUTPUT BY COUNTRY

Figure 4.4.1 shows a map highlighting all countries with one or more publication from IMI projects between 2010 and 2018. Figure 4.4.2 shows a map highlighting all countries with at least ten Web of Science publications from IMI projects between 2010 and 2018. Table 4.4.1 and Figure 4.4.3 shows the corresponding data; the total number of publications for the 20 and 10 countries respectively with the highest number publications from IMI projects between 2010 and 2018. A full list of all countries output of publications is included in Annex 3.

FIGURE 4.4.1 MAP OF COUNTRIES WHICH HAVE AT LEAST ONE WEB OF SCIENCE PUBLICATION FOR IMI PROJECTS, 2010-2018

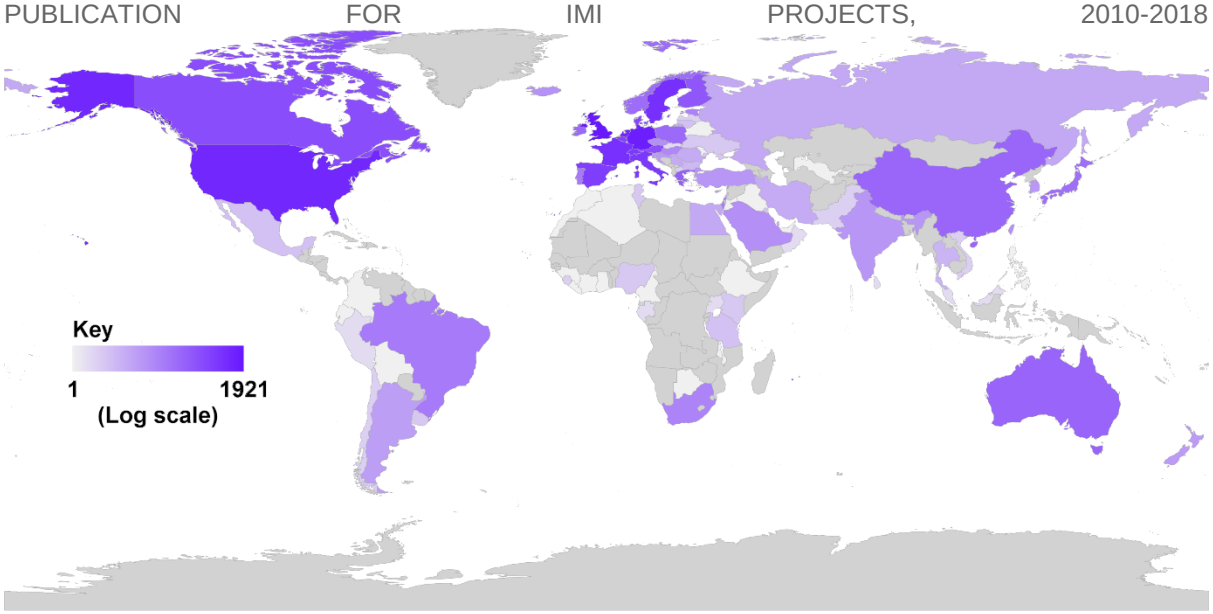
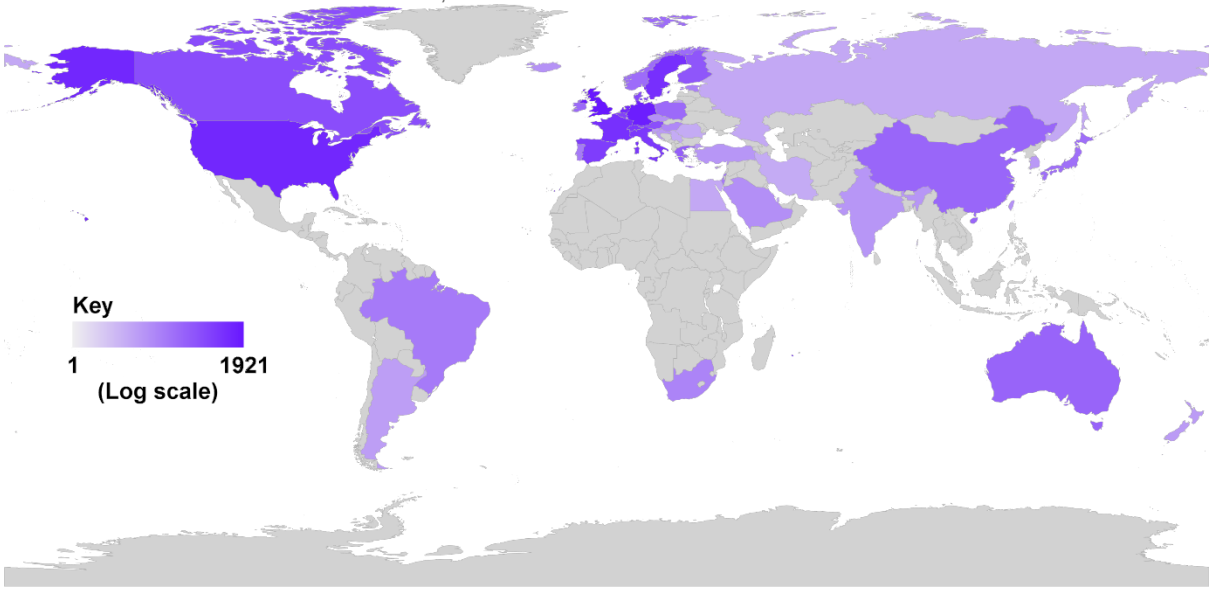


FIGURE 4.4.2 MAP OF COUNTRIES WHICH HAVE AT LEAST TEN WEB OF SCIENCE PUBLICATION FOR IMI PROJECTS, 2010-2018



- In total 96 countries have at least one IMI publications and 47 countries have at least ten IMI publications.

FIGURE 4.4.3 TEN COUNTRIES WITH THE MOST IMI PROJECT PUBLICATIONS. ANNEX 3 LISTS ALL COUNTRIES WITH AT LEAST ONE IMI PROJECT PUBLICATION, 2010-2018

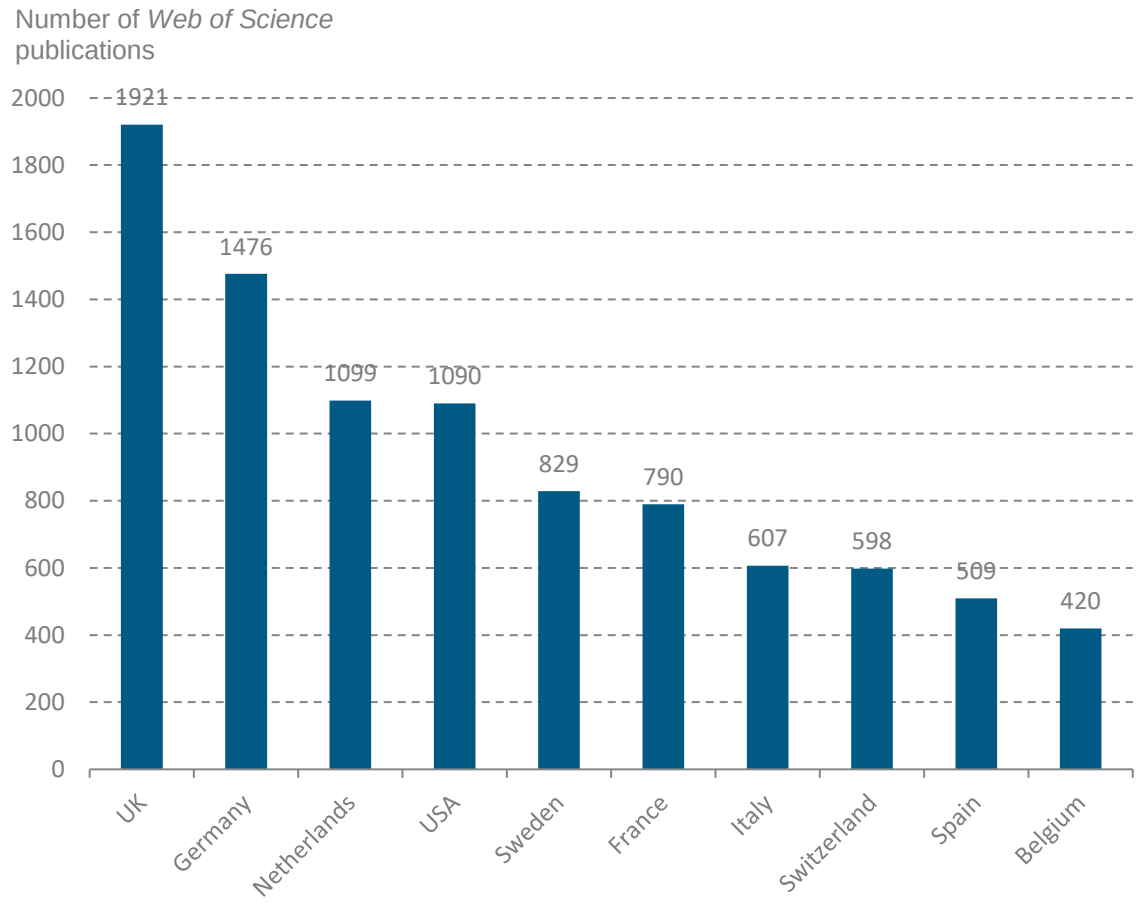


TABLE 4.4.1 TWENTY COUNTRIES WITH THE MOST IMI PROJECT PUBLICATIONS. ANNEX 3 LISTS ALL COUNTRIES WITH AT LEAST ONE IMI PROJECT PUBLICATION, 2010-2018

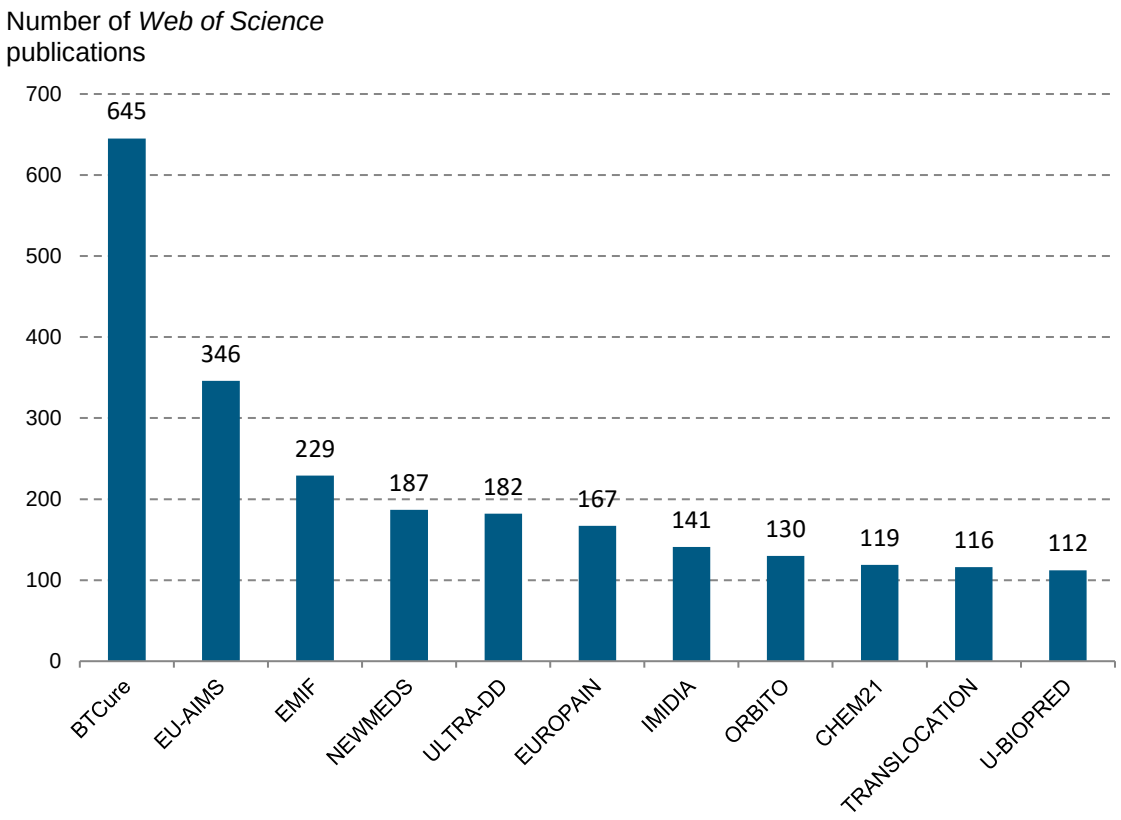
Country	Number of publications
United Kingdom	1,921
Germany	1,476
Netherlands	1,099
USA	1,090
Sweden	829
France	790
Italy	607
Switzerland	598
Spain	509
Belgium	420
Denmark	347
Canada	290
Austria	268
Finland	209
Greece	157
Australia	128
China	121
Ireland	107
Poland	103
Norway	99
Japan	88

- Researchers affiliated to the United Kingdom co-authored the most IMI project publications (1,921 publications).
- Other EU-28 countries where among the countries with the highest output. The most productive exceptions are the USA (1,090 publications) and Switzerland (598 publications).

4.5 PUBLICATION OUTPUT BY IMI PROJECT

Figure 4.5.1 shows the ten IMI projects with the highest output of publications between 2010 and 2018. Table 4.5.1, expands upon Figure 4.5.1, listing the 20 IMI projects with the most publications, including the number and percentage of open access publications and the number of papers between 2010 and 2018. A full list projects and the number of associated publications is presented in Annex 4.

FIGURE 4.5.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS FOR TEN IMI PROJECTS WITH THE HIGHEST OUTPUT OF PUBLICATIONS, 2010-2018



- BTCure has been the most projective IMI project in terms of number of publications (645 publications) with nearly double the output of publications than the second most productive project EU-AIMS (346 publications).

TABLE 4.5.1 TWENTY IMI PROJECTS WITH THE MOST PUBLICATIONS, THE NUMBER OF PAPERS, NUMBER AND PERCENTAGE OF OPEN ACCESS PUBLICATIONS, 2010-2018.

ANNEX 4 LISTS THE SAME INFORMATION FOR ALL IMI PROJECTS WITH AT LEAST ONE PUBLICATION

Project	Number of publications	Number of paper	Number of open access publications	% of open access publications
BTCure	645	603	388	60.2%
EU-AIMS	346	337	220	63.6%
EMIF	229	214	157	68.6%
NEWMEDS	187	183	96	51.3%
ULTRA-DD	182	177	107	58.8%
EUROPAIN	167	167	49	29.3%
IMIDIA	141	132	102	72.3%
ORBITO	130	128	26	20.0%
CHEM21	119	116	32	26.9%
TRANSLOCATION	116	116	59	50.9%
U-BIOPRED	112	68	33	29.5%
SUMMIT	110	107	75	68.2%
MIP-DILI	105	98	55	52.4%
CANCER-ID	105	90	61	58.1%
STEMBANCC	103	100	76	73.8%
ELF	103	102	47	45.6%
PROTECT	97	95	37	38.1%
PreDiCT-TB	95	91	73	76.8%
eTOX	95	91	57	60.0%
Quic-Concept	94	93	65	69.1%

4.6 IS IMI PROJECT RESEARCH WELL-CITED?

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

Figure 4.6.1 shows the average field-normalised citation impact for all IMI papers compared to the average for EU-28 papers in relevant journal categories and all global papers published between 2010 and 2018. Tables 4.6.1 and 4.6.2 present average citation impact indicators for all IMI papers.

FIGURE 4.6.1 FIELD-NORMALISED CITATION IMPACT FOR IMI SUPPORTED RESEARCH PAPERS COMPARED TO THE AVERAGE FOR EU-28 PAPERS AND WORLD PAPERS, 2010-2018

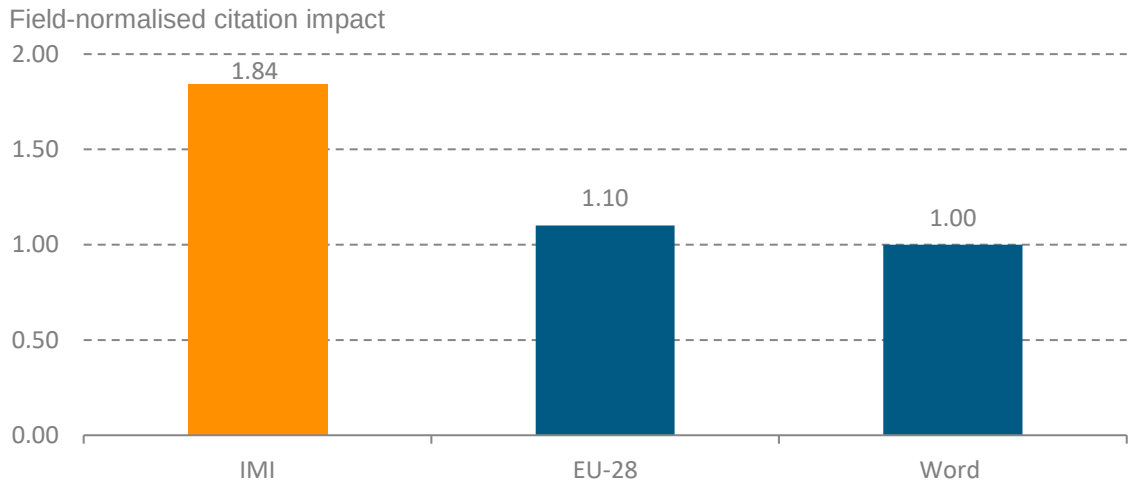


TABLE 4.6.1 SUMMARY CITATION ANALYSIS FOR IMI SUPPORTED RESEARCH PAPERS, 2010-2018

		Citation impact			
	Number of papers	Normalised at field level (nci_F)	Normalised at journal level (nci_J)	Average percentile	% of highly cited papers
IMI projects	4,556	1.84	1.19	40.0	22.1%
IMI 1	4,297	1.89	1.20	37.7	22.4%
IMI 2	257	1.59	0.89	57.1	14.4%

TABLE 4.6.2 SUMMARY OF IMI SUPPORTED RESEARCH PUBLICATIONS, 2010-2018

	Number of publications	% of open access publications	Number of papers	Citations	Raw citation impact
IMI Projects	4,938	55.9%	4,556	81,819	17.96
IMI 1	4,608	58.0%	4,297	80,279	18.68
IMI 2	326	63.2%	257	1,029	4.00

SUMMARY OF KEY FINDINGS

- The field-normalised citation impact of IMI project papers was 1.84 for the nine-year period, 2010-2018 (almost twice the world average of 1.0). This shows that the impact of IMI-associated research (as indicated by citations) had been maintained while output had continued to grow.
- The field-normalised citation impact of IMI project papers was 60% higher than the EU's average citation impact (1.10)[5,6] between 2010 and 2018, in the same group of journal categories. This is the same percentage point difference as seen in the previous report. A change in the world average, resulting in slightly lower normalised impacts for both the EU-28 and IMI, is likely due to a sizable increase in the volume and impact of research output by China.
- Almost a quarter (22.1%) 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.

[5] EU-28 grouping of countries: Clarivate Analytics National Science Indicators 2018 database; similar research has been defined as including the same journal categories as in the IMI project dataset.
[6] For this analysis, only papers are considered since only these publication types have normalised citation impact data (see Section 3).

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

The 20 journals in which IMI project publications appeared most frequently (ranked by number of publications) between 2010 and 2018, are listed in Table 4.7.1. Together, the 20 most frequently used journals account for 1,124 Web of Science publications - almost one-quarter of all IMI project publications.

IMI project publications appeared most frequently in *PLOS One* (162 publications), followed by *Annals of the Rheumatic Diseases* (153 publications). Of the 28 IMI publications in *the American Journal of Respiratory and Critical Care Medicine* (JIF = 16.49), 23 were meeting abstracts, four were articles and one was a letter.

IMI continued to have a strong focus on Rheumatology, and three of the ten most frequently used journals are assigned to this journal subject category. However, the top 20 most frequently used journals contain, three titles in the Neurosciences category; five in Pharmacology & Pharmacy and four in the Multidisciplinary category, indicating the broad range of research IMI funds.

Of the 20 journals in Table 4.7.1, 14 were in the top quartile by Journal Impact Factor and six were in the second quartile ranked against other journals in the same category.

Overall IMI project publications were published in a total of 1052 journals, of which 525 were ranked in the top quartile (by Journal Impact Factor) of journals in their relevant journal category. A total of 2,938 publications (60% of IMI project publications) were published in these well-regarded journals. The average Journal Impact Factor of all IMI project publications is 6.77, an increase of 0.67 compared to the previous year.

The 20 highest Journal Impact Factor journals in which IMI project research was published are listed in Table 4.7.2. The highest Impact Factor journal is *The New England Journal of Medicine*, with a Journal Impact Factor of 70.67. IMI projects have published a total of 11 publications (two since the 9th report) in *Nature*, which had a Journal Impact Factor of 43.07 and nine (one since the 9th report) in *Science* with a Journal Impact Factor of 41.04.

The 20 open access journals in which IMI projects publish most frequently (ranked by number of publications), are listed in Table 4.7.3. Of the top 20 open access journals *Annals of the Rheumatic Diseases* had the highest impact factor (14.30) and *PLUS One* published the most IMI publications (162 publications).

TABLE 4.7.1 JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 20 RANKED BY NUMBER OF WEB OF SCIENCE PUBLICATIONS, 2010-2018

Journal	Number of *Web of Science* publications	Number of papers	Journal Impact Factor (2018)	*Web of Science* journal categories	Quartile
PLOS One	162	162	2.776	Multidisciplinary Sciences	Q2
Annals of the Rheumatic Diseases	153	106	14.299	Rheumatology	Q1
Scientific Reports	104	104	4.011	Multidisciplinary Sciences	Q1
Diabetologia	84	50	7.113	Endocrinology & Metabolism	Q1
Arthritis Research & Therapy	50	50	4.148	Rheumatology	Q2
Nature Communications	49	49	11.878	Multidisciplinary Sciences	Q1
Arthritis & Rheumatology	48	41	9.002	Rheumatology	Q1
Pain	47	47	6.029	Anesthesiology; Clinical Neurology; Neurosciences	Q1
European Journal of Pharmaceutical Sciences	45	43	3.532	Pharmacology & Pharmacy	Q2
Journal of Alzheimer's Disease	43	43	3.517	Neurosciences	Q2
Psychopharmacology	42	42	3.424	Neurosciences; Pharmacology & Pharmacy; Psychiatry	Q2
European Respiratory Journal	42	13	11.807	Respiratory System	Q1
Diabetes	39	31	7.199	Endocrinology & Metabolism	Q1
Proceedings of The National Academy of Sciences of the United States of America	35	35	9.580	Multidisciplinary Sciences	Q1
Drug Safety	33	32	3.526	Pharmacology & Pharmacy; Public, Environmental & Occupational Health; Toxicology	Q1
Molecular Pharmaceutics	33	33	4.396	Research & Experimental Medicine; Pharmacology & Pharmacy	Q1
Journal of Medicinal Chemistry	30	30	6.054	Medicinal Chemistry	Q1
Journal of Antimicrobial Chemotherapy	29	28	5.113	Infectious Diseases; Microbiology; Pharmacology & Pharmacy	Q1
Bioorganic & Medicinal Chemistry	28	28	2.802	Biochemistry & Molecular Biology; Medicinal Chemistry; Organic Chemistry	Q2
American Journal of Respiratory and Critical Care Medicine	28	4	16.494	Critical Care Medicine; Respiratory System	Q1

TABLE 4.7.2 JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 20 RANKED BY JOURNAL IMPACT FACTOR, 2010-2018

Journal	Number of *Web of Science* publications	Number of papers	Journal Impact Factor (2018)	*Web of Science* journal categories	Quartile
The New England Journal of Medicine	1	1	70.670	General & Internal Medicine	Q1
The Lancet	3	2	59.102	General & Internal Medicine	Q1
Nature Reviews Drug Discovery	7	3	57.618	Biotechnology & Applied Microbiology; Pharmacology & Pharmacy	Q1
Chemical Reviews	2	2	54.301	Multidisciplinary Chemistry	Q1
Nature Reviews Cancer	1	1	51.848	Oncology	Q1
Jama-Journal of the American Medical Association	8	6	51.273	General & Internal Medicine	Q1
Nature Reviews Immunology	2	2	44.019	Immunology	Q1
Nature Reviews Genetics	2	2	43.704	Genetics & Heredity	Q1
Nature Reviews Molecular Cell Biology	1	1	43.351	Cell Biology	Q1
Nature	11	11	43.070	Multidisciplinary Sciences	Q1
Science	9	8	41.037	Multidisciplinary Sciences	Q1
Chemical Society Reviews	1	1	40.443	Multidisciplinary Chemistry	Q1
Cell	3	3	36.216	Biochemistry & Molecular Biology; Cell Biology	Q1
Lancet Oncology	1	1	35.386	Oncology	Q1
Nature Reviews Microbiology	1	1	34.648	Microbiology	Q1
Nature Reviews Clinical Oncology	6	5	34.106	Oncology	Q1
Nature Reviews Neuroscience	2	2	33.162	Neurosciences	Q1
Nature Reviews Disease Primers	2	2	32.274	General & Internal Medicine	Q1
Nature Biotechnology	1	0	31.864	Biotechnology & Applied Microbiology	Q1
Nature Medicine	6	6	30.641	Biochemistry & Molecular Biology; Cell Biology; Research & Experimental Medicine	Q1

TABLE 4.7.3 OPEN ACCESS JOURNALS IN WHICH IMI PROJECT PUBLICATIONS WERE PUBLISHED MOST FREQUENTLY, TOP 20 RANKED BY NUMBER OF WEB OF SCIENCE PUBLICATIONS, 2010-2018

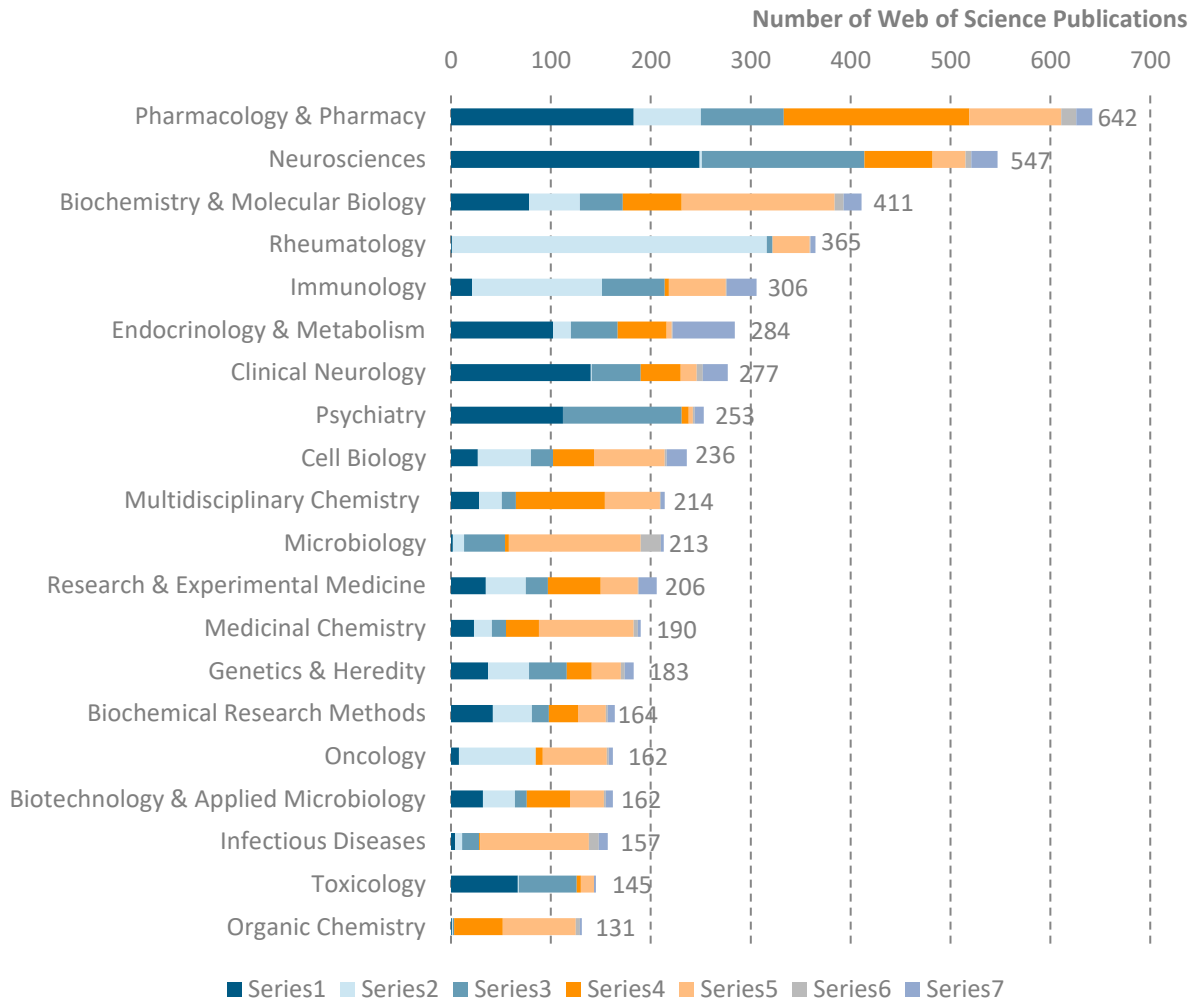
Open access journal	Number of *Web of Science* publications	Number of papers	Journal Impact Factor (2018)	*Web of Science* journal categories
PLOS One	162	162	2.776	Multidisciplinary Sciences
Scientific Reports	104	104	4.011	Multidisciplinary Sciences
Annals of the Rheumatic Diseases	55	32	14.299	Rheumatology
Arthritis Research & Therapy	50	50	4.148	Rheumatology
Nature Communications	49	49	11.878	Multidisciplinary Sciences
Diabetologia	44	42	7.113	Endocrinology & Metabolism
Proceedings of the National Academy of Sciences of the United States of America	34	34	9.58	Multidisciplinary Sciences
Arthritis & Rheumatology	33	33	9.002	Rheumatology
Nucleic Acids Research	27	27	11.147	Biochemistry & Molecular Biology
Journal of Immunology	26	26	4.718	Immunology
Diabetes	26	26	7.199	Endocrinology & Metabolism
Journal of Antimicrobial Chemotherapy	26	25	5.113	Infectious Diseases; Microbiology; Pharmacology & Pharmacy
Antimicrobial Agents and Chemotherapy	26	25	4.715	Microbiology; Pharmacology & Pharmacy
Bioinformatics	26	26	4.531	Biochemical Research Methods; Biotechnology & Applied Microbiology; Interdisciplinary Applications Computer Science,; Mathematical & Computational Biology; Statistics & Probability
Toxicological Sciences	24	24	3.564	Toxicology
Journal of Alzheimer's Disease	24	24	3.517	Neurosciences
Frontiers in Immunology	24	23	4.716	Immunology
Cell Reports	22	22	7.815	Cell Biology
Translational Psychiatry	22	22	5.182	Psychiatry
BMJ Open	21	21	2.376	General & Internal Medicine

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

Figure 4.8.1 shows the ten Web of Science journal categories[7] most frequently associated with IMI funded research[8]. IMI 1 calls 5-11 have a lower number of publications relative to calls 1-4 and for clarity of presentation these publications are shown as one group in Figure 4.8.1.Likewise, IMI 2 has far fewer publication compared to IMI 1 and so all IMI 2 publications are shown as one group in Figure 4.8.1. Publications that acknowledge IMI funding but do not specify a project, phase or call are classed as Unassigned.

Table 4.8.1 shows the same data as Figure 4.8.1 for the top twenty journal categories. 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 by IMI 1 calls and IMI 2.

FIGURE 4.8.1 TOP TEN WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED MOST FREQUENTLY, 2010-2018. DATA LABELS SHOWS THE TOTAL NUMBER OF PUBLICATIONS PER JOURNAL CATEGORY



[7] Journals can be associated with more than one Web of Science category.

[8] It should be noted that there are 152 publications which are associated with multiple IMI calls. This probably happens when a publications acknowledges funding from multiple IMI projects in different calls and phases.

- IMI projects produced more publications in Pharmacology & Pharmacy than in other journal categories, followed by Neurosciences and Biochemistry & Molecular Biology.
- Since the last report, Multidisciplinary Chemistry has dropped below Cell Biology and Endocrinology & Metabolism has overtaken Clinical Neurology and Psychiatry.
- The majority of publications (86.3%) in Rheumatology were from the call 2 project BTCURE.
- The publications assigned to Neurosciences, Clinical Neurology and Psychiatry were predominantly from calls 1 and 3.

TABLE 4.8.1 NUMBER OF PUBLICATIONS BY IMI 1 CALL AND IMI 2 FOR TWENTY WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED MOST FREQUENTLY, 2010-2018. ORDERED BY TOTAL NUMBER OF PUBLICATIONS.

	Number of publications by IMI 1 Call												
Journal Category	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**IMI 2**	**Not assigned**
Pharmacology & Pharmacy	183	67	83	186	7	18	7	5	29	0	26	16	15
Neurosciences	249	2	163	68	0	0	0	22	3	0	8	26	6
Biochemistry & Molecular Biology	78	51	43	59	23	31	0	18	6	0	75	18	9
Rheumatology	1	315	6	0	0	0	1	24	0	0	12	5	1
Immunology	21	130	63	4	0	5	6	12	4	19	11	30	1
Endocrinology & Metabolism	102	18	47	49	0	0	0	1	2	0	2	62	1
Clinical Neurology	140	1	49	40	0	0	0	6	0	0	10	25	6
Psychiatry	112	0	119	7	0	0	1	1	0	0	2	9	2
Cell Biology	27	53	22	41	1	5	0	12	2	0	51	20	2
Multidisciplinary Chemistry	28	23	14	89	29	7	0	5	1	0	13	4	1
Microbiology	2	11	41	4	0	57	1	4	37	4	29	3	20
Research & Experimental Medicine	35	40	22	53	0	1	8	2	1	9	16	18	1
Medicinal Chemistry	23	18	14	33	37	7	0	2	0	0	49	3	4
Genetics & Heredity	37	41	38	25	0	2	0	7	1	0	19	9	4
Biochemical Research Methods	42	39	17	29	1	5	0	8	0	1	13	7	2
Oncology	8	77	0	7	1	0	2	1	0	0	60	4	2
Biotechnology & Applied Microbiology	32	32	12	43	1	3	0	12	2	5	11	7	2
Infectious Diseases	4	7	17	1	0	29	2	2	38	6	32	9	10
Toxicology	67	1	58	4	0	0	1	0	8	0	4	2	0
Organic Chemistry	1	1	1	49	58	3	0	1	0	0	11	2	4

Table 4.8.2 and Table 4.8.3 provide the citation impact, percentage of highly-cited papers and percentage of open access publications for the IMI project research in the top twenty journal categories.

TABLE 4.8.2 FIELD-NORMALISED, JOURNAL-NORMALISED AND RAW CITATION IMPACT OF PAPERS FOR THE TWENTY WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED MOST FREQUENTLY, 2010-2018. ORDERED BY TOTAL NUMBER OF PAPERS

Journal category	Number of papers	Citation impact		
		Normalised at field level (nci_f)	Normalised at journal level (nci_j)	Raw citation impact
Pharmacology & Pharmacy	595	1.54	1.02	12.48
Neurosciences	507	1.70	1.21	22.87
Biochemistry & Molecular Biology	392	2.58	1.63	19.77
Rheumatology	302	1.90	0.97	20.23
Immunology	281	1.54	1.16	15.87
Endocrinology & Metabolism	229	1.85	0.95	13.29
Clinical Neurology	244	2.44	1.24	28.49
Psychiatry	232	2.15	1.04	20.30
Cell Biology	224	1.81	1.22	17.83
Multidisciplinary Chemistry	207	1.35	1.18	21.10
Research & Experimental Medicine	196	2.29	1.04	16.91
Medicinal Chemistry	182	1.63	1.22	8.46
Microbiology	172	1.63	1.08	9.93
Genetics & Heredity	159	2.20	1.22	23.54
Oncology	145	2.76	1.50	25.98
Biochemical Research Methods	151	1.52	1.19	15.50
Biotechnology & Applied Microbiology	139	1.74	1.34	15.22
Toxicology	136	1.47	1.24	11.39
Organic Chemistry	130	1.14	1.02	6.69
Infectious Diseases	114	2.01	1.09	9.57

TABLE 4.8.3 NUMBER OF PUBLICATIONS, NUMBER OF PAPERS, PERCENTAGE OPEN ACCESS AND PERCENTAGE HIGHLY CITED PAPERS FOR THE TOP TWENTY WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS PUBLISHED MOST FREQUENTLY 2010-2018. ORDERED BY TOTAL NUMBER OF PAPERS

Journal category	Number of publications	% of open access publications	Number of papers	% of highly cited papers
Pharmacology & Pharmacy	625	39.5%	595	17.5%
Neurosciences	537	49.5%	507	21.1%
Biochemistry & Molecular Biology	398	55.3%	392	21.7%
Rheumatology	364	50.5%	302	25.8%
Immunology	294	59.2%	281	16.7%
Endocrinology & Metabolism	274	56.9%	229	17.9%
Clinical Neurology	271	38.4%	244	33.2%
Psychiatry	246	53.3%	232	20.7%
Cell Biology	231	66.2%	224	25.4%
Multidisciplinary Chemistry	212	42.5%	207	13.5%
Research & Experimental Medicine	201	56.7%	196	27.6%
Medicinal Chemistry	184	38.0%	182	15.9%
Microbiology	179	71.5%	172	22.7%
Genetics & Heredity	170	71.8%	159	28.3%
Oncology	161	61.5%	145	33.8%
Biochemical Research Methods	153	54.2%	151	19.2%
Biotechnology & Applied Microbiology	152	67.8%	139	19.4%
Toxicology	144	36.8%	136	18.4%
Organic Chemistry	130	33.1%	130	10.0%
Infectious Diseases	125	60.0%	114	28.9%

- IMI project research was most frequently published in Pharmacology & Pharmacy journals. Of the 625 publications published in this field, 17.5% were highly-cited.
- There were 271 publications (244 papers) in Clinical Neurology; this category has the highest percentage of highly cited papers (33.2%).
- The percentage of open access publications is highest in Cell Biology (66.2%).

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

Figure 4.9.1 shows the field-normalised citation impact of IMI funded research in the twenty Web of Science journal categories to which is it most frequently appeared. These data are benchmarked against the average citation impact of all EU-28 research papers in the same journal categories. Table 4.9.1, expands on the data presented in Figure 4.9.1 showing the percentage of IMI and EU-28 papers in each journal category.

FIGURE 4.9.1 TOP 20 WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS MOST FREQUENTLY PUBLISHED, BENCHMARKED AGAINST EU-28 PAPERS IN THE SAME JOURNAL CATEGORIES, 2010-2018

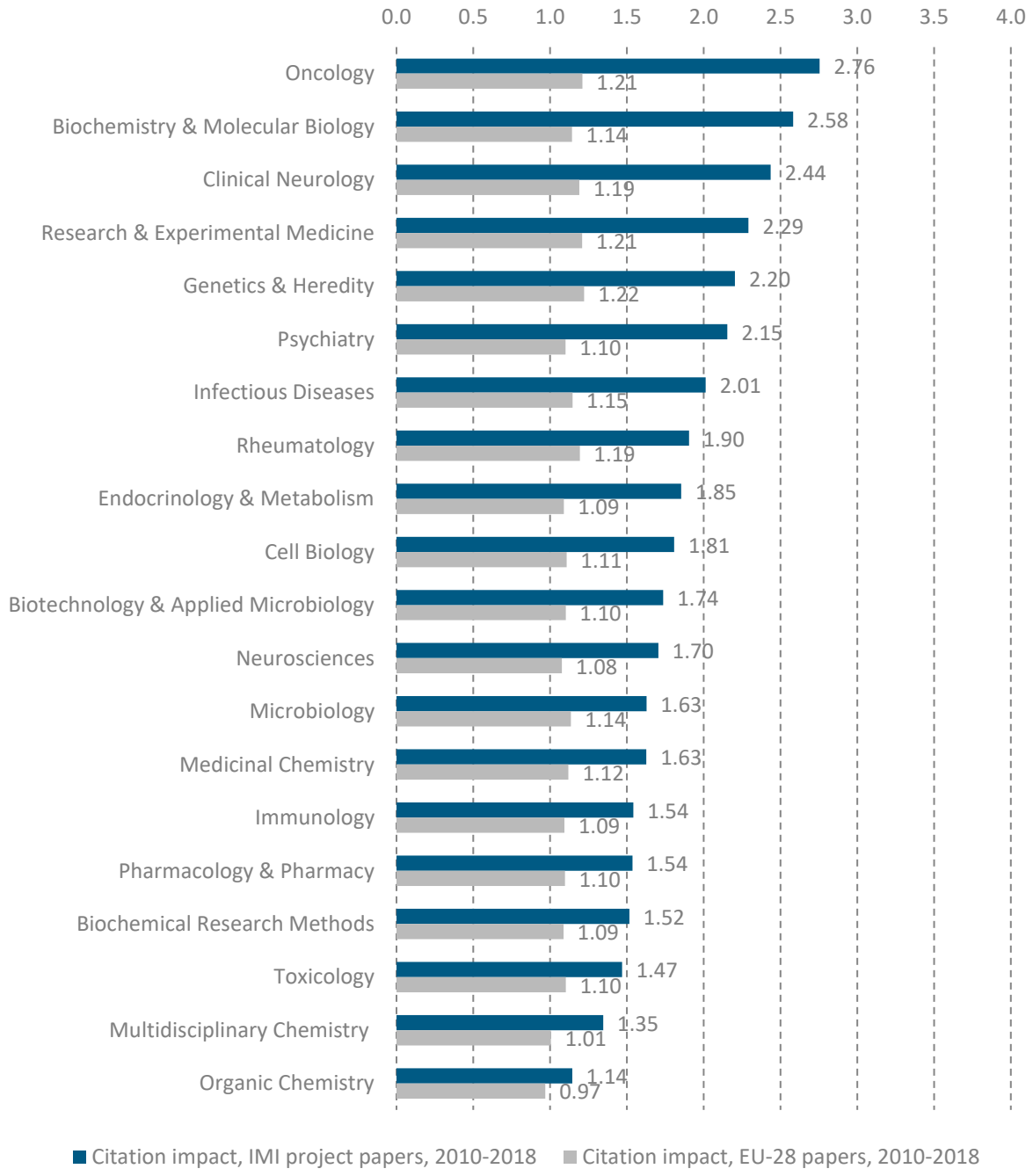


TABLE 4.9.1 CITATION IMPACT AND PERCENTAGE OF PAPERS IN TOP TWENTY WEB OF SCIENCE JOURNAL CATEGORIES IN WHICH IMI PROJECT RESEARCH WAS MOST FREQUENTLY PUBLISHED, BENCHMARKED AGAINST EU-28 PAPERS IN THE SAME JOURNAL CATEGORIES, 2010-2018

Journal category	% of IMI papers	% of EU-28 papers	Citation impact normalised at field level	
			IMI papers	EU-28
Oncology	2.5%	2.5%	2.76	1.21
Biochemistry & Molecular Biology	3.9%	3.9%	2.58	1.14
Clinical Neurology	2.0%	2.0%	2.44	1.19
Research & Experimental Medicine	1.2%	1.2%	2.29	1.21
Genetics & Heredity	1.5%	1.5%	2.20	1.22
Psychiatry	1.5%	1.5%	2.15	1.10
Infectious Diseases	1.1%	1.1%	2.01	1.15
Rheumatology	0.5%	0.5%	1.90	1.19
Endocrinology & Metabolism	1.5%	1.5%	1.85	1.09
Cell Biology	2.0%	2.0%	1.81	1.11
Biotechnology & Applied Microbiology	1.6%	1.6%	1.74	1.10
Neurosciences	3.1%	3.1%	1.70	1.08
Microbiology	1.6%	1.6%	1.63	1.14
Medicinal Chemistry	0.7%	0.7%	1.63	1.12
Immunology	1.7%	1.7%	1.54	1.09
Pharmacology & Pharmacy	2.3%	2.3%	1.54	1.10
Biochemical Research Methods	1.2%	1.2%	1.52	1.09
Toxicology	0.7%	0.7%	1.47	1.10
Multidisciplinary Chemistry	3.1%	3.1%	1.35	1.01
Organic Chemistry	1.0%	1.0%	1.14	0.97
Oncology	2.5%	2.5%	2.76	1.21

- In all journal categories analysed, IMI project research had a higher field-normalised citation impact than the average for all EU-28 papers.
- The journal category in which IMI-supported research had the highest field-normalised citation impact was Oncology (2.76)
- The average field-normalised citation impact of EU-28 papers was highest in Genetics & Heredity (1.22).

5 CITATION ANALYSIS – AT IMI PROJECT LEVEL

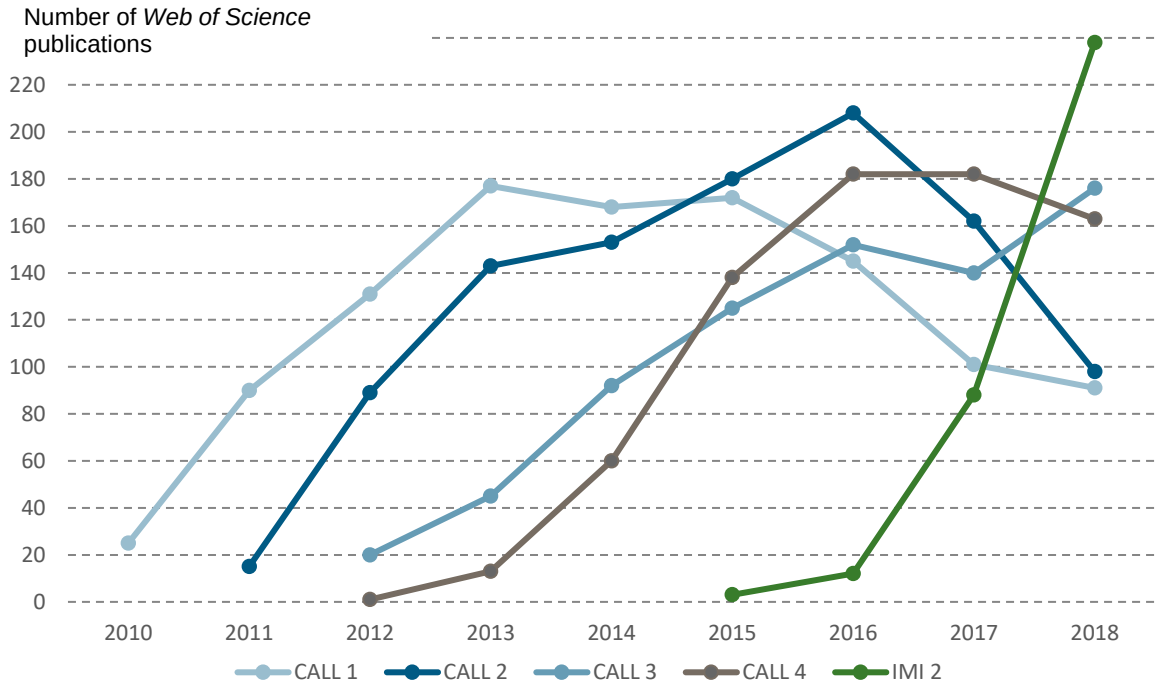
This Section analyses the volume and citation impact of publications arising from different IMI-phases and calls.

5.1 TRENDS IN PUBLICATION OUTPUT BY IMI FUNDING CALL

Figures 5.1.1 and 5.1.2 show the number of Web of Science publications between 2010 and 2018 for IMI project research disaggregated by call. IMI 1 calls 1-4 (Figure 5.1.1) are shown separately from the more recent IMI 1 calls 5-11 (Figure 5.1.2) which have fewer publication as the research projects have been running for fewer years. Likewise, individual IMI 2 calls has far fewer publication compared to most IMI 1 calls, so all IMI 2 publications are aggregated into a single group.

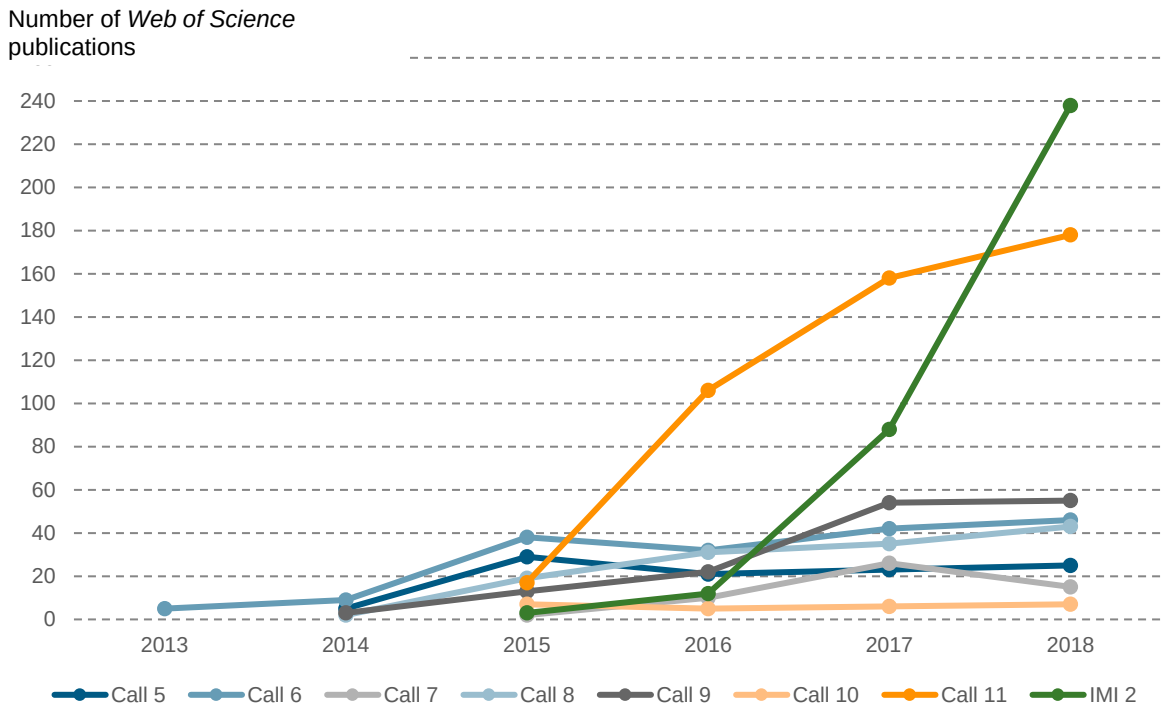
Table 5.1.1 presents summary bibliometric data for all IMI 1 and IMI 2 calls that have at least one publication, including the number of publications, numbers of papers, and citation impact.

FIGURE 5.1.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL, 2010-2018



- Since 2010 the number of publications from IMI 1, call 1 increased to a peak of 177 publications in 2013.
- After steep growth from 2011, in 2015 and 2016, IMI 1 call 2 had the highest number of publications (180 and 208, respectively). In 2017 call 2 output of publications fell (162 publication) and in that year call 4 had the most publications (182 publications).
- The number of publications from IMI 2 has grown rapidly since 2016, with 238 publications in 2018.
- There appear to be is a general trend in the output of publications over a call's lifetime. IMI 1 calls 1 – 4 all grow approximately linearly for 3 - 4 years from first publications, followed by a short plateau. Both IMI 1 calls 1 and 2 have started to show a decline starting around 2016 and 2017 respective.

FIGURE 5.1.2 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL, 2010-2018



- Overall IMI 1 calls 5-10 have not grown as rapidly as IMI 1 calls 1-4. Of the more recent IMI 1 calls, call 11 is the exception, with the growth akin to IMI 1 calls 1-4.

5.1.1 SUMMARY BIBLIOMETRIC ANALYSES OF IMI PROJECTS AGGREGATED BY FUNDING CALL, 2010-2018

Phase	Call	Number of publications [9]	% of open access publications	Number of papers	Citation impact: Raw citation impact	Citation impact: Normalised at field level (nci_F)	Citation impact: Normalised at journal level (nci_J)
1	1	1,100	48.9%	1,018	26.18	1.73	1.12
1	2	1,048	62.7%	987	22.92	1.93	1.17
1	3	751	61.3%	693	17.16	1.82	1.08
1	4	739	49.9%	711	15.11	2.10	1.32
1	5	103	45.6%	102	8.22	1.18	1.07
1	6	172	55.8%	169	9.33	1.32	1.02
1	7	53	60.4%	46	5.80	1.88	1.23
1	8	130	63.1%	110	9.96	2.82	1.52
1	9	147	54.4%	135	9.10	2.27	1.80

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

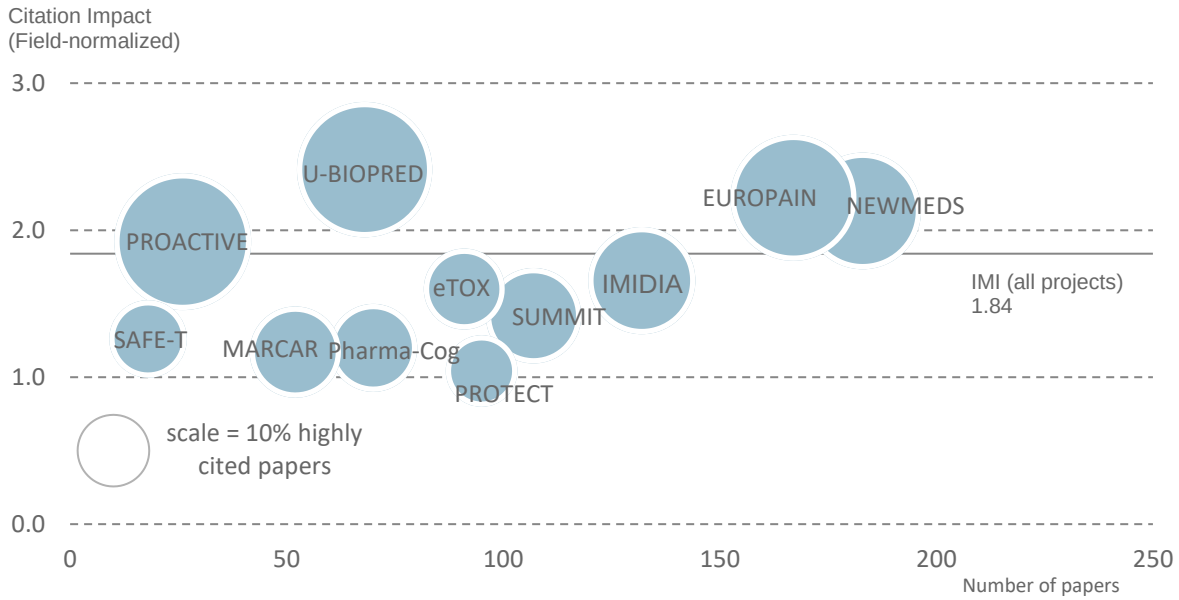
Phase	Call	Number of publications [9]	% of open access publications	Number of papers	Citation impact		
					Raw citation impact	Normalised at field level (nci_F)	Normalised at journal level (nci_J)
1	10	25	72.0%	25	8.36	2.02	1.68
1	11	459	58.8%	409	10.29	2.08	1.18
2	1	64	53.1%	55	2.38	1.19	0.69
2	2	51	72.5%	46	6.13	2.01	1.29
2	3	56	41.1%	36	3.39	1.57	0.77
2	4	2	0.0%	2	3.50	0.67	0.31
2	5	65	70.8%	53	2.53	1.45	0.70
2	6	36	55.6%	21	1.81	1.42	0.75
2	7	29	72.4%	27	7.89	2.79	0.98
2	8	8	25.0%	7	2.71	1.39	1.01
2	9	26	73.1%	21	2.90	1.38	1.11
2	10	5	80.0%	3	0.33	0.41	0.19

- IMI 1, call 1 produced the highest number of Web of Science publications (1,100), and papers (1,018). Of the 1,100 publications in call 1, around half (48.9%) were open access. The publications from IMI 1 call 1 also had the highest raw citation impact (26.18), this is probably because they are older and have had longer to accrue citations.
- Papers assigned to IMI 1, call 8 had the highest average field-normalised citation impact (2.82).

5.2 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 1

Figure 5.2.1 compares the number of papers, average field-normalised citation impact and share of highly-cited papers of IMI 1, call 1 projects. Only projects with at least 10 papers and one highly-cited paper over the time period (2010-2018) are shown. The area of the 'bubble' is proportional to the share of highly-cited papers. The solid horizontal line indicates the average field-normalised citation impact for all IMI project papers.

FIGURE 5.2.1 PAPER NUMBERS, AVERAGE FIELD-NORMALISED CITATION IMPACT AND SHARE OF HIGHLY-CITED RESEARCH FOR SELECTED IMI 1 PROJECTS – CALL 1, 2010-2018



The data in Figure 5.2.1 shows that:

- The average field-normalised citation impact of all projects with at least 10 papers was above the world average (1.0) and the percentage of highly-cited research was above the world average (10%). This indicates excellent research performance.
- Research associated with NEWMEDS, EUROPAIN and U-BIOPRED was cited more than twice the world average.
- Of the 11 projects shown in Figure 5.2.1, four (NEWMEDS, EUROPAIN, U-BIOPRED, PROACTIVE) had papers with an average citation impact greater than the average citation impact of all IMI project papers (1.84).

Table 5.2.1 shows raw citation impact and the percentage of open access publication by project for call 2 publications. Table 5.2.2 shows the normalised citation impact (normalised against world average values) of IMI 1 call 1 projects and is an expansion of the data shown in Figure 5.3.1.

TABLE 5.2.1 BIBLIOMETRIC INDICATORS FOR IMI 1 PROJECTS IN CALL 1, 2010-2018

Project	Number of publications	Number of papers	% of open access publications	Citations	Raw citation impact
NEWMEDS	187	183	51.3%	6,839	37.37
EUROPAIN	167	167	29.3%	5,479	32.81
IMIDIA	141	132	72.3%	3,530	26.74
SUMMIT	110	107	68.2%	1,855	17.34
PROTECT	97	95	38.1%	1,297	13.65
eTOX	95	91	60.0%	2,275	25.00
Pharma-Cog	76	70	27.6%	1,615	23.07
U-BIOPRED	112	68	29.5%	1,881	27.66
MARCAR	53	52	71.7%	867	16.67
PROACTIVE	31	26	67.7%	723	27.81
SAFE-T	20	18	25.0%	247	13.72

TABLE 5.2.2 SUMMARY CITATION INDICATORS FOR IMI 1 PROJECTS IN CALL 1, 2010-2018

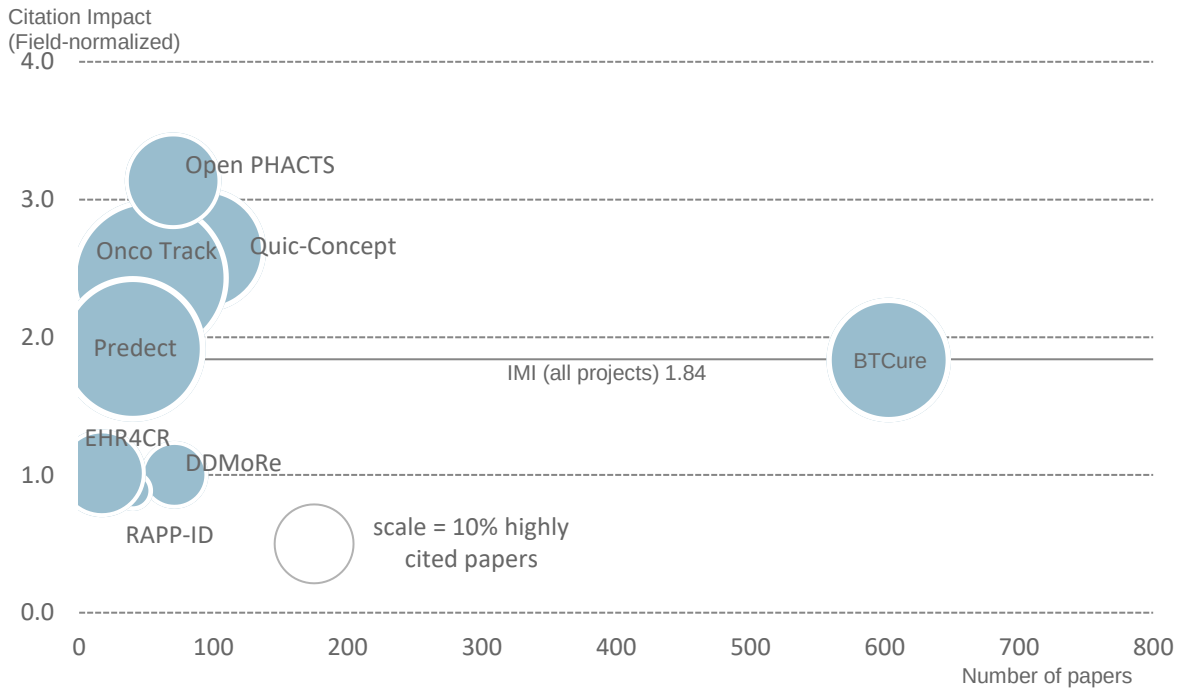
		Citation impact			
Project	Number of papers	Normalised at field level (nci_F)	Normalised at journal level (nci_J)	Average percentile	% of highly cited papers
NEWMEDS	183	2.13	1.14	35.4	25.1%
EUROPAIN	167	2.22	1.36	31.6	29.3%
IMIDIA	132	1.66	1.05	34.5	21.2%
SUMMIT	107	1.42	0.93	44.7	16.8%
PROTECT	95	1.04	0.95	44.4	9.5%
eTOX	91	1.60	1.30	38.9	12.1%
Pharma-Cog	70	1.20	0.84	49.2	14.3%
U-BIOPRED	68	2.41	1.31	30.3	33.8%
MARCAR	52	1.17	0.82	42.8	15.4%
PROACTIVE	26	1.92	1.73	34.0	34.6%
SAFE-T	18	1.26	1.07	36.9	11.1%
Overall (IMI projects)	**4556**	**1.84**	**1.19**	**39.8**	**22.1%**

- Of the projects in call 1, NEWMEDS had the highest number of publications (187) and IMIDIA had the highest percentage of open access publications (72.3%).

5.3 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 2

Figure 5.3.1 compares the number of papers, average field-normalised citation impact and share of highly-cited papers of IMI 1, call 2 projects. Only projects with at least 10 papers and one highly-cited paper over the time period (2010-2018) are shown. The area of the 'bubble' is proportional to the share of highly-cited papers. The solid horizontal line indicates the average field-normalised citation impact for all IMI project papers.

FIGURE 5.3.1 PAPER NUMBERS, AVERAGE FIELD-NORMALISED CITATION IMPACT AND SHARE OF HIGHLY-CITED RESEARCH FOR SELECTED IMI 1 PROJECTS – CALL 2, 2010-2018



The data in Figure 5.3.1 shows that:

- The average field-normalised citation impact of most IMI 1 call 2 projects was above world average. RAPP-ID had the lowest citation impact (0.89).
- BTCURE was by far the most prolific IMI 1, call 2 project with 603 papers and the field-normalised citation impact of this research was nearly twice the world average (1.83).
- QUIC-CONCEPT, Open PHACTS and Onco Track were very well-cited with field-normalised citation impacts more than twice the world average; 2.63, 3.14 and 2.43 respectively.
- Four of the nine projects in this call had an average field-normalised citation impact greater than the citation impact of all IMI project papers (1.84), and BTCure (1.83) was very close to the IMI average.

Table 5.3.1 shows raw citation impact and the percentage of open access publication by project for call 2 publications. Table 5.3.2 shows the normalised citation impact (normalised against world average values) of IMI 1 call 2 projects and is an expansion of the data shown in Figure 5.3.1.

TABLE 5.3.1 BIBLIOMETRIC INDICATORS FOR IMI 1 PROJECTS IN CALL 2, 2010-2018

Project	Number of publications	Number of papers	% of open access publications	Citations	Raw citation impact
BTCure	645	603	60.2%	13,167	21.84
Quic-Concept	94	93	69.1%	3,140	33.76
DDMoRe	76	71	63.2%	579	8.15
Open PHACTS	73	70	80.8%	2,248	32.11
Onco Track	57	53	59.6%	2,242	42.30
Predect	43	40	72.1%	798	19.95
RAPP-ID	41	40	51.2%	520	13.00
EHR4CR	19	17	57.9%	192	11.29

TABLE 5.3.2 SUMMARY CITATION INDICATORS FOR IMI 1 PROJECTS IN CALL 2, 2010-2018

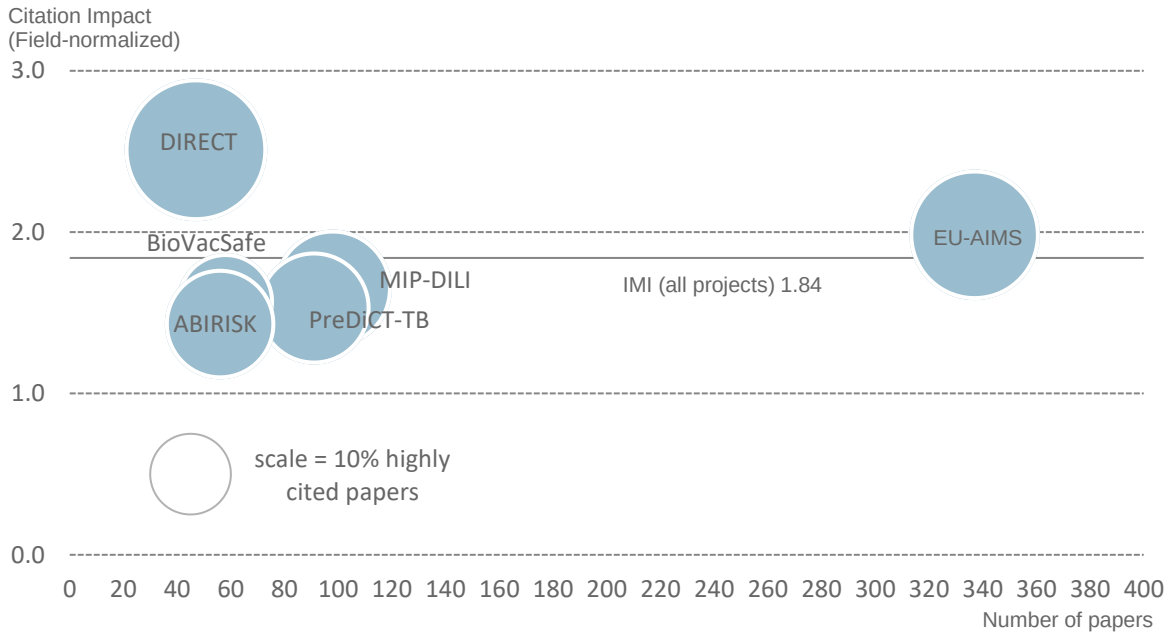
Project	Number of papers	Citation impact		Average percentile	% of highly cited papers
		Normalised at field level (nci_F)	Normalised at journal level (nci_J)		
BTCure	603	1.83	1.04	33.8	23.7%
Quic-Concept	93	2.63	1.86	35.9	23.7%
DDMoRe	71	1.00	0.90	55.8	7.0%
Open PHACTS	70	3.14	1.75	44.9	14.3%
Onco Track	53	2.43	1.22	27.9	37.7%
RAPP-ID	40	0.89	0.83	49.3	2.5%
Predect	40	1.92	1.30	39.3	32.5%
EHR4CR	17	1.01	1.04	51.2	11.8%
Overall (IMI projects)	**4556**	**1.84**	**1.19**	**39.8**	**22.1%**

- Among IMI 1 call 2 projects BTCURE has the highest number of open access publications (363) and Open PHACTS had the highest fraction of open access publications (80.8%)

5.4 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 3

Figure 5.4.1 compares the number of papers, average field-normalised citation impact and share of highly-cited papers of IMI 1, call 3 projects. Only projects with at least 10 papers and one highly-cited paper over the time period (2010-2018) are shown. The area of the 'bubble' is proportional to the share of highly-cited papers. The solid horizontal line indicates the average field-normalised citation impact for all IMI project papers.

FIGURE 5.4.1 PAPER NUMBERS, AVERAGE FIELD-NORMALISED CITATION IMPACT AND SHARE OF HIGHLY-CITED RESEARCH FOR SELECTED IMI 1 PROJECTS – CALL 3, 2010-2018



The data in Figure 5.4.1 shows that:

- The average field-normalised citation impact of all projects in this call was above world average.
- EU-AIMS was by far the most prolific IMI 1, call 3 project with 337 papers. The field-normalised citation impact of this research was twice the world average (1.98).
- Research associated with DIRECT was very well-cited with a field-normalised citation impact over two and a half (2.51) times the world average.
- Two of the six IMI 1, call 3 projects (DIRECT and EU-AIMS) had field-normalised average citation impacts greater than the citation impact of all IMI related projects.

Table 5.4.1 shows raw citation impact and the percentage of open access publications by project for call 3 publications. Table 5.4.2 shows the normalised citation impact (normalised against world average values) of IMI 1 call 3 projects and is an expansion of the data shown in Figure 5.4.1.

TABLE 5.4.1 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI 1 PROJECTS IN CALL 3, 2010-2018

Project	Number of publications	Number of papers	% of open access publications	Citations	Raw citation impact
EU-AIMS	346	337	63.6%	6,974	20.69
MIP-DILI	105	98	52.4%	1,116	11.39
PreDiCT-TB	95	91	76.8%	1,020	11.21
BioVacSafe	60	58	70.0%	997	17.19
ABIRISK	70	56	41.4%	866	15.46
DIRECT	68	47	50.0%	967	20.57

TABLE 5.4.2 SUMMARY CITATION INDICATORS FOR IMI 1 PROJECTS IN CALL 3, 2010-2018

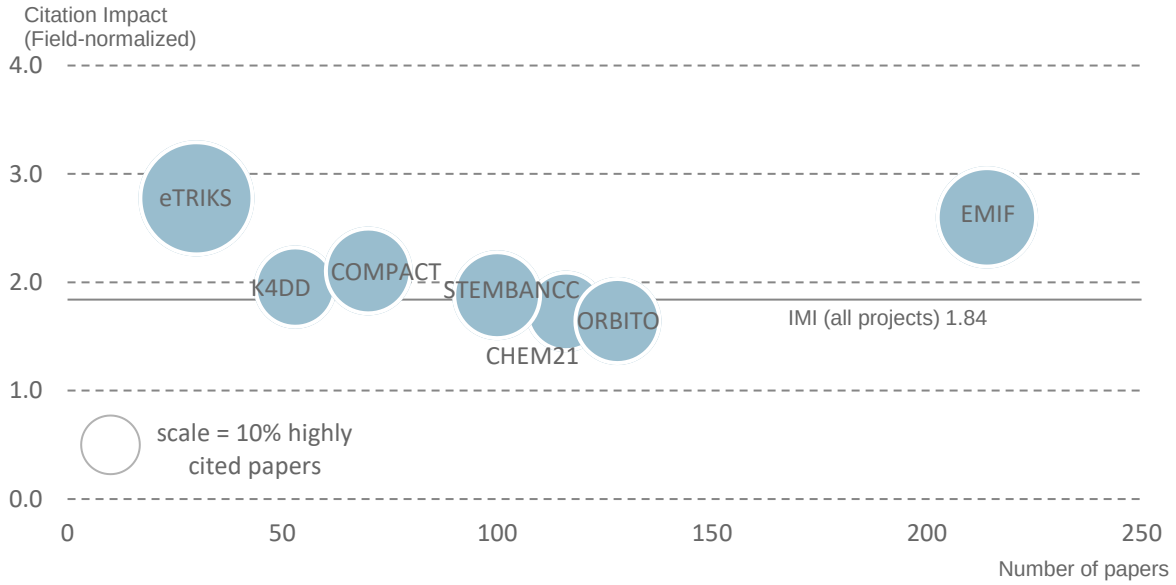
		Citation impact			
Project	Number of papers	Normalised at field level (nci_F)	Normalised at journal level (nci_J)	Average percentile	% of highly cited papers
EU-AIMS	337	1.98	1.04	39.0	24.9%
MIP-DILI	98	1.65	1.30	41.8	20.4%
PreDiCT-TB	91	1.53	0.89	44.9	18.7%
BioVacSafe	58	1.57	1.17	39.6	13.8%
ABIRISK	56	1.43	1.01	48.2	17.9%
DIRECT	47	2.51	1.18	45.9	29.8%
Overall (IMI projects)	**4,556**	**1.84**	**1.19**	**39.8**	**22.1%**

- Among the projects with at least 10 publications, EU-AIMS had the highest number of open access publications (220), but PreDiCT-TB had the highest percentage of open access publications (76.8%).

5.5 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI PROJECTS – CALL 4

Figure 5.5.1 compares the number of papers, average field-normalised citation impact and share of highly-cited papers of IMI 1, call 4 projects. Only projects with at least 10 papers and one highly-cited paper over the time period (2010-2018) are shown. The area of the 'bubble' is proportional to the share of highly-cited papers. The solid horizontal line indicates the average field-normalised citation impact for all IMI project papers.

FIGURE 5.5.1 PAPER NUMBERS, AVERAGE FIELD-NORMALISED CITATION IMPACT AND SHARE OF HIGHLY-CITED RESEARCH FOR SELECTED IMI 1 PROJECTS – CALL 4, 2010-2018



The data in Figure 5.5.1 shows that:

- The average field-normalised citation impact of all projects in this call is above world average.
- EMIF produced the highest number of papers in call 4, with 214 papers published by the end of 2018.
- Research associated with EMIF and eTRICKS was very well-cited, with field-normalised citation impacts of 2.60 and 2.77, respectively.
- Five of the seven projects in this call had an average field-normalised citation impact greater than the citation impact of all IMI related projects.

Table 5.5.1 shows raw citation impact and the percentage of open access publications by project for call 4 publications. Table 5.5.2 shows the normalised citation impact (normalised against world average values) of IMI 1 call 4 projects and is an expansion of the data shown in Figure 5.5.1.

TABLE 5.5.1 BIBLIOMETRIC INDICATORS FOR IMI 1 PROJECTS IN CALL 4, 2010-2018

Project	Number of publications	Number of papers	% of open access publications	Citations	Raw citation impact
EMIF	229	214	68.6%	3,669	17.14
ORBITO	130	128	20.0%	1,386	10.83
CHEM21	119	116	26.9%	2,167	18.68
STEMBANCC	103	100	73.8%	1,235	12.35
COMPACT	70	70	37.1%	1,308	18.69
K4DD	53	53	54.7%	500	9.43
eTRIKS	35	30	65.7%	509	16.97

TABLE 5.5.2 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI 1 PROJECTS IN CALL 4, 2010-2018

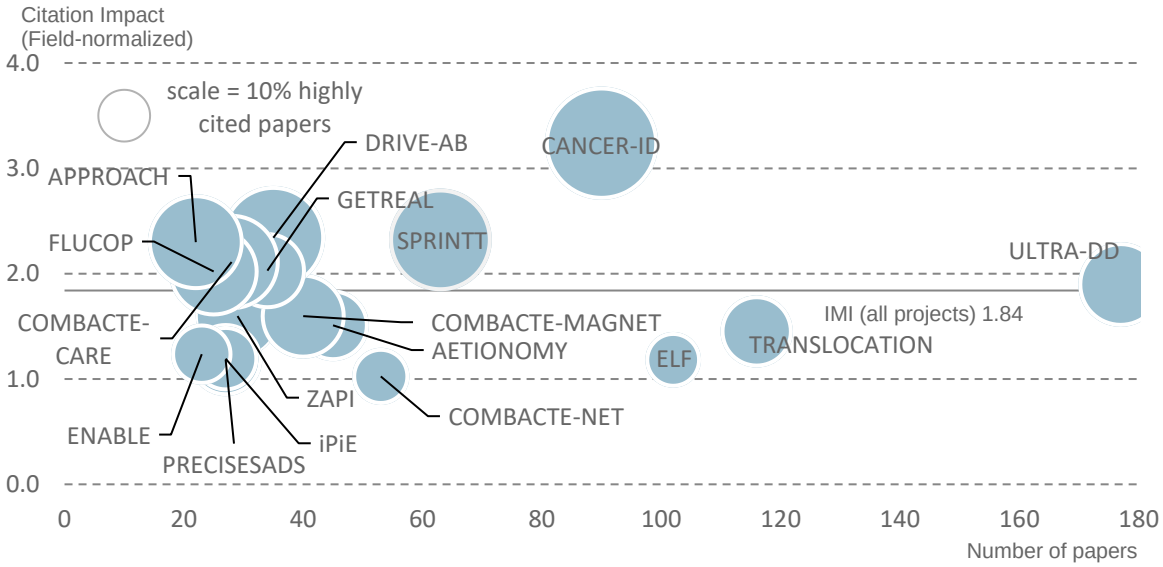
Project	Number of papers	Citation impact		Average percentile	% of highly cited papers
		Normalised at field level (nci_F)	Normalised at journal level (nci_J)		
EMIF	214	2.60	1.25	36.5	28.5%
ORBITO	128	1.64	1.19	40.5	21.1%
CHEM21	116	1.73	1.34	39.5	18.1%
STEMBANCC	100	1.88	1.31	40.5	22.0%
COMPACT	70	2.10	1.54	32.1	21.4%
K4DD	53	1.96	1.40	36.7	18.9%
eTRIKS	30	2.77	1.63	28.7	36.7%
Overall (IMI projects)	**4,556**	**1.84**	**1.19**	**39.8**	**22.1%**

- EMIF has the highest number of citations (3,669).
- COMPACT has the highest raw citation impact (18.69) but is only just above CHEM21 (18.68).
- EMIF is the project with the highest number of open access publications (157) and STEMBANCC has the highest percentage in open access publications (73.8%)

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

Figure 5.6.1 compares the number of papers, average field-normalised citation impact and share of highly-cited papers of IMI 1, call 5-11 projects. Only projects with at least 10 papers and one highly-cited paper over the time period (2010-2018) are shown. The area of the 'bubble' is proportional to the share of highly-cited papers. The solid horizontal line indicates the average field-normalised citation impact for all IMI project papers.

FIGURE 5.6.1 PAPER NUMBERS, AVERAGE FIELD-NORMALISED CITATION IMPACT AND SHARE OF HIGHLY-CITED RESEARCH FOR SELECTED IMI 1 PROJECTS – CALL 5-11, 2010-2018



The data in Figure 5.6.1 shows that:

- Research associated with CANCER-ID was very well-cited with a field-normalised citation impact of more than three times the world average (3.24), and 44.4% of its papers are highly-cited.
- ULTRA-DD produced the most papers (177) though it should be considered that some projects have been publishing for longer than others across calls 5-11.
- All projects in calls 5-11 have a field-normalised citation impact greater than the world average, with the lowest being COMBACT-NET (1.02).

Table 5.6.1 shows raw citation impact and the percentage of open access publications by project for call 5-11 publications. Table 5.6.2 shows the normalised citation impact (normalised against world average values) of IMI 1 calls 5-11 projects and is an expansion of the data shown in Figure 5.6.1.

TABLE 5.6.1 BIBLIOMETRIC INDICATORS FOR IMI 1 PROJECTS IN CALL 5-11, 2010-2018

Project	Number of publications	Number of papers	% of open access publications	Citations	Raw citation impact
ULTRA-DD	182	177	58.8%	1,530	8.64
TRANSLOCATION	116	116	50.9%	1,301	11.22
ELF	103	102	45.6%	839	8.23
CANCER-ID	105	90	58.1%	1693	18.81
SPRINTT	65	63	40.0%	706	11.21
COMBACTE-NET	56	53	66.1%	278	5.25
AETIONOMY	46	45	71.7%	343	7.62
COMBACTE-MAGNET	48	40	60.4%	210	5.25
DRIVE-AB	41	35	70.7%	302	8.63
GETREAL	40	34	57.5%	207	6.09
ZAPI	31	29	87.1%	252	8.69
COMBACTE-CARE	31	28	58.1%	189	6.75
PRECISESADS	42	27	47.6%	313	11.59
iPiE	28	27	60.7%	106	3.93
FLUCOP	25	25	72.0%	209	8.36
ENABLE	23	23	69.6%	195	8.48
APPROACH	27	22	51.9%	319	14.50
EPAD	22	18	45.5%	143	7.94
EBiSC	19	15	68.4%	248	16.53
ADVANCE	13	12	69.2%	77	6.42

TABLE 5.6.2 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI 1 PROJECTS IN CALL 5-11, 2010-2018

Project	Number of papers	Citation impact		Average percentile	% of highly cited papers
		Normalised at field level (nci_F)	Normalised at journal level (nci_J)		
ULTRA-DD	177	1.90	1.08	39.2	24.9%
TRANSLOCATION	116	1.45	1.13	40.8	18.1%
ELF	102	1.18	1.07	44.0	10.8%
CANCER-ID	90	3.24	1.56	29.9	44.4%
SPRINTT	63	2.32	2.29	27.6	36.5%
COMBACTE-NET	53	1.02	0.78	53.5	11.3%
AETIONOMY	45	1.51	1.09	47.7	17.8%
COMBACTE-MAGNET	40	1.60	1.05	45.8	25.0%
DRIVE-AB	35	2.34	1.33	31.4	37.1%
GETREAL	34	2.03	1.30	37.4	20.6%
ZAPI	29	1.60	0.91	41.6	24.1%
COMBACTE-CARE	28	2.11	1.20	39.0	32.1%
iPiE	27	1.19	1.09	51.6	14.8%

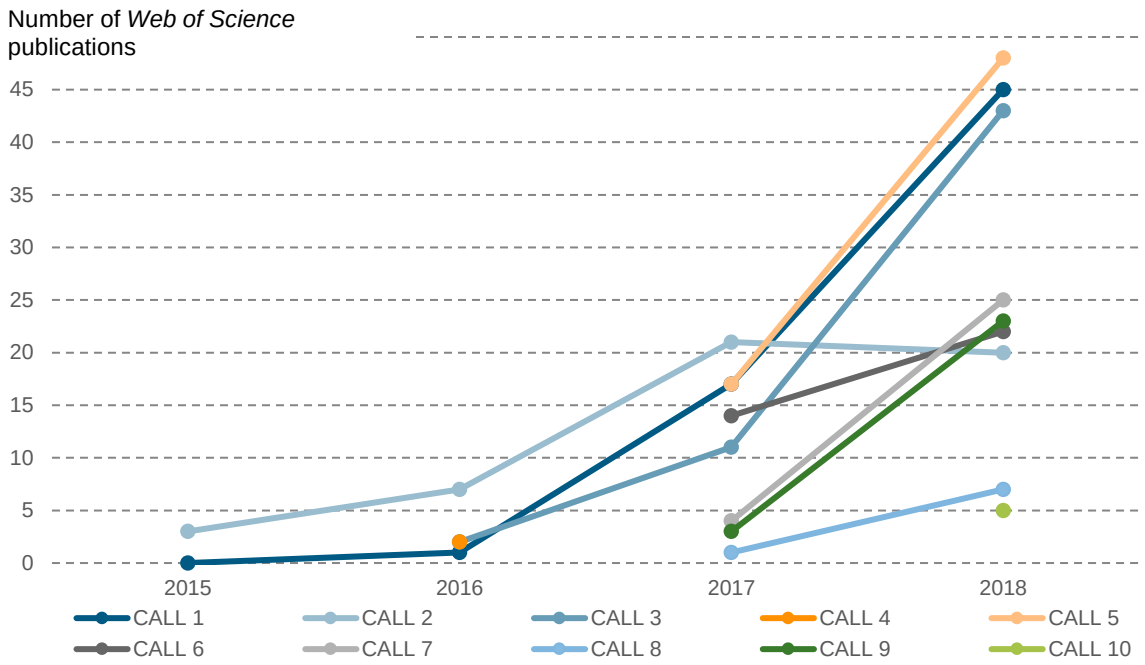
Project	Number of papers	Citation impact		Average percentile	% of highly cited papers
		Normalised at field level (nci_F)	Normalised at journal level (nci_J)		
PRECISESADS	27	1.18	0.77	47.7	18.5%
FLUCOP	25	2.02	1.68	38.0	28.0%
ENABLE	23	1.24	0.84	47.0	13.0%
APPROACH	22	2.30	1.60	31.2	31.8%
EPAD	18	1.17	0.52	58.8	16.7%
EBiSC	15	12.13	5.15	30.1	20.0%
ADVANCE	12	1.46	1.06	52.5	16.7%
Overall (IMI projects)	**4556**	**1.84**	**1.19**	**39.8**	**22.1%**

- ZAPI has the highest percentage (87.1%) of open access publications.
- ULTRA-DD has the highest number of publications (182) but CANCER-ID has the most citations (1,693) from only 105 publications.

5.7 SUMMARY BIBLIOMETRIC ANALYSES FOR IMI 2 PROJECTS

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

FIGURE 5.7.1 NUMBER OF WEB OF SCIENCE PUBLICATIONS BY YEAR AND FUNDING CALL 2015-2018 FOR IMI 2 PROJECTS



- IMI 2 projects from call 1 generated the greatest number of publications from 2015-2018. This is consistent with the growth profile of project output over time.

TABLE 5.7.1 SUMMARY BIBLIOMETRIC ANALYSES OF IMI 2 PROJECTS AGGREGATED BY FUNDING CALL, 2015-2018

IMI 2 Call	Number of publications[10]	% of open access publications	Number of papers	Citation impact		
				Raw citation impact	Normalised at field level (nci_f)	Normalised at journal level (nci_j)
1	64	53.1%	55	2.38	1.19	0.69
2	51	72.5%	46	6.13	2.01	1.29
3	56	41.1%	36	3.39	1.57	0.77
4	2	0.0%	2	3.50	0.67	0.31
5	65	70.8%	53	2.53	1.45	0.70
6	36	55.6%	21	1.81	1.42	0.75
7	29	72.4%	27	7.89	2.79	0.98
8	8	25.0%	7	2.71	1.39	1.01
9	26	73.1%	21	2.90	1.38	1.11
10	5	80.0%	3	0.33	0.41	0.19

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

- Call 10 has the highest percentage (80.0%) of open access publications but only has 5 publications in total. Call 2 has the highest percentage (72.5%) of open access publications for projects with more than 10 publications.

Table 5.7.2 shows raw citation impact and percentage of open access publications by project for IMI 2 publications. Table 5.7.3 shows indicators for IMI 2 project research where citation impact has been normalised against world average values.

TABLE 5.7.2 BIBLIOMETRIC INDICATORS FOR IMI 2 PROJECTS, 2015-2018

Project	Number of publications	Number of papers	% of open access publications	Citations	Raw citation impact
ADAPTED	10	9	80.0%	17	1.89
ADAPT-SMART	2	2	0.0%	7	3.50
AIMS-2-TRIALS	4	3	75.0%	3	1.00
AMYPAD	7	4	57.1%	12	3.00
BEAT-DKD	34	33	76.5%	74	2.24
BigData@Heart	9	8	77.8%	13	1.63
c4c	1	0	100.0%	0	0.00
DRIVE	3	2	66.7%	1	0.50
EBODAC	1	1	100.0%	1	1.00
Ebola+	1	1	0.0%	12	12.00
EbolaMoDRAD	15	14	60.0%	44	3.14
EBOVAC1	17	15	88.2%	174	11.60
EBOVAC2	7	7	100.0%	23	3.29
EQIPD	2	0	50.0%	1	0.00
eTRANSAFE	4	4	75.0%	1	0.25
FILODIAG	1	0	100.0%	2	0.00
HARMONY	15	5	46.7%	21	4.20
IMPRiND	15	15	66.7%	190	12.67
INNODIA	64	55	53.1%	135	2.45
LITMUS	2	0	50.0%	1	0.00
MACUSTAR	2	1	50.0%	0	0.00
PERISCOPE	2	2	100.0%	0	0.00
PHAGO	7	7	100.0%	31	4.43
PREFER	7	0	14.3%	8	0.00
PRISM	7	7	57.1%	13	1.86
RADAR-CNS	27	11	25.9%	21	1.91
RESCEU	3	2	100.0%	3	1.50
RHAPSODY	19	15	52.6%	98	6.53
ROADMAP	12	8	50.0%	12	1.50
RTCure	15	15	80.0%	59	3.93
TransQST	6	6	66.7%	19	3.17
TRISTAN	3	3	100.0%	15	5.00
VAC2VAC	1	1	0.0%	0	0.00
VSV-EBOPLUS	7	6	28.6%	7	1.17
VSV-EBOVAC	10	9	40.0%	53	5.89

TABLE 5.7.3 SUMMARY BIBLIOMETRIC INDICATORS FOR IMI 2 PROJECTS, 2015-2018

Project	Number of papers	Citation impact			% of highly cited papers
		Normalised at field level (nci_F)	Normalised at journal level (nci_J)	Average percentile	
ADAPTED	9	2.56	1.04	40.8	22.2%
ADAPT-SMART	2	0.67	0.31	63.8	0.0%
AIMS-2-TRIALS	3	0.41	0.19	76.8	0.0%
AMYPAD	4	1.82	0.97	41.2	25.0%
BEAT-DKD	33	0.99	0.57	55.3	6.1%
BigData@Heart	8	1.22	1.28	52.6	12.5%
DRIVE	2	0.77	1.16	66.1	0.0%
EBODAC	1	0.51	0.53	64.4	0.0%
Ebola+	1	3.62	0.70	6.2	100.0%
EbolaMoDRAD	14	1.85	1.47	53.3	14.3%
EBOVAC1	15	2.85	1.45	31.8	40.0%
EBOVAC2	7	1.47	1.12	43.3	14.3%
eTRANSAFE	4	0.39	0.76	82.8	0.0%
HARMONY	5	1.55	0.78	55.3	40.0%
IMPRiND	15	4.24	1.01	57.4	20.0%
INNODIA	55	1.19	0.69	60.9	9.1%
MACUSTAR	1	0.00	0.00	100.0	0.0%
PERISCOPE	2	0.00	0.00	100.0	0.0%
PHAGO	7	1.93	0.75	54.2	28.6%
PRISM	7	2.38	0.54	59.6	14.3%
RADAR-CNS	11	0.95	1.65	64.0	9.1%
RESCEU	2	0.00	0.00	100.0	0.0%
RHAPSODY	15	1.96	0.50	54.6	20.0%
ROADMAP	8	1.75	0.19	73.8	25.0%
RTCure	15	1.73	1.19	57.8	13.3%
TransQST	6	1.35	1.71	72.0	16.7%
TRISTAN	3	0.69	0.42	71.5	0.0%
VAC2VAC	1	0.00	0.00	100.0	0.0%
VSV-EBOPLUS	6	1.02	1.06	55.5	0.0%
VSV-EBOVAC	9	1.44	0.98	40.6	11.1%
Overall (IMI projects)	4556	1.84	1.19	39.8	22.1%

- INNODIA has the highest number of papers (55) but IMPRiND has the highest number of citations (190), with a raw citation impact of 12.67.
- Very low paper counts make it difficult to draw firm conclusions from average citation impact indicators. However, the IMPRiND project has a very high field-normalised citation impact (4.24) followed by Ebola+ (3.62).

6 GEOGRAPHIC CLUSTERING ANALYSIS

This Section of the report analyses geographic clusters where IMI research activity occurs, the citation impact of these clusters and it the constituent institutions within the clusters.

Substantive clusters of research activity were identified in Europe and North America. While IMI project research also involves institutions in other parts of the world, publication rates for other geographies were low. This analysis, therefore, focuses on Europe and North America and we have identified the 37 and 13 geographic clusters respectively with the highest output.

Clusters have a 20km radius and the clusters in both Europe and North America tend to focus on major cities with an existing strong academic research base. The largest European clusters are London (983 publications), Amsterdam (794 publications), Stockholm (464 publications), Paris (403 publications) and Copenhagen (342 publications). The largest clusters in North America are Boston (194 publications), Toronto (187 publications), Bethesda (116 publications), Montreal (83 publications) and New York (81 publications). It is also clear that the citation impact of the research IMI supports within these clusters is higher than the average national benchmark. A relatively high percentage of IMI supported research is open access, with the Oxford cluster publishing over 75% of its IMI affiliated research as open access publications.

Rates of international collaboration are very high for most clusters. Around 35-40% of all EU-28 biomedical research involves international co-authorship, whereas for IMI project research the lowest rate of international co-authorship for the European clusters was 66.93% (Madrid). In addition, over half of the European clusters have rates of international co-authorship of at least 80%. Rates of international co-authorship are even higher for North American clusters, approaching 100%, this is expected as IMI is a European funding organisation.

The clusters are visualised as maps in Figure 6.1 and 6.2. Both maps are scaled separately so that the most intensive areas of output are shaded red and the lowest areas of output are blue. This means that the same colour shading is not comparable between maps. Tables 6.1 to 6.4 show the research publication outputs of the individual clusters along with bibliometric indicators of their research performance. The citation metrics in Tables 6.2 and 6.4 are shaded green when the performance of a cluster of IMI-supported research outperforms the national average performance for biomedical research.[11]

The institutions that constitute the top five clusters within each of the European and North American regions are shown in Tables 6.5 and 6.6 respectively. The five journal subject categories in which the top five clusters published most frequently within each of the European and North American regions are shown in Tables 6.7 and 6.8 respectively.

[11] Web of Science journal categories which capture medically related publications used to calculate the national baselines are given in Annex 2.

FIGURE 6.1 MAP SHOWING EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2018

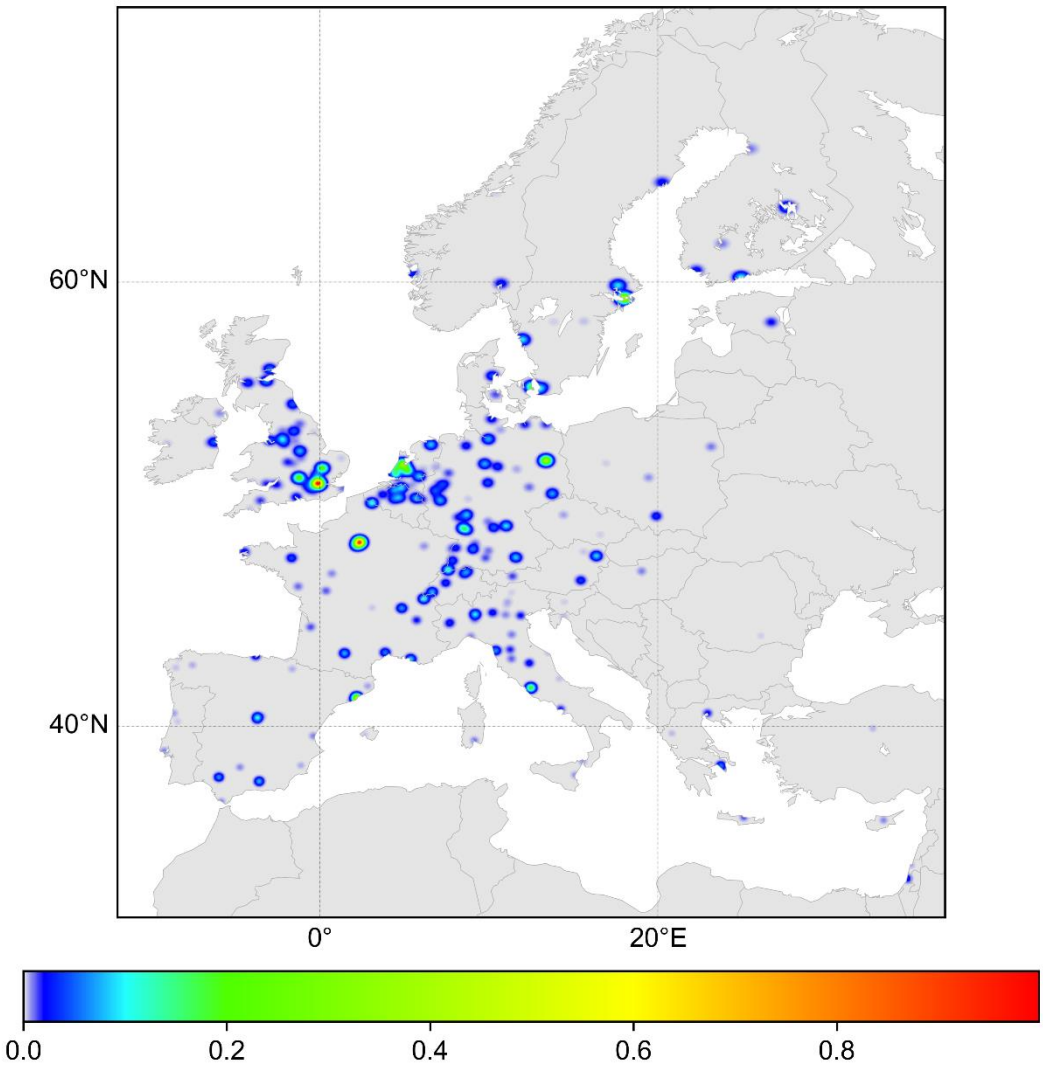


FIGURE 6.2 MAP SHOWING NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2018

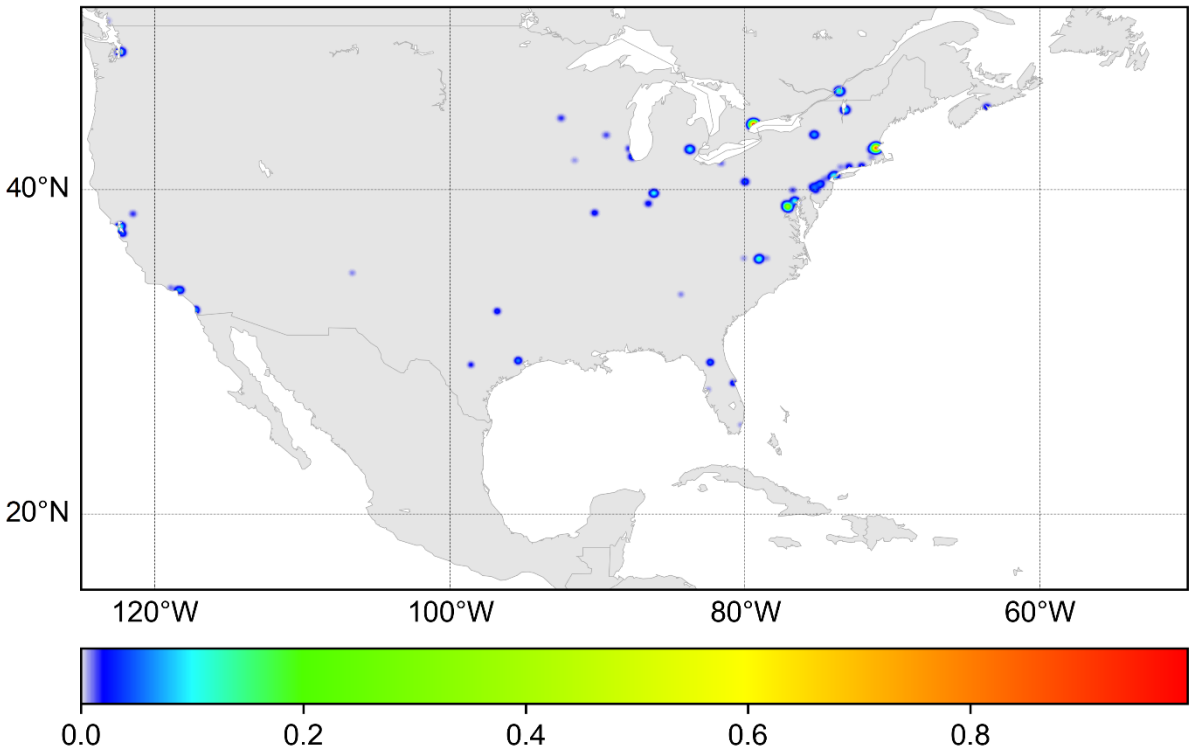


TABLE 6.1 OUTPUT AND RESEARCH PERFORMANCE OF EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2018

Cluster	Number of publications	Number of papers	% of publications open access	Raw citation impact	% of internationally collaborative publications
London (UK)	983	918	64.2%	21.51	83.3%
Amsterdam (Netherlands)	794	715	55.8%	22.05	76.3%
Stockholm (Sweden)	464	432	59.3%	22.47	74.6%
Paris (France)	403	382	59.8%	21.43	83.9%
Copenhagen (Denmark)	342	321	51.5%	17.39	78.1%
Cambridge (UK)	313	289	71.6%	26.11	85.0%
Oxford (UK)	307	291	75.2%	19.07	81.4%
Barcelona (Spain)	256	233	60.2%	16.82	73.4%
Berlin (Germany)	224	206	61.6%	20.46	75.9%
Basel (Switzerland)	210	195	55.7%	16.85	92.8%
Mannheim (Germany)	200	195	59.0%	30.51	84.0%
Uppsala (Sweden)	182	172	63.2%	13.74	68.1%
Geneva (Switzerland)	177	160	63.3%	26.65	84.2%
Molndal (Sweden)	172	160	53.5%	17.02	87.2%
Rome (Italy)	168	149	42.3%	19.51	74.4%
Manchester (UK)	164	143	60.4%	25.11	86.0%
Nijmegen (Netherlands)	155	149	65.2%	24.41	81.0%
Antwerp (Belgium)	154	148	50.0%	17.56	77.3%
Groningen (Netherlands)	150	145	65.3%	23.41	77.3%
Erlangen (Germany)	149	146	59.7%	28.31	74.5%
Vienna (Austria)	148	140	58.8%	13.23	77.7%
Milan (Italy)	144	124	52.1%	19.39	85.4%
Hamburg (Germany)	138	130	63.0%	16.44	79.7%
Munich (Germany)	131	122	55.0%	22.73	79.4%
Madrid (Spain)	127	121	66.9%	17.65	66.9%
Nottingham (UK)	125	111	48.0%	14.30	89.6%
Frankfurt (Germany)	121	113	69.4%	13.56	87.6%
Maastricht (Netherlands)	121	118	49.6%	41.50	88.4%
Hannover (Germany)	105	88	59.1%	14.03	67.6%
Helsinki (Finland)	104	102	69.2%	21.36	87.5%
Leuven (Belgium)	100	87	50.0%	23.73	81.0%
Bonn (Germany)	80	76	73.8%	24.14	75.0%
Toulouse (France)	79	65	46.8%	15.72	94.9%
Marseille (France)	77	67	42.7%	16.81	88.3%
Lausanne (Switzerland)	76	71	72.4%	33.20	79.0%
Granada (Spain)	57	46	56.1%	21.68	71.9%
Lille (France)	53	49	43.4%	18.23	90.6%

TABLE 6.2 RESEARCH PERFORMANCE OF EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH COMPARED TO NATIONAL BENCHMARKS, 2010-2018

	Field-normalised citation impact		Journal-normalised citation impact		% of highly-cited papers	
Cluster	Cluster	National	Cluster	National	Cluster	National
London (UK)	2.54	1.48	1.34	1.09	30.0%	17.2%
Amsterdam (Netherlands)	2.50	1.63	1.31	1.14	29.1%	18.9%
Stockholm (Sweden)	2.60	1.56	1.27	1.14	31.0%	17.3%
Paris (France)	2.53	1.40	1.14	1.09	28.0%	15.2%
Copenhagen (Denmark)	2.18	1.65	1.18	1.18	24.0%	18.4%
Cambridge (UK)	3.37	1.48	1.50	1.09	32.9%	17.2%
Oxford (UK)	2.89	1.48	1.49	1.09	34.0%	17.2%
Barcelona (Spain)	2.37	1.32	1.32	1.08	26.6%	14.1%
Berlin (Germany)	2.41	1.32	1.20	1.10	27.2%	15.0%
Basel (Switzerland)	2.07	1.68	1.28	1.18	26.7%	19.4%
Mannheim (Germany)	3.04	1.32	1.21	1.10	35.4%	15.0%
Uppsala (Sweden)	2.47	1.56	1.27	1.14	22.7%	17.3%
Geneva (Switzerland)	2.63	1.68	1.25	1.18	30.0%	19.4%
Molndal (Sweden)	3.51	1.56	1.63	1.14	37.5%	17.3%
Rome (Italy)	2.78	1.33	1.54	1.14	37.6%	14.5%
Manchester (UK)	2.93	1.48	1.42	1.09	34.3%	17.2%
Nijmegen (Netherlands)	3.03	1.63	1.44	1.14	32.9%	18.9%
Antwerp (Belgium)	2.73	1.68	1.67	1.21	26.4%	19.3%
Groningen (Netherlands)	2.47	1.63	1.16	1.14	24.8%	18.9%
Erlangen (Germany)	2.79	1.32	1.30	1.10	33.6%	15.0%
Vienna (Austria)	1.72	1.55	0.98	1.16	17.9%	17.3%
Milan (Italy)	2.82	1.33	1.07	1.14	33.1%	14.5%
Hamburg (Germany)	2.40	1.32	0.96	1.10	26.9%	15.0%
Munich (Germany)	2.41	1.32	1.13	1.10	31.2%	15.0%
Madrid (Spain)	2.20	1.32	0.99	1.08	26.5%	14.1%
Nottingham (UK)	2.62	1.48	1.28	1.09	31.5%	17.2%
Frankfurt (Germany)	2.36	1.32	1.21	1.10	32.7%	15.0%
Maastricht (Netherlands)	4.62	1.63	2.25	1.14	43.2%	18.9%
Hannover (Germany)	2.13	1.32	1.01	1.10	29.6%	15.0%
Helsinki (Finland)	3.58	1.54	1.44	1.10	42.2%	16.4%
Leuven (Belgium)	3.08	1.68	1.43	1.21	35.6%	19.3%
Bonn (Germany)	2.70	1.32	1.33	1.10	26.3%	15.0%
Toulouse (France)	2.70	1.40	1.45	1.09	40.0%	15.2%
Marseille (France)	2.42	1.40	1.06	1.09	32.8%	15.2%
Lausanne (Switzerland)	2.93	1.68	1.20	1.18	32.4%	19.4%
Granada (Spain)	2.25	1.32	0.66	1.08	21.7%	14.1%
Lille (France)	1.99	1.40	0.88	1.09	30.6%	15.2%

TABLE 6.3 OUTPUT AND RESEARCH PERFORMANCE OF NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2018

Cluster	Number of publications	Number of papers	% of publications open access	Raw citation impact	% of internationally collaborative publications
Boston (USA)	194	189	78.4%	43.08	97.9%
Toronto (Canada)	187	183	66.3%	25.66	89.8%
Bethesda (USA)	116	111	61.2%	34.50	98.3%
Montreal (Canada)	83	83	63.7%	29.27	100.0%
New York (USA)	81	79	58.0%	33.79	98.8%
Indianapolis (USA)	62	60	53.2%	26.45	98.4%
San Francisco (USA)	56	56	73.2%	60.95	100.0%
Burlington (USA)	55	54	56.4%	16.67	100.0%
Chapel Hill (USA)	51	49	76.5%	33.04	92.2%
Baltimore (USA)	47	47	83.0%	41.23	100.0%
New York (USA)	46	46	76.1%	28.72	100.0%
Ann Arbor (USA)	35	34	62.9%	32.51	100.0%
Seattle (USA)	33	32	81.8%	53.55	100.0%

TABLE 6.4 RESEARCH PERFORMANCE OF NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH COMPARED TO NATIONAL BENCHMARKS, 2010-2018

	Field-normalised citation impact		Journal-normalised citation impact		% of highly-cited papers	
Cluster	Cluster	National	Cluster	National	Cluster	National
Boston (USA)	4.00	1.32	1.67	1.03	40.7%	15.6%
Toronto (Canada)	2.82	1.45	1.36	1.08	33.3%	16.0%
Bethesda (USA)	3.55	1.32	1.45	1.03	46.9%	15.6%
Montreal (Canada)	2.70	1.45	1.04	1.08	28.9%	16.0%
New York (USA)	2.75	1.32	1.12	1.03	27.9%	15.6%
Indianapolis (USA)	3.14	1.32	1.23	1.03	35.0%	15.6%
San Francisco (USA)	6.15	1.32	1.94	1.03	57.1%	15.6%
Burlington (USA)	1.78	1.32	0.73	1.03	22.2%	15.6%
Chapel Hill (USA)	3.85	1.32	1.88	1.03	38.8%	15.6%
Baltimore (USA)	5.44	1.32	1.75	1.03	51.1%	15.6%
New York (USA)	5.25	1.32	1.81	1.03	47.8%	15.6%
Ann Arbor (USA)	3.99	1.32	1.46	1.03	50.0%	15.6%
Seattle (USA)	4.88	1.32	1.52	1.03	50.0%	15.6%

TABLE 6.5 INSTITUTIONS CONSTITUTING TOP-FIVE (BY NUMBER OF PUBLICATIONS) EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2018

Cluster	Country	Institutions	Number of publications
London	**United Kingdom**	Kings College London	354
		Imperial College London	254
		University College London	213
		GlaxoSmithKline	164
		London School of Hygiene & Tropical Medicine	40
		Guy's & St Thomas' NHS Foundation Trust	35
		Birkbeck University London	32
		Queen Mary University London	29
		South London & Maudsley NHS Trust	29
		Public Health England	22
		Royal Brompton Hosp	22
		St Georges University London	21
		Medicines and Healthcare products Regulatory Agency	19
		Royal Brompton Harefield NHS Foundation Trust	19
		European Medicines Agency	16
		Medical Research Council	13
		Francis Crick Institute	12
		Royal Marsden Hospital	12
		University College London Hospitals NHS Foundation Trust	11
		London School Economics & Political Science	10
		UCB Pharma SA	9
		Social Genetic and Developmental Psychiatry Centre	8
		South London & Maudsley NHS Foundation	8
		Amgen	7
		EMA	6
		Genetic Alliance UK	5
		Heptares Therapeutics Ltd	5
		National Institute for Biological Standards and Control	5
		Royal Marsden NHS Foundation Trust	1
Amsterdam	**Netherlands**	Leiden University	239
		Vrije Universiteit Amsterdam	206
		Utrecht University	196
		University of Amsterdam	195
		Academic Medical Center, University of Amsterdam	170
		Erasmus University Rotterdam	133
		Erasmus University Medical Center	92
		VU University Medical Center Amsterdam	55
		Utrecht University Medical Center	53
		Netherlands National Institute for Public Health & the Environment	18
		Netherlands Institute for Health Services Research	8
		Medicines Evaluation Board	7
		Jan van Breemen Research Institute Reade	6
Stockholm	**Sweden**	Karolinska Institutet	427

Cluster	Country	Institutions	Number of publications
		Karolinska University Hospital	154
		Stockholm City Council	37
		Royal Institute of Technology	30
		Stockholm University	26
		Danderyds Hospital	9
		AstraZeneca	8
Paris	**France**	Institut National de la Sante et de la Recherche Medicale (Inserm)	225
		University Paris	123
		Universite Paris Saclay (ComUE)	116
		Sorbonne University	107
		University Paris Saclay	100
		Centre National de la Recherche Scientifique (CNRS)	96
		CEA	72
		University Sorbonne Paris Cite-USPC ComUE	56
		Hopital Universitaire Pitie-Salpetriere - APHP	54
		Hopital Universitaire Cochin - APHP	40
		CNRS INSB	39
		University Paris Sud	38
		Le Reseau International des Instituts Pasteur (RIIP)	33
		Sanofi France	32
		Inst Pasteur Paris	31
		Assistance Publique Hopitaux Paris (APHP)	28
		Institut de Recherches Internationales Servier	23
		University Paris Descartes	21
		Hopital Universitaire Necker-Enfants Malades - APHP	14
		University Paris Diderot	14
		University of Versailles Saint-Quentin-En-Yvelines	14
		Orsay Hosp	13
		Hopital Universitaire Europeen Georges-Pompidou - APHP	12
		Hopital Universitaire Saint-Louis - APHP	11
		Hopital Universitaire Bichat-Claude Bernard - APHP	10
		Instit Ecol Environment	9
		CNRS Inst Chem	6
		Gustave Roussy	6
		Hopital University Ambroise-Pare APHP	6
		Hopital Universitaire Bicetre - APHP	6
		Hopital Universitaire Paul-Brousse - APHP	6
		Université Paris Sciences et Lettres	6
		Communaute University Grenoble Alpes	5
		Muséum national d'histoire naturelle	5
		Universite Grenoble Alpes (UGA)	5
		Servier	3
		Sanofi-Aventis	1
Copenhagen	**Denmark**	University of Copenhagen	153
		Lund University	96
		Rigshospitalet	62

Cluster	Country	Institutions	Number of publications
		Skane University Hospital	47
		Lundbeck Corporation	44
		Technical University of Denmark	44
		Novo Nordisk	32
		Steno Diabetes Center	22
		Novo Nordisk Foundation	17
		Statens Serum Institut	13

TABLE 6.6 INSTITUTIONS CONSTITUTING TOP-FIVE (BY NUMBER OF PUBLICATIONS) NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH, 2010-2018

Cluster	Country	Institutions	Number of publications
Boston	**USA**	Harvard University	140
		VA Boston Healthcare System	68
		Harvard University Medical Affiliates	46
		Broad Institute	36
		Pfizer	27
		Harvard T.H. Chan School of Public Health	26
		Boston University	17
		Boston Child Hospital	14
		Dana-Farber Cancer Institute	14
		NIH National Heart Lung & Blood Institute (NHLBI)	7
		Framingham Heart Study	6
		Massachusetts General Hospital	6
		Massachusetts Institute of Technology (MIT)	6
		CARB X	5
		Tufts University	5
		US Dept Health Human Services	5
Toronto	**Canada**	University of Toronto	186
		Structural Genomics Consortium	70
		Baycrest	47
		Hospital for Sick Children (SickKids)	39
		Princess Margaret Cancer Center	31
		University Toronto Affiliates	28
		Ontario Institute for Cancer Research	11
		Centre for Addiction & Mental Health - Canada	10
		University Health Network Toronto	10
		Lunenfeld Tanenbaum Res Inst	7
		Mt Sinai Hospital Toronto	1
Bethesda	**USA**	National Institute of Health USA	60
		US Department of Health Human Services	37
		NIH National Heart Lung & Blood Institute (NHLBI)	15
		AstraZeneca	14
		NIH National Institute of Mental Health (NIMH)	9
		NIH National Institute on Aging (NIA)	8
		US Food & Drug Administration (FDA)	8
		Medimmune	5
		NIH National Human Genome Research Institute (NHGRI)	5
		Naval Research Laboratory	5
		National Institute Allergy Infectious Diseases (NIAID)	4
		NIH National Cancer Institute	2
Montreal	**Canada**	University of Montreal	60
		McGill University	51
New York	**USA**	Pfizer	27
		Columbia University	25
		New York University	25

Cluster	Country	Institutions	Number of publications
		Albert Einstein College of Medicine	9

TABLE 6.7 FIVE JOURNAL SUBJECT CATEGORIES IN WHICH TOP-FIVE (BY NUMBER OF PUBLICATIONS) EUROPEAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH PUBLISHED MOST FREQENTLY, 2010-2018

Cluster	Country	Journal subject category	Number of publications
London	**United Kingdom**	Neurosciences	220
		Psychiatry	123
		Pharmacology & pharmacy	106
		Clinical neurology	104
		Respiratory system	67
Amsterdam	**Netherlands**	Rheumatology	125
		Pharmacology & pharmacy	122
		Neurosciences	86
		Immunology	63
		Clinical neurology	54
Stockholm	**Sweden**	Rheumatology	92
		Immunology	58
		Neurosciences	51
		Clinical neurology	41
		Biochemistry & molecular biology	34
Paris	**France**	Neurosciences	85
		Psychiatry	48
		Pharmacology & pharmacy	42
		Endocrinology & metabolism	33
		Biochemistry & molecular biology	28
Copenhagen	**Denmark**	Endocrinology & metabolism	63
		Pharmacology & pharmacy	50
		Neurosciences	39
		Clinical neurology	37
		Anesthesiology	32

TABLE 6.8 FIVE JOURNAL SUBJECT CATEGORIES IN WHICH TOP-FIVE (BY NUMBER OF PUBLICATIONS) NORTH AMERICAN GEOGRAPHIC CLUSTERS OF IMI PROJECT RESEARCH PUBLISHED MOST FREQUENTLY, 2010-2018

Cluster	Country	Journal subject category	Number of publications
Boston	**USA**	Genetics & heredity	26
		Neurosciences	25
		Pharmacology & pharmacy	22
		Endocrinology & metabolism	21
		Clinical neurology	19
Toronto	**Canada**	Biochemistry & molecular biology	44
		Psychiatry	41
		Neurosciences	39
		Medicinal chemistry	22
		Cell biology	19
Bethesda	**USA**	Pharmacology & pharmacy	27
		Public, environmental & occupational health	19
		Neurosciences	15
		Toxicology	15
		Biochemistry & molecular biology	12
Montreal	**Canada**	Psychiatry	33
		Neurosciences	31
		Biochemistry & molecular biology	10
		Developmental psychology	10
		Genetics & heredity	9
New York	**USA**	Pharmacology & pharmacy	33
		Neurosciences	18
		Psychiatry	18
		Public, environmental & occupational health	15
		Clinical neurology	11

7 COLLABORATION ANALYSIS FOR IMI RESEARCH

7.1 COLLABORATION ANALYSIS FOR IMI RESEARCH

International research collaboration is increasing.[12] The reasons for this have not been fully clarified but include increasing access to facilities, resources, knowledge, people and expertise. In addition, international collaboration has been shown to be associated with an increase in the number of citations received by research papers, although this does depend upon the partner countries involved.[13] Co-authorship is likely to be a good indicator of collaboration, although there will be research 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 of papers[14] is used as a measure of collaboration between different sectors, institutions and countries.

In this analysis different institutions/organisation are assigned to sectors with the following definitions:

- **Medical:** Organisations with the primary function of providing patient care. Typical these are public, private and university hospitals, though we have included Chinese medicine hospitals and umbrella organisations such as hospital systems (e.g. Mt Sinai) or UK National Health Services Healthcare Trusts.
- **Corporate:** Private or public companies or enterprises that operate for-profit. For IMI projects most corporate organisations are pharmaceuticals, others manufacture medical devices or provide information technology services. Included in this sector are any organisation with a suffix indicating limited liability (e.g. AB, LTD, GmBH, SA, LLC, INC and AG). Other organisations were identified as corporate from their website. This means it is can be challenging to assign smaller organisations, potential small and medium sized enterprises (SMEs) to this category as they may have a limited online presence. Alternately if a potential SME is has spun out from a university it can be difficult to ascertain the current relationship between the spin out and academic institution.
- **Academic:** Public and private universities and university departments. This includes research institutes, that may not have a teaching remit but have a clear affiliation to one or more universities and programs of research spanning multiple academic institutions.
- **Government:** Includes state, regional or federally funded research institutions, laboratories and facilities such as NIH or the World Health Organization (WHO); country or regional funders that disperse public money to research (e.g. BBSRC in the UK); government departments and agencies.
- **Other:** Organisation that do not fit in any other category but have a role in the healthcare or research infrastructure. For example, research institutions not attached to a government, university or hospital; non-governmental organisation like patient group, advocacy group, not-for profit and charities; medical profession associations; non-governmental funders; regulators and tissue sample banks.
- **Unknown:** If an organisation cannot be identified as belonging to any of the above sectors then it is assigned as unknown.

A paper is defined as cross-sector if the listed addresses are for organisations from more than one sector. For example, if a paper has addresses corresponding to the University of Copenhagen and the company Novartis, it would be classified as cross-sector. If a paper has addresses corresponding to the University of Cambridge and Utrecht University, it would be classified as single-sector since both addresses are academic institutions, but it would be defined as cross-institution as 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.

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

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

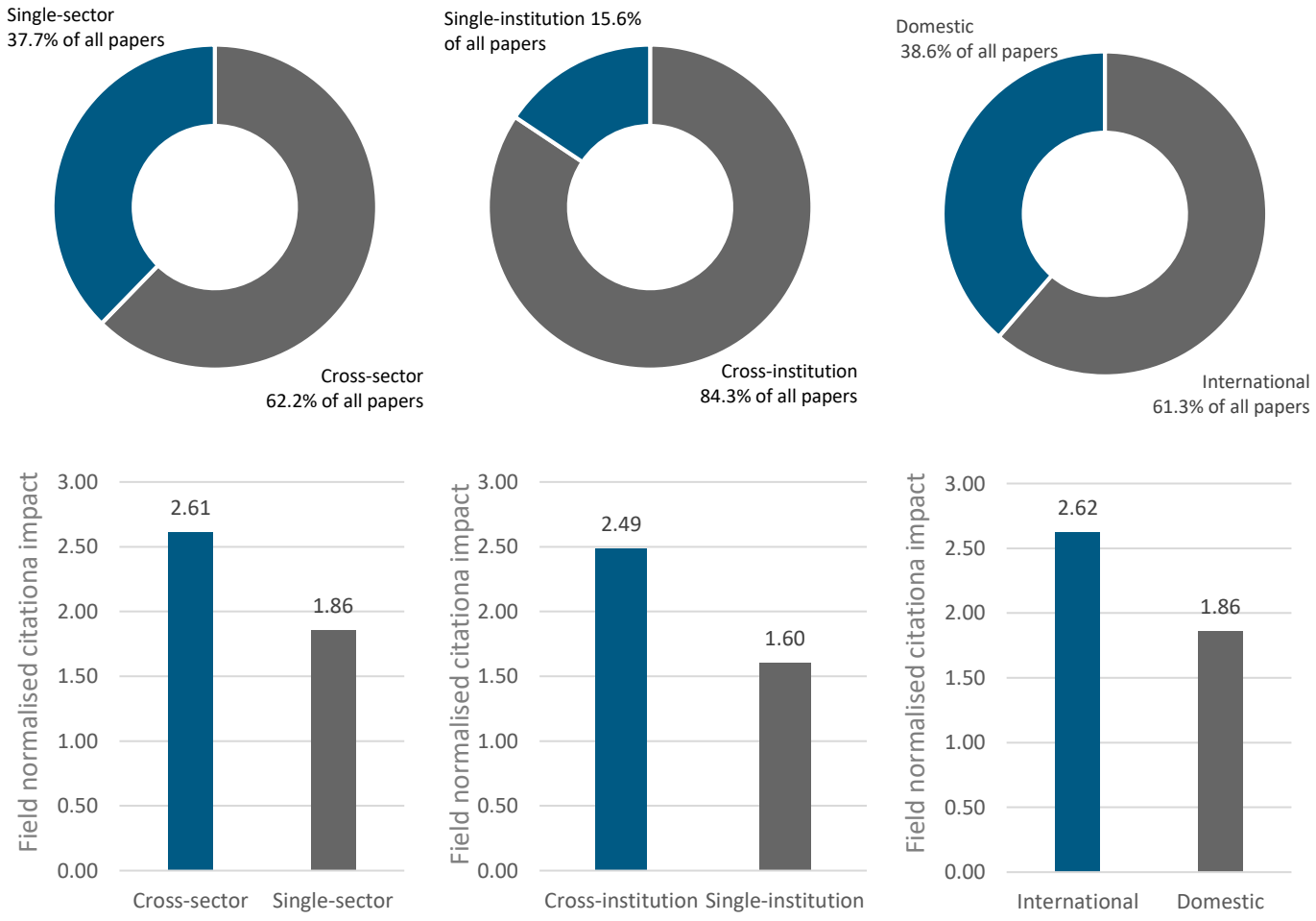
[14] In the collaboration analysis papers rather than publications are analysed as some publications, such as editorials do not communicate novel research finding so cannot be considered a product of research collaboration.

The data in Table 7.1.1 compares the output and field-normalised citation impact of collaborative IMI project research. Figure 7.1.1 presents the percentage of collaborative research compared to non-collaborative research.

TABLE 7.1.1 CROSS-SECTOR, CROSS-INSTITUTION AND INTERNATIONAL OUTPUT OF IMI PROJECT RESEARCH, 2010-2018

	Number of papers	% of papers	Citation impact (normalised at field level)
Cross-sector	2,836	62.2%	2.61
Single-sector	1,717	37.7%	1.86
Cross-institution	3,841	84.3%	2.49
Single-institution	712	15.6%	1.60
International	2,793	61.3%	2.62
Domestic	1,760	38.6%	1.86

FIGURE 7.1.1 FIELD NORMALISED CITATION IMPACT OF AND PERCENTAGE OF CROSS-SECTOR, CROSS-INSTITUTION AND INTERNATIONALLY COLLABORATIVE PAPERS FROM IMI PROJECT RESEARCH, 2010-2018



- Over half (62.2%) of all MI project papers were published by researchers affiliated with different sectors.
- More than three-quarters (84.3%) of IMI project papers involved collaboration between institutions.
- More than half (61.3%) of all IMI project papers were internationally collaborative.
- Collaborative IMI project research was internationally influential with a field-normalised citation impact well over twice the world average (1.00). Regardless of the type of collaborations, IMI's collaborative research has a higher average field-normalised impact than its non-collaborative research.

7.2 COLLABORATION ANALYSIS BY IMI PROJECT

This section analyses the collaboration of IMI research at the individual project level. Table 7.2.1 shows the number, percentage and field-normalised citation impact of IMI-supported research papers with authors from more than one country. Table 7.2.2 shows number, percentage, and field-normalised citation impact of IMI-supported research papers with authors from more than one institution. Table 7.2.3 shows number, percentage and field-normalised citation impact of IMI-supported research papers with authors from more than one sector. Figures 7.2.1 to 7.2.5 are maps showing international collaboration for the five IMI projects with the highest number of papers: BTCURE, EU-AIMS, EMIF, NEWMEDS and ULTRA-DD. The countries with the most frequent collaboration are shaded purple, those with little collaboration in white, and those with no collaboration in grey.

It should be noted that the last column in Table 7.2.1 to 7.2.3 does not show the field-normalised citation impact of all papers for that project, rather it is the field-normalised citation impact of those papers involving collaboration of the type being analysed. Therefore, in Table 7.2.1, the last column contains the field-normalised citation impact of only the internationally collaborative papers for each project. Similarly, the last column in Table 7.2.2 contains only the field-normalised citation impact of the papers from more than one institution, and in Table 7.2.3, the last column contains only the field-normalised citation impact of cross-sector papers.

The key findings of Section 7.2 are:

- BTCURE had the highest number of papers with authors from more than one country, institution and sector (Table 7.1.1-7.2.3). This may be due to BTCURE having the highest overall number of papers.
- EU-AIMS had the second highest number of papers with authors from more than one country, institution and sector (Table 7.1.1-7.2.3).
- The majority of collaborative papers from the top five projects were co-authored with researchers from the United States (USA) and Europe (Figure 7.2.2-7.2.5). The most frequent collaborating European countries were the UK, Sweden, Netherlands and Germany.
- EU-AIMS, NEWMEDS and ULTRA-DD also had substantial input from Canada (Figure 7.2.3-7.2.5).

TABLE 7.2.1 NUMBER, PERCENTAGE AND CITATION IMPACT[15] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE COUNTRY, 2010-2018

Project	Number of papers	Number of internationally collaborative papers	% of internationally collaborative papers	Citation impact (normalised at field level)
BTCure	603	350	58.0%	2.25
EU-AIMS	337	236	70.0%	2.59
EMIF	214	158	73.8%	3.60
NEWMEDS	183	117	63.9%	2.57
ULTRA-DD	177	130	73.4%	2.32
EUROPAIN	167	69	41.3%	2.83
IMIDIA	132	74	56.1%	2.01
ORBITO	128	70	54.7%	1.78
CHEM21	116	42	36.2%	2.34
TRANSLOCATION	116	68	58.6%	2.03
SUMMIT	107	72	67.3%	1.97
ELF	102	57	55.9%	1.35
STEMBANCC	100	57	57.0%	2.56
MIP-DILI	98	52	53.1%	2.43
PROTECT	95	69	72.6%	1.20
Quic-Concept	93	63	67.7%	3.54
PreDiCT-TB	91	56	61.5%	2.17
Etox	91	37	40.7%	1.41
CANCER-ID	90	45	50.0%	4.49
DDMoRe	71	45	63.4%	1.27
Pharma-Cog	70	56	80.0%	1.53
COMPACT	70	33	47.1%	2.86
Open PHACTS	70	43	61.4%	3.32
U-BIOPRED	68	47	69.1%	3.44
SPRINTT	63	40	63.5%	2.50
BioVacSafe	58	29	50.0%	1.98
ABIRISK	56	25	44.6%	1.54
INNODIA	55	41	74.5%	2.30
K4DD	53	33	62.3%	2.43
COMBACTE-NET	53	29	54.7%	1.21
Onco Track	53	26	49.1%	3.17
MARCAR	52	27	51.9%	1.58
DIRECT	47	34	72.3%	3.19
AETIONOMY	45	20	44.4%	1.89
COMBACTE-MAGNET	40	28	70.0%	1.92
Predect	40	28	70.0%	1.86
RAPP-ID	40	20	50.0%	1.04
DRIVE-AB	35	24	68.6%	2.54
GETREAL	34	28	82.4%	2.26

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

Project	Number of papers	Number of internationally collaborative papers	% of internationally collaborative papers	Citation impact (normalised at field level)
BEAT-DKD	33	25	75.8%	1.31
eTRIKS	30	28	93.3%	3.03
ZAPI	29	21	72.4%	2.19
COMBACTE-CARE	28	21	75.0%	2.17
iPiE	27	9	33.3%	2.35
PRECISESADS	27	21	77.8%	1.54
PROACTIVE	26	22	84.6%	2.19
ND4BB	25	13	52.0%	1.69
FLUCOP	25	17	68.0%	2.64
ENABLE	23	12	52.2%	1.64
APPROACH	22	20	90.9%	2.51
EPAD	18	13	72.2%	2.21
SAFE-T	18	10	55.6%	1.27
EHR4CR	17	12	70.6%	1.27
EBOVAC1	15	9	60.0%	3.39
RHAPSODY	15	11	73.3%	3.39
IMPRiND	15	9	60.0%	7.84
EBiSC	15	12	80.0%	1.92
COMBACTE	15	2	13.3%	6.17
RTCure	15	8	53.3%	2.24
EbolaMoDRAD	14	9	64.3%	2.59
ADVANCE	12	11	91.7%	2.05
RADAR-CNS	11	9	81.8%	1.11
VSV-EBOVAC	9	6	66.7%	1.85
ADAPTED	9	8	88.9%	3.29
WEB-RADR	9	8	88.9%	2.22
BigData@Heart	8	7	87.5%	1.58
ROADMAP	8	7	87.5%	1.17
PHAGO	7	7	100.0%	2.11
EBOVAC2	7	6	85.7%	1.71
PRISM	7	5	71.4%	1.51
EUPATI	6	6	100.0%	0.71
iABC	6	4	66.7%	2.44
TransQST	6	3	50.0%	3.25
VSV-EBOPLUS	6	4	66.7%	1.36
HARMONY	5	5	100.0%	1.93
AMYPAD	4	2	50.0%	2.18
eTRANSAFE	4	1	25.0%	0.00
SafeSciMET	4	4	100.0%	0.85
Eu2P	3	2	66.7%	0.00
AIMS-2-TRIALS	3	2	66.7%	0.00
TRISTAN	3	3	100.0%	1.04

Project	Number of papers	Number of internationally collaborative papers	% of internationally collaborative papers	Citation impact (normalised at field level)
ADAPT-SMART	2	1	50.0%	1.34
RESCEU	2	1	50.0%	0.00
DRIVE	2	1	50.0%	1.55
PERISCOPE	2	0	0.0%	0.00
Pharmatrain	1	1	100.0%	0.00
EBODAC	1	1	100.0%	0.51
Ebola+	1	1	100.0%	3.62
EMTRAIN	1	1	100.0%	0.07
MACUSTAR	1	0	0.0%	0.00
VAC2VAC	1	1	100.0%	0.00
c4c	0	0	0.0%	0.00
EQIPD	0	0	0.0%	0.00
LITMUS	0	0	0.0%	0.00
PREFER	0	0	0.0%	0.00
FILODIAG	0	0	0.0%	0.00

TABLE 7.2.2 NUMBER, PERCENTAGE AND CITATION IMPACT[16] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE INSTITUTION, 2010-2018

Project	Number of papers	Number of papers from more than one institution	% of papers from more than one institution	Citation impact (normalised at field level)
BTCure	603	491	81.4%	2.13
EU-AIMS	337	311	92.3%	2.48
EMIF	214	201	93.9%	3.27
NEWMEDS	183	165	90.2%	2.41
ULTRA-DD	177	169	95.5%	2.32
EUROPAIN	167	128	76.6%	2.43
IMIDIA	132	107	81.1%	1.81
ORBITO	128	97	75.8%	1.86
CHEM21	116	66	56.9%	2.18
TRANSLOCATION	116	85	73.3%	1.81
SUMMIT	107	92	86.0%	1.79
ELF	102	71	69.6%	1.31
STEMBANCC	100	79	79.0%	2.39
MIP-DILI	98	71	72.4%	2.14
PROTECT	95	93	97.9%	1.10
Quic-Concept	93	79	84.9%	3.24
PreDiCT-TB	91	72	79.1%	1.83
eTOX	91	61	67.0%	2.00
CANCER-ID	90	78	86.7%	4.04
DDMoRe	71	57	80.3%	1.24
Pharma-Cog	70	68	97.1%	1.40
COMPACT	70	52	74.3%	2.31
Open PHACTS	70	57	81.4%	3.98
U-BIOPRED	68	61	89.7%	2.87
SPRINTT	63	56	88.9%	2.55
BioVacSafe	58	43	74.1%	1.67
ABIRISK	56	49	87.5%	1.63
INNODIA	55	53	96.4%	2.13
K4DD	53	42	79.2%	2.38
COMBACTE-NET	53	44	83.0%	1.44
Onco Track	53	47	88.7%	2.68
MARCAR	52	38	73.1%	1.40
DIRECT	47	46	97.9%	3.16
AETIONOMY	45	45	100.0%	1.90
COMBACTE-MAGNET	40	35	87.5%	2.27
Predect	40	34	85.0%	1.79
RAPP-ID	40	30	75.0%	1.03
DRIVE-AB	35	28	80.0%	2.45
GETREAL	34	34	100.0%	2.39

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

Project	Number of papers	Number of papers from more than one institution	% of papers from more than one institution	Citation impact (normalised at field level)
BEAT-DKD	33	30	90.9%	1.49
eTRIKS	30	30	100.0%	2.97
ZAPI	29	25	86.2%	1.88
COMBACTE-CARE	28	28	100.0%	2.57
iPiE	27	24	88.9%	1.74
PRECISESADS	27	27	100.0%	1.35
PROACTIVE	26	26	100.0%	1.92
ND4BB	25	22	88.0%	1.38
FLUCOP	25	24	96.0%	2.19
ENABLE	23	21	91.3%	1.47
APPROACH	22	22	100.0%	2.49
EPAD	18	14	77.8%	2.11
SAFE-T	18	17	94.4%	1.22
EHR4CR	17	16	94.1%	1.09
EBOVAC1	15	12	80.0%	3.38
RHAPSODY	15	14	93.3%	3.20
IMPRiND	15	13	86.7%	7.84
EBiSC	15	14	93.3%	12.97
COMBACTE	15	13	86.7%	2.34
RTCure	15	11	73.3%	2.08
EbolaMoDRAD	14	13	92.9%	2.30
ADVANCE	12	11	91.7%	2.05
RADAR-CNS	11	11	100.0%	1.49
VSV-EBOVAC	9	7	77.8%	1.85
ADAPTED	9	9	100.0%	3.29
WEB-RADR	9	9	100.0%	2.42
BigData@Heart	8	7	87.5%	1.58
ROADMAP	8	7	87.5%	1.17
PHAGO	7	7	100.0%	2.11
EBOVAC2	7	6	85.7%	1.71
PRISM	7	6	85.7%	1.23
EUPATI	6	6	100.0%	0.71
iABC	6	6	100.0%	2.12
TransQST	6	6	100.0%	2.69
VSV-EBOPLUS	6	5	83.3%	1.36
HARMONY	5	5	100.0%	1.93
AMYPAD	4	4	100.0%	1.82
eTRANSAFE	4	4	100.0%	0.79
SafeSciMET	4	4	100.0%	0.85
Eu2P	3	3	100.0%	1.88
AIMS-2-TRIALS	3	2	66.7%	0.00
TRISTAN	3	3	100.0%	1.04
ADAPT-SMART	2	2	100.0%	0.67

Project	Number of papers	Number of papers from more than one institution	% of papers from more than one institution	Citation impact (normalised at field level)
RESCEU	2	2	100.0%	0.00
DRIVE	2	2	100.0%	0.77
PERISCOPE	2	1	50.0%	0.00
Pharmatrain	1	1	100.0%	0.00
EBODAC	1	1	100.0%	0.51
Ebola+	1	1	100.0%	3.62
EMTRAIN	1	1	100.0%	0.07
MACUSTAR	1	0	0.0%	0.00
VAC2VAC	1	1	100.0%	0.00
c4c	0	0	0.0%	0.00
EQIPD	0	0	0.0%	0.00
LITMUS	0	0	0.0%	0.00
PREFER	0	0	0.0%	0.00
FILODIAG	0	0	0.0%	0.00

TABLE 7.2.3 NUMBER, PERCENTAGE AND CITATION IMPACT[17] OF IMI-SUPPORTED RESEARCH PAPERS WITH AUTHORS FROM MORE THAN ONE SECTOR, 2010-2018

Project	Number of papers	Number of cross sector papers	% of cross sector papers	Citation impact (normalised at field level)
BTCure	603	380	63.0%	2.28
EU-AIMS	337	228	67.7%	2.59
EMIF	214	170	79.4%	3.05
NEWMEDS	183	118	64.5%	2.61
ULTRA-DD	177	110	62.1%	2.70
EUROPAIN	167	90	53.9%	2.63
IMIDIA	132	69	52.3%	1.99
ORBITO	128	75	58.6%	2.16
CHEM21	116	27	23.3%	2.43
TRANSLOCATION	116	37	31.9%	1.86
SUMMIT	107	78	72.9%	1.74
ELF	102	38	37.3%	1.32
STEMBANCC	100	55	55.0%	2.49
MIP-DILI	98	65	66.3%	2.05
PROTECT	95	93	97.9%	1.10
Quic-Concept	93	70	75.3%	2.27
PreDiCT-TB	91	50	54.9%	1.91
eTOX	91	26	28.6%	1.51
CANCER-ID	90	66	73.3%	4.40
DDMoRe	71	44	62.0%	1.36
Pharma-Cog	70	59	84.3%	1.45
COMPACT	70	16	22.9%	3.41
Open PHACTS	70	42	60.0%	3.94
U-BIOPRED	68	53	77.9%	3.05
SPRINTT	63	36	57.1%	2.46
BioVacSafe	58	25	43.1%	2.09
ABIRISK	56	42	75.0%	1.85
INNODIA	55	43	78.2%	1.94
K4DD	53	28	52.8%	2.45
COMBACTE-NET	53	37	69.8%	1.37
Onco Track	53	32	60.4%	2.68
MARCAR	52	23	44.2%	1.44
DIRECT	47	36	76.6%	3.88
AETIONOMY	45	28	62.2%	1.96
COMBACTE-MAGNET	40	26	65.0%	1.91
Predect	40	27	67.5%	1.87
RAPP-ID	40	13	32.5%	1.17
DRIVE-AB	35	25	71.4%	2.50
GETREAL	34	30	88.2%	2.65

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

Project	Number of papers	Number of cross sector papers	% of cross sector papers	Citation impact (normalised at field level)
BEAT-DKD	33	25	75.8%	1.43
eTRIKS	30	25	83.3%	3.32
ZAPI	29	19	65.5%	2.25
COMBACTE-CARE	28	27	96.4%	2.57
iPiE	27	16	59.3%	1.59
PRECISESADS	27	20	74.1%	1.51
PROACTIVE	26	26	100.0%	1.92
ND4BB	25	12	48.0%	1.53
FLUCOP	25	23	92.0%	2.19
ENABLE	23	11	47.8%	1.81
APPROACH	22	18	81.8%	1.89
EPAD	18	14	77.8%	2.11
SAFE-T	18	17	94.4%	1.22
EHR4CR	17	16	94.1%	1.09
EBOVAC1	15	8	53.3%	3.59
RHAPSODY	15	9	60.0%	1.92
IMPRiND	15	6	40.0%	2.60
EBiSC	15	10	66.7%	17.86
COMBACTE	15	7	46.7%	2.68
RTCure	15	6	40.0%	3.42
EbolaMoDRAD	14	8	57.1%	3.44
ADVANCE	12	9	75.0%	2.50
RADAR-CNS	11	4	36.4%	0.54
VSV-EBOVAC	9	4	44.4%	1.70
ADAPTED	9	8	88.9%	3.84
WEB-RADR	9	8	88.9%	2.21
BigData@Heart	8	7	87.5%	1.58
ROADMAP	8	7	87.5%	1.17
PHAGO	7	5	71.4%	2.65
EBOVAC2	7	3	42.9%	0.85
PRISM	7	5	71.4%	3.75
EUPATI	6	6	100.0%	0.71
iABC	6	5	83.3%	2.44
TransQST	6	3	50.0%	3.25
VSV-EBOPLUS	6	3	50.0%	0.91
HARMONY	5	5	100.0%	1.93
AMYPAD	4	3	75.0%	1.87
eTRANSAFE	4	1	25.0%	0.00
SafeSciMET	4	4	100.0%	0.85
Eu2P	3	1	33.3%	0.00
AIMS-2-TRIALS	3	1	33.3%	0.00
TRISTAN	3	2	66.7%	0.00

Project	Number of papers	Number of cross sector papers	% of cross sector papers	Citation impact (normalised at field level)
ADAPT-SMART	2	2	100.0%	0.67
RESCEU	2	2	100.0%	0.00
DRIVE	2	2	100.0%	0.77
PERISCOPE	2	0	0.0%	0.00
Pharmatrain	1	1	100.0%	0.00
EBODAC	1	0	0.0%	0.00
Ebola+	1	1	100.0%	3.62
EMTRAIN	1	1	100.0%	0.07
MACUSTAR	1	0	0.0%	0.00
VAC2VAC	1	1	100.0%	0.00
c4c	0	0	0.0%	0.00
EQIPD	0	0	0.0%	0.00
LITMUS	0	0	0.0%	0.00
PREFER	0	0	0.0%	0.00
FILODIAG	0	0	0.0%	0.00

FIGURE 7.2.2 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: BTCURE, 2010-2018

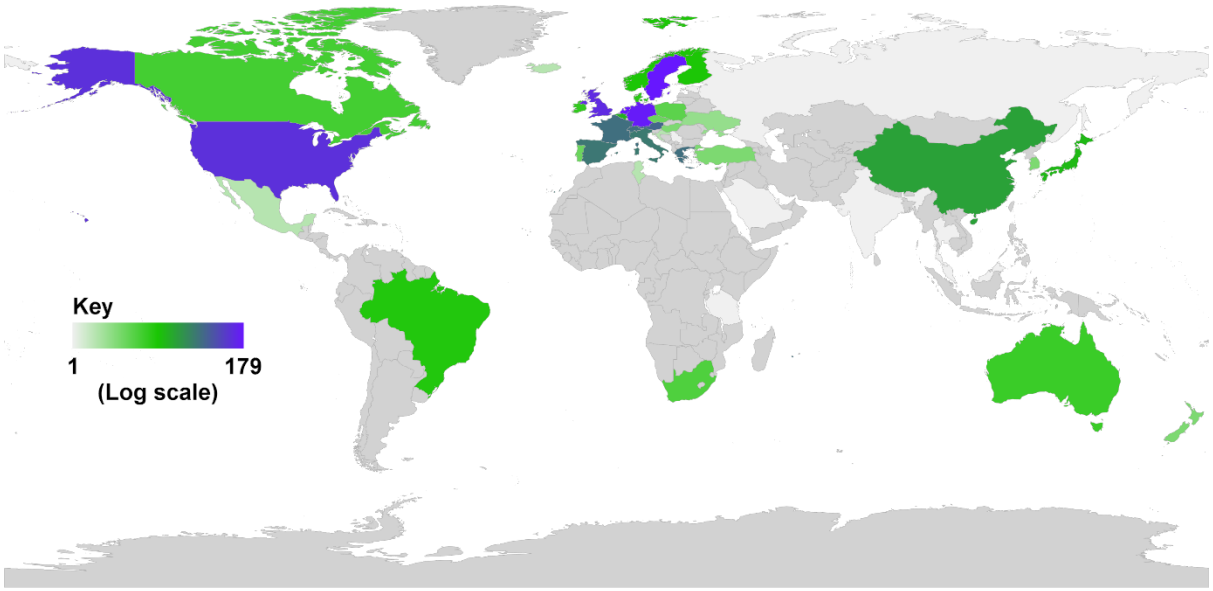


FIGURE 7.2.3 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: EU-AIMS, 2010-2018

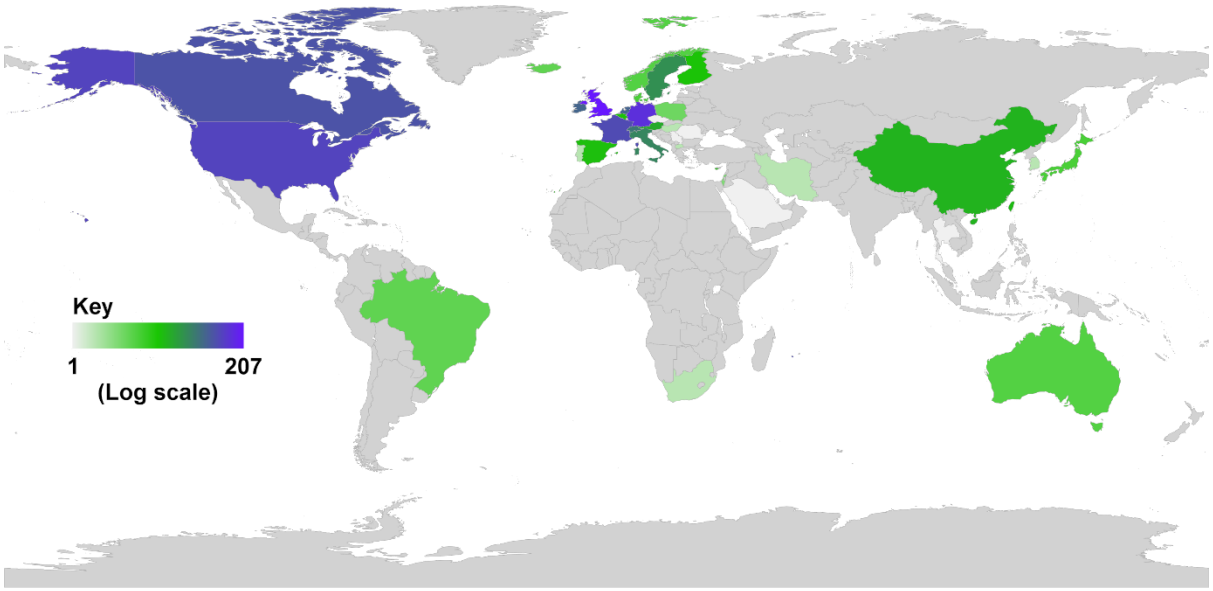


FIGURE 7.2.4 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: EMIF, 2010-2018

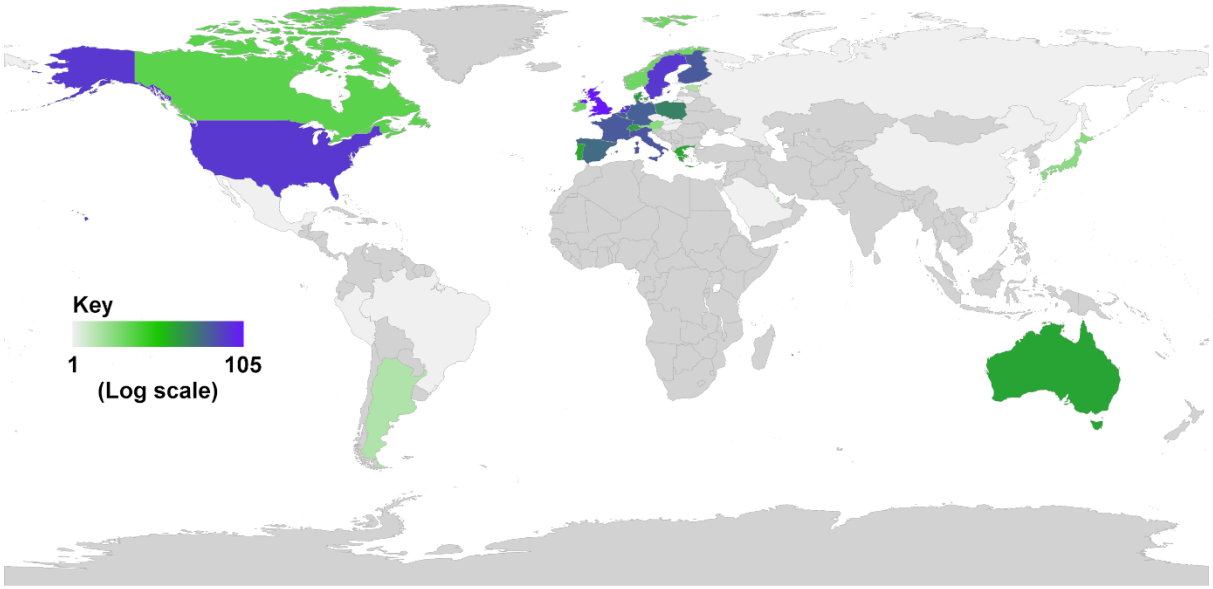


FIGURE 7.2.5 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: NEWMEDS, 2010-2018

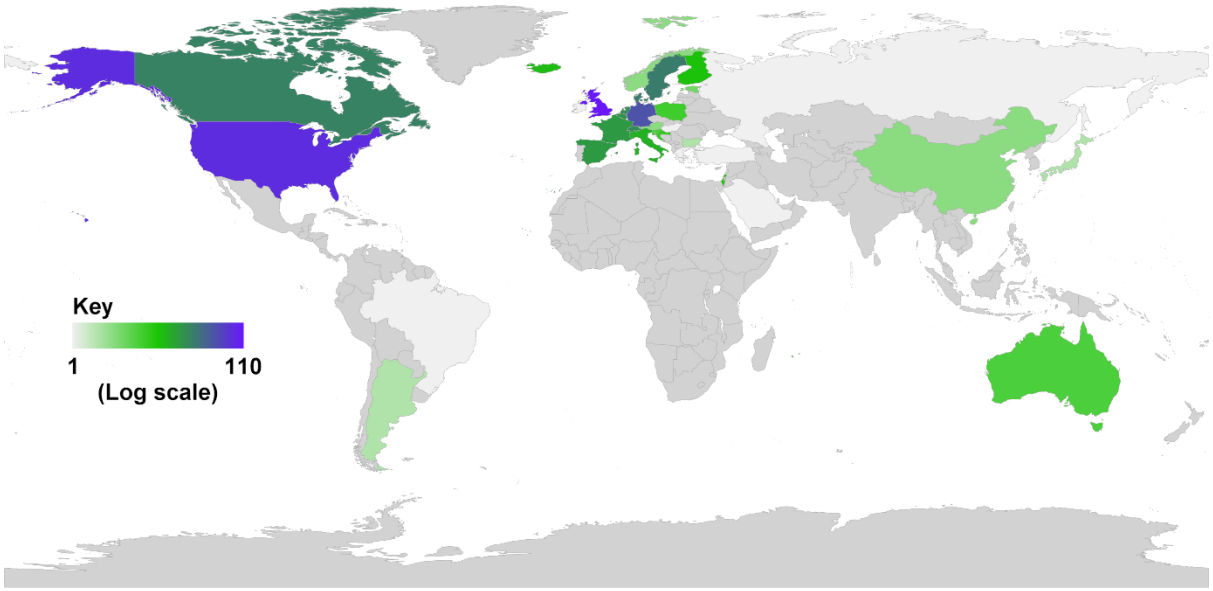
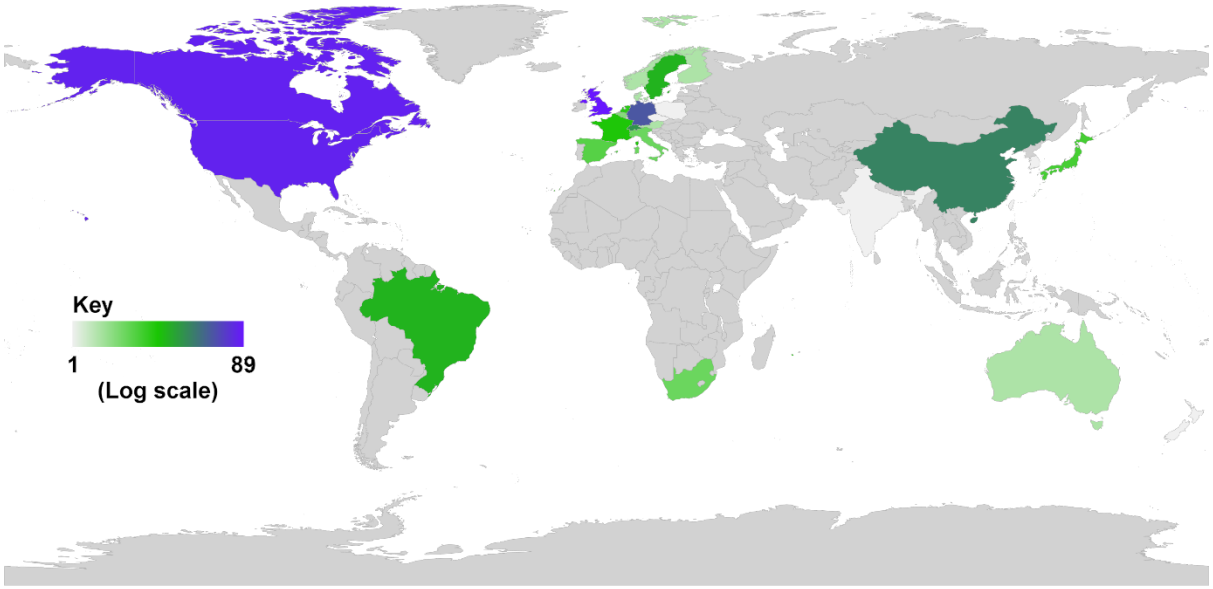


FIGURE 7.2.6 INTERNATIONAL COLLABORATION BY COUNTRY, FOR IMI PROJECT: ULTRA-DD, 2010-2018



7.3 COLLABORATION METRICS FOR IMI RESEARCH

This section of the report analyses the types of collaboration that occurred within each IMI project paper and examines the stability of institutional collaborations within each project. In common with other metrics based on papers and citations, the indicators we present here work best with larger sample sizes. Indicators based on small numbers of papers will be less informative than those calculated for larger bodies of work. Therefore, the analysis presented in this section is for projects with at least 20 papers published between 2010 and 2018. In previous versions of this report metric 3 indicated the intensity of international collaboration, in this report it has been updated to measure the stability of institutional collaborations.

The results for all projects are shown in Annex 5.

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

- Metric 1 (X-sector Score) – Fraction of "cross sector" papers with co-authors affiliated to institutions in different sectors (Figure 7.3.1.1). The institutions affiliated with each author on a paper within the dataset were manually assigned by Clarivate Analytics to the relevant sector. Author affiliations were obtained through Web of Science.
- Metric 2 (International Score) – Percentage of internationally collaborative papers. In calculating the international score for each project, greater weighting is given to papers with multilateral collaboration (co-authors from more than two countries), compared to bilateral collaboration (co-authors from two countries) (Figure 7.3.2.1). The country location of each author was determined using author addresses extracted in the Web of Science.
- Metric 3 (Stability Score) – Stability of institutional collaboration over the lifetime of the project. The collaboration stability for pairs of collaborating institutions was calculated following the method proposed by Y. Bu et al.[18] A stable institutional collaboration has a stable output, i.e. pairs of institutions co-publish a similar volume of papers in consecutive years for the duration of a project. The stability score for each project is the mean average stability of all the collaborating intuitional pairs that have contributed to that IMI project research.

Each metric is calculated for an IMI project and can take a value between 0 and 1, with 1 indicating more collaborative activity. The collaboration index is a sum of all three metrics and the maximum possible value for a project is 3.

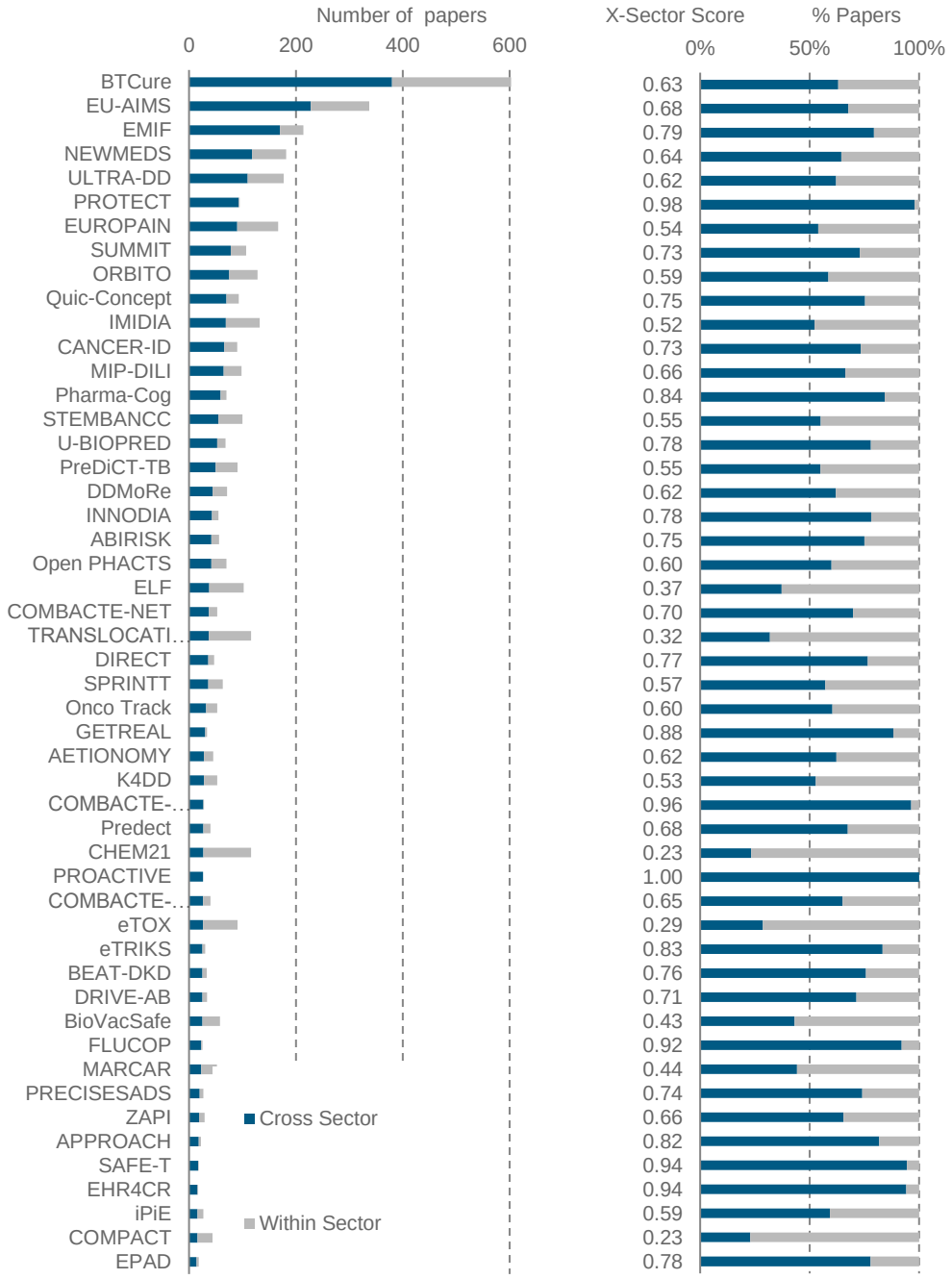
[18] Bu, Y., Murray, D.S., Ding, Y. et al. (2018) Measuring the stability of scientific collaboration. *Scientometrics,* **114**, 463.

7.3.1 METRIC 1 (X-SECTOR SCORE): FRACTION OF CROSS SECTOR COLLABORATIVE PAPERS

The sectors to which organisations listed in authors affiliation on IMI project papers belonged were used to classify each paper as “within one sector” or “cross sector”. Number and percentage of cross sector collaborative papers for each project are presented in Table 7.2.3.

FIGURE 7.3.1.1 shows the total number of papers for each project. Projects are ordered by the number of cross sector collaborative papers. Only projects with more than 20 associated papers are shown. The dark blue bars represent the number of papers or fraction of papers that include at least one cross sector collaboration. The fraction of papers in each project that involve cross-sector collaborations is referred to in the diagram by the abbreviation “X-Sector Score”. Number and percentage of cross sector collaborative papers for each project are presented in Table 7.2.3.

FIGURE 7.3.1.1 FRACTION OF CROSS-SECTOR COLLABORATIVE PAPERS BY PROJECT, 2010-2018



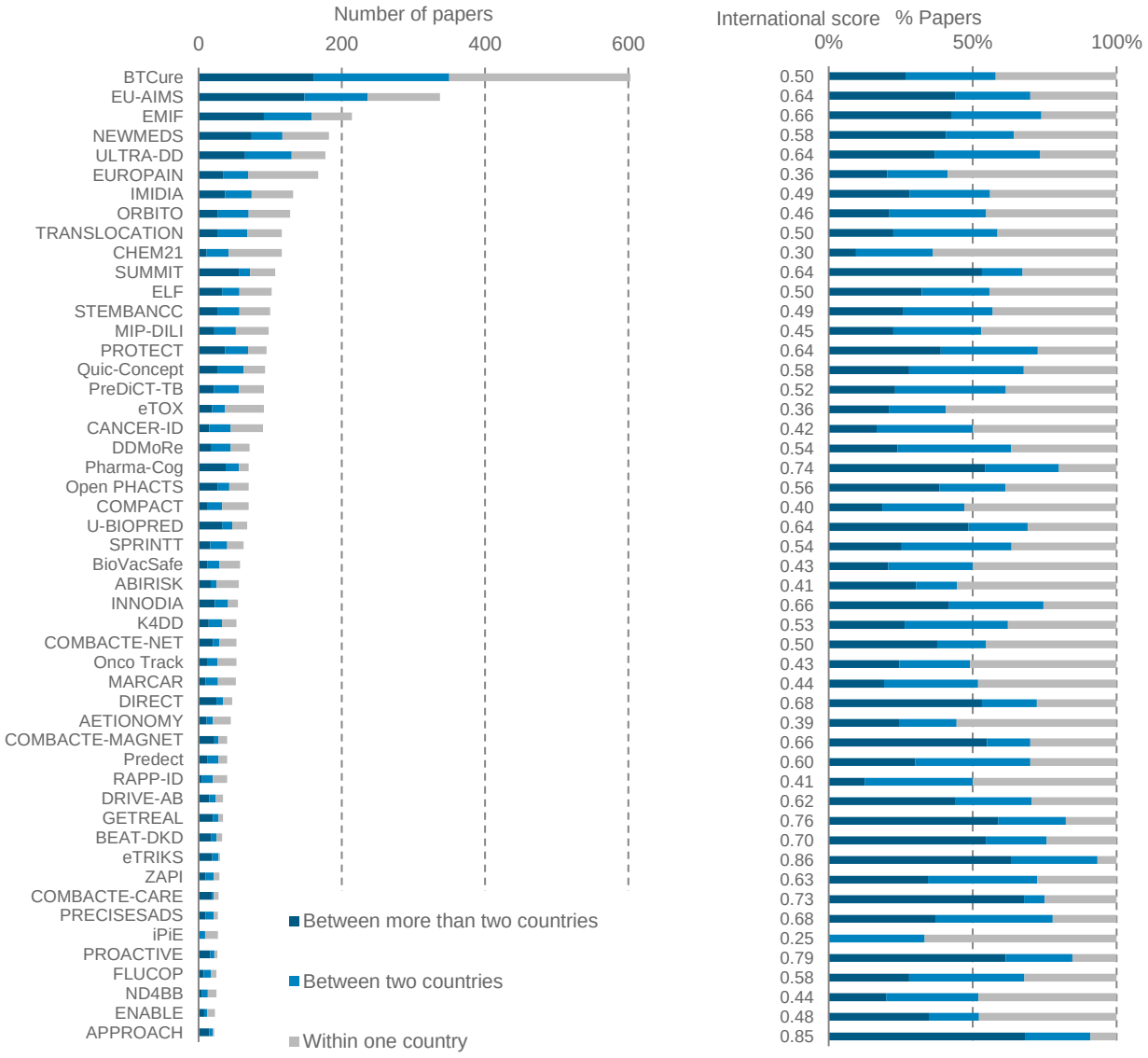
- BTCURE had the greatest number of cross-sector collaborative papers, 380 out of a total of 603. PRO-active, Protect and COMBACTE-CARE had the highest percentage of cross-sector collaborative papers (100%, 97.9% and 96.4% respectively).

7.3.2 METRIC 2 (INTERNATIONAL SCORE): FRACTION OF INTERNATIONALLY COLLABORATIVE PAPERS

Author names and affiliations were extracted for all IMI project papers. The number of countries in the author affiliations for each paper was counted and used to classify the papers as “more than two countries”, “two countries” or “within one country” (same as domestic in the Section 7.1).

FIGURE 7.3.2.1 below shows the total number of papers for each project. Projects are ordered by the number of papers with author affiliations from more than one country. The bar colours reflect the fraction of papers that include international collaboration between “two countries” (bilateral) and “more than two countries” (multilateral). Only projects with more than 20 associated papers are shown. The International Score was calculated by weighting each paper that involved only two countries by 0.75 and each paper that involved more than two countries by 1.00. The sum of the weighted papers was then divided by the total number of project papers. Total number of internationally collaborative papers for each project is shown in Table 7.2.1.

FIGURE 7.3.2.1 FRACTION OF INTERNATIONALLY COLLABORATIVE PAPERS BY PROJECT, 2010-2018



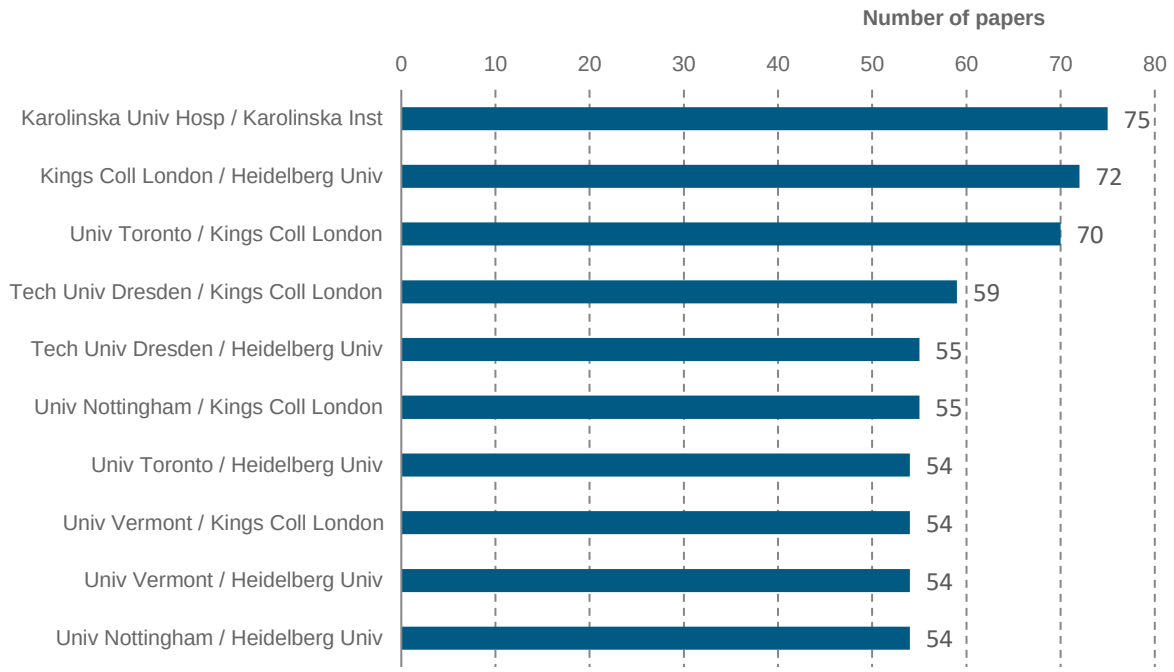
- BTCURE had the most internationally collaborative papers involving two or more countries (350 out of 603), with an International Score of 0.50. eTRICKS, APPROACH and PRO-active, had the highest International Score (0.86, 0.85 and 0.90 respectively).

7.3.3 METRIC 3 (STABILITY SCORE): STABILITY OF INSTITUTIONAL COLLABORATION

This Section looks in depth at institutional collaboration activities in IMI funded research. Figure 7.3.3.1 shows the ten most productive, collaborating institution pairs, by total number of collaborative papers. Figure 7.3.3.2 shows the ten institutions that collaborate with the highest number of other institution. Figure 7.3.3.3 shows the distribution of Metric 3 scores for IMI projects. Table 7.3.3.1 is an expansion of the data in Figure 7.3.3.3, showing the Metric 3 score for all projects with at least 20 papers and the number of collaborating institution pairs. The number and proportion of papers with authors for more than one institution for each project is shown in Table 7.2.2.

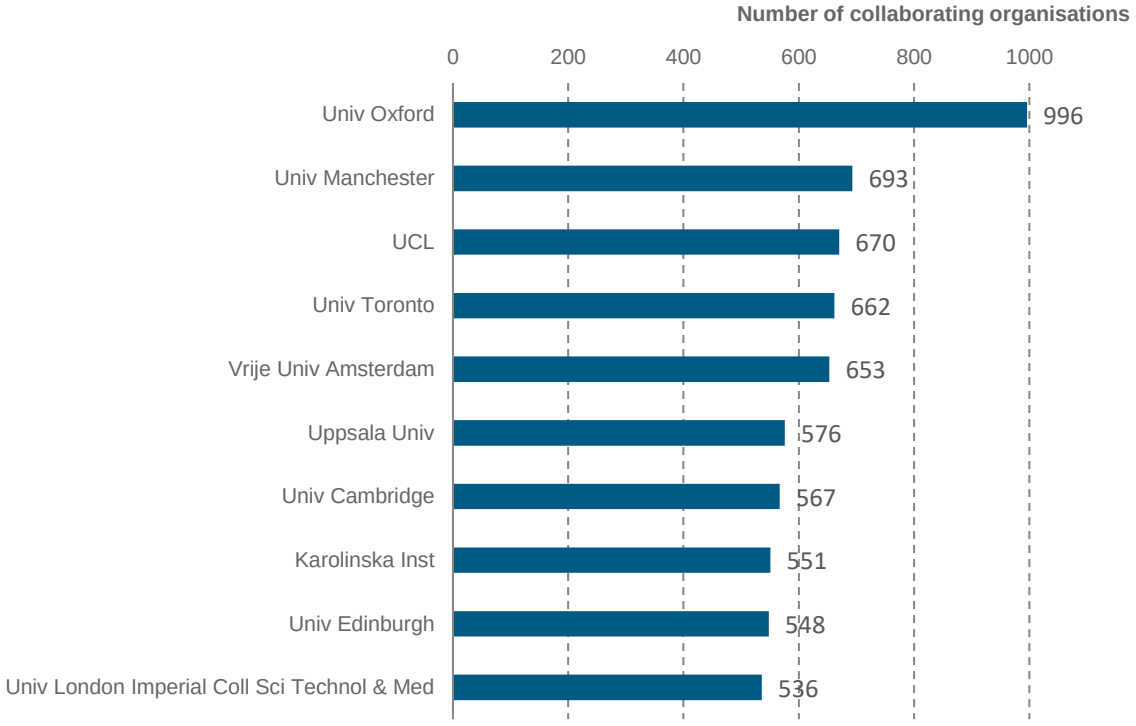
Metric 3 for a project is the mean average stability of collaborations between pairs of institutions that have co-authored papers that acknowledge funding from that IMI project. Pairs of institutions had to have publishing two or more papers together as part of the same IMI project research to be considered. A second requirement is that the IMI projects had to have started in, or before, 2016. If a project started after 2016, too little time has elapsed for most pairs of institutions to have published more than one paper.

FIGURE 7.3.3.1 THE TEN MOST PRODUCTIVE PAIRS OF COLLABORATING INSTITUTIONS, 2010-2018



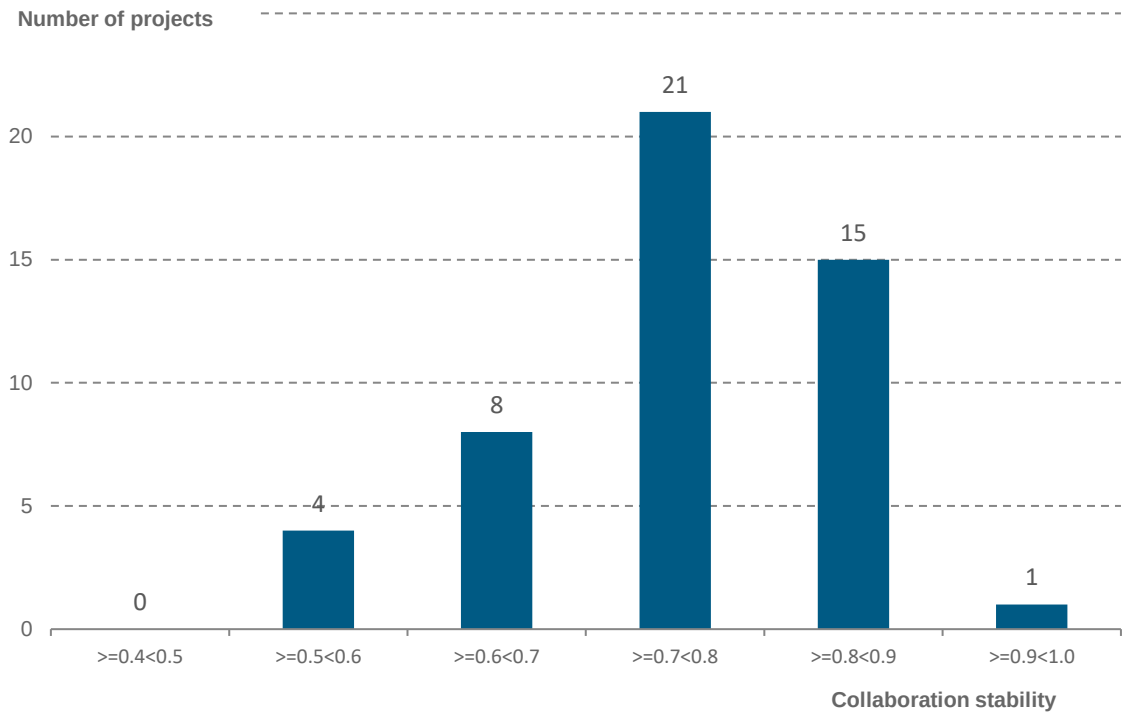
- The institutions that collaborated most frequently on IMI project papers were the Karolinska Institute and the Karolinska University Hospital.

FIGURE 7.3.3.2 THE TEN MOST DIVERSE COLLABORATIVE INSTITUTIONS, 2010-2018



- University of Oxford has collaborated with 996 different institutions on IMI project papers.
- Six out of the ten most collaborative institutions are located in the United Kingdom.

FIGURE 7.3.3.3 METRIC 3: STABILITY SCORE DISTRIBUTION, 2010-2018



Most IMI project have stability score of between 0.70 and 0.90.

TABLE 7.3.3.1 STABILITY SCORE FOR IMI PROJECTS, NUMBER OF COLLABORATING PAIRS OF INSTITUTORS, TOTAL NUMBER OF PROJECT PAPERS AND PROJECT START YEAR FOR ALL PROJECTS WITH AT LEAST 20 PAPERS THAT STARTED IN OR BEFORE 2016.

Project	Stability score (Metric 3)	Number of collaborating pairs	Number of papers	Project start year
BTCure	0.79	953	603	2011
EU-AIMS	0.74	1,816	337	2012
EMIF	0.80	1,134	214	2012
NEWMEDS	0.77	603	183	2010
ULTRA-DD	0.70	255	177	2015
EUROPAIN	0.83	294	167	2010
IMIDIA	0.81	138	132	2010
ORBITO	0.70	206	128	2013
TRANSLOCATION	0.78	44	116	2013
CHEM21	0.72	20	116	2013
SUMMIT	0.76	3,435	107	2011
ELF	0.66	28	102	2014
STEMBANCC	0.83	38	100	2013
MIP-DILI	0.79	108	98	2012
PROTECT	0.82	298	95	2010
Quic-Concept	0.76	108	93	2012
PreDiCT-TB	0.86	51	91	2009
eTOX	0.83	127	91	2010
CANCER-ID	0.62	59	90	2015
DDMoRe	0.76	32	71	2012
Pharma-Cog	0.82	797	70	2010
Open PHACTS	0.77	63	70	2011
COMPACT	0.63	22	70	2014
U-BIOPRED	0.86	935	68	2010
SPRINTT	0.74	99	63	2014
BioVacSafe	0.70	9	58	2012
ABIRISK	0.82	187	56	2012
INNODIA	0.92	73	55	2010
K4DD	0.82	21	53	2013
Onco Track	0.80	52	53	2011
MARCAR	0.77	34	52	2011
DIRECT	0.77	217	47	2012
AETIONOMY	0.74	36	45	2014
RAPP-ID	0.83	6	40	2011
Predect	0.76	51	40	2012
COMBACTE-MAGNET	0.70	75	40	2015
DRIVE-AB	0.73	40	35	2015
GETREAL	0.61	36	34	2015
eTRIKS	0.67	399	30	2014
ZAPI	0.54	44	29	2015
COMBACTE-CARE	0.58	458	28	2015

Project	Stability score (Metric 3)	Number of collaborating pairs	Number of papers	Project start year
iPiE	0.66	5	27	2016
PRECISESADS	0.57	73	27	2015
PROACTIVE	0.82	156	26	2011
ND4BB	0.81	5	25	2013
FLUCOP	0.55	14	25	2015
ENABLE	0.77	12	23	2015
APPROACH	0.62	36	22	2015

- INNODIA has the highest stability score (0.92) while FLUCOP has the lowest (0.55).
- There is considerable variation in the number collaborating institutions pairs that does not appear to be proportional to the number of project papers or dependent on the project start year. For example, BTCure started in 2011 and has the most of papers (603), only has 934 institutional pairs compared with SUMMIT that started in the same year, has only produced 107 papers but has 3,435 collaborating institution pairs.

7.4 COLLABORATION INDEX

Metrics 1 and 2 (described above) measure different types of collaboration. The first measures the fraction of papers that involve cross sector collaborations, and the second reflects the fraction of papers that involve multilateral and bilateral international collaborations. Metric 3 is based on the collaboration stability of pairs of institutional collaborators that contribute to IMI project research. We compute a "collaboration index" across IMI projects as the sum of all three of the metrics. These data are shown in Table 7.4.1 for all IMI projects with 20 or more papers. The collaboration index for all projects is presented in Annex 5.

This year's collaboration index is not comparable with the collaboration index in the previous report (ninth version) as Metric 3 has been updated to indicate the stability of institutional collaboration rather than intensity.

- PROTECT had the highest overall collaboration index score (2.61) followed by Pharma-Cog (2.57).

TABLE 7.4.1 SUMMARY SCORE FOR COLLABORATION METRICS, TOTAL NUMBER OF PAPERS AND FIELD-NORMALISED CITATION IMPACT FOR IMI PROJECTS WITH AT LEAST 20 PAPERS, 2010-2018

Project	X-sector Score (Metric 1)	International Score (Metric 2)	Stability score (Metric 3)	Collaboration index	Number of papers	Citation impact (field-normalised)
BTCure	0.63	0.50	0.79	1.93	603	2.10
EU-AIMS	0.68	0.64	0.74	2.05	337	2.41
EMIF	0.79	0.66	0.80	2.26	214	3.21
NEWMEDS	0.64	0.58	0.77	1.99	183	2.35
ULTRA-DD	0.62	0.64	0.70	1.97	177	2.33
EUROPAIN	0.54	0.36	0.83	1.73	167	2.37
IMIDIA	0.52	0.49	0.81	1.83	132	1.70
ORBITO	0.59	0.46	0.70	1.75	128	1.93
TRANSLOCATION	0.32	0.50	0.78	1.59	116	1.72
CHEM21	0.23	0.30	0.72	1.25	116	1.94
SUMMIT	0.73	0.64	0.76	2.13	107	1.65
ELF	0.37	0.50	0.66	1.53	102	1.40
STEMBANCC	0.55	0.49	0.83	1.87	100	2.17
MIP-DILI	0.66	0.45	0.79	1.91	98	2.01
PROTECT	0.98	0.64	0.82	2.44	95	1.08
Quic-Concept	0.75	0.58	0.76	2.09	93	3.00
PreDiCT-TB	0.55	0.52	0.86	1.93	91	1.80
eTOX	0.29	0.36	0.83	1.47	91	1.67
CANCER-ID	0.73	0.42	0.62	1.77	90	3.81
DDMoRe	0.62	0.54	0.76	1.92	71	1.27
Pharma-Cog	0.84	0.74	0.82	2.40	70	1.36
Open PHACTS	0.60	0.56	0.77	1.93	70	3.43
COMPACT	0.23	0.40	0.63	1.26	70	2.21
U-BIOPRED	0.78	0.64	0.86	2.28	68	2.63
SPRINTT	0.57	0.54	0.74	1.85	63	2.50
BioVacSafe	0.43	0.43	0.70	1.56	58	1.63
ABIRISK	0.75	0.41	0.82	1.98	56	1.61

Project	X-sector Score (Metric 1)	International Score (Metric 2)	Stability score (Metric 3)	Collaboration index	Number of papers	Citation impact (field-normalised)
INNODIA	0.78	0.66	0.92	2.36	55	2.13
K4DD	0.53	0.53	0.82	1.88	53	2.27
COMBACTE-NET	0.70	0.50	0.75	1.96	53	1.35
Onco Track	0.60	0.43	0.80	1.83	53	2.48
MARCAR	0.44	0.44	0.77	1.65	52	1.21
DIRECT	0.77	0.68	0.77	2.21	52	3.09
AETIONOMY	0.62	0.39	0.74	1.75	47	1.90
COMBACTE-MAGNET	0.65	0.66	0.70	2.01	45	2.20
Predect	0.68	0.60	0.76	2.03	40	2.07
RAPP-ID	0.33	0.41	0.83	1.56	40	0.98
DRIVE-AB	0.71	0.62	0.73	2.07	40	2.32
GETREAL	0.88	0.76	0.61	2.26	35	2.39
BEAT-DKD	0.76	0.70	0.00	1.46	34	1.48
eTRIKS	0.83	0.86	0.67	2.37	33	2.97
ZAPI	0.66	0.63	0.54	1.83	30	1.93
COMBACTE-CARE	0.96	0.73	0.58	2.28	29	2.57
PRECISESADS	0.74	0.68	0.57	1.98	28	1.35
iPiE	0.59	0.25	0.66	1.50	27	1.61
PROACTIVE	1.00	0.79	0.82	2.61	27	1.92
FLUCOP	0.92	0.58	0.55	2.05	26	2.10
ND4BB	0.48	0.44	0.81	1.73	25	1.47
ENABLE	0.48	0.48	0.77	1.73	25	1.50
APPROACH	0.82	0.85	0.62	2.29	23	2.49
EPAD	0.78	0.68	0.62	2.08	22	2.11

8 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, Australia and North America.

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

8.1 IDENTIFYING COMPARATORS

The seven funders listed in Table 8.1.1 were used as comparators for IMI in this report. They are the same comparators as in the previous ninth report produced in 2018. Each comparator had sufficient publications to allow a meaningful analysis.

TABLE 8.1.1 SUMMARY OF INFORMATION OF IMI-SELECTED COMPARATORS, 2010-2018

Comparator	Number of publications (2010-2018)	Number of papers (2010-2018)	Country	Region
Critical Path (C-Path)	417	394	USA	North America
Commonwealth Scientific and Industrial Research Organisation (CSIRO) [19]	718	704	Australia	Australia
Foundation for the National Institutes of Health (FNIH)	2,985	2,868	USA	North America
Grand Challenges in Global Health (GCGH)	839	838	USA	North America
Indian Council of Medical Research (ICMR)	11,379	11,198	India	Asia
Medical Research Council (MRC)	95,077	86,787	UK	Europe
Wellcome Trust (WT)	71,723	67,449	UK	Europe

[19] The dataset containing all publications attributed to CSIRO between 2010 and 2018 has been reduced to include only medically related publications for these analyses. A list of Web of Science journal categories which capture medically related publications is given in Annex 2.

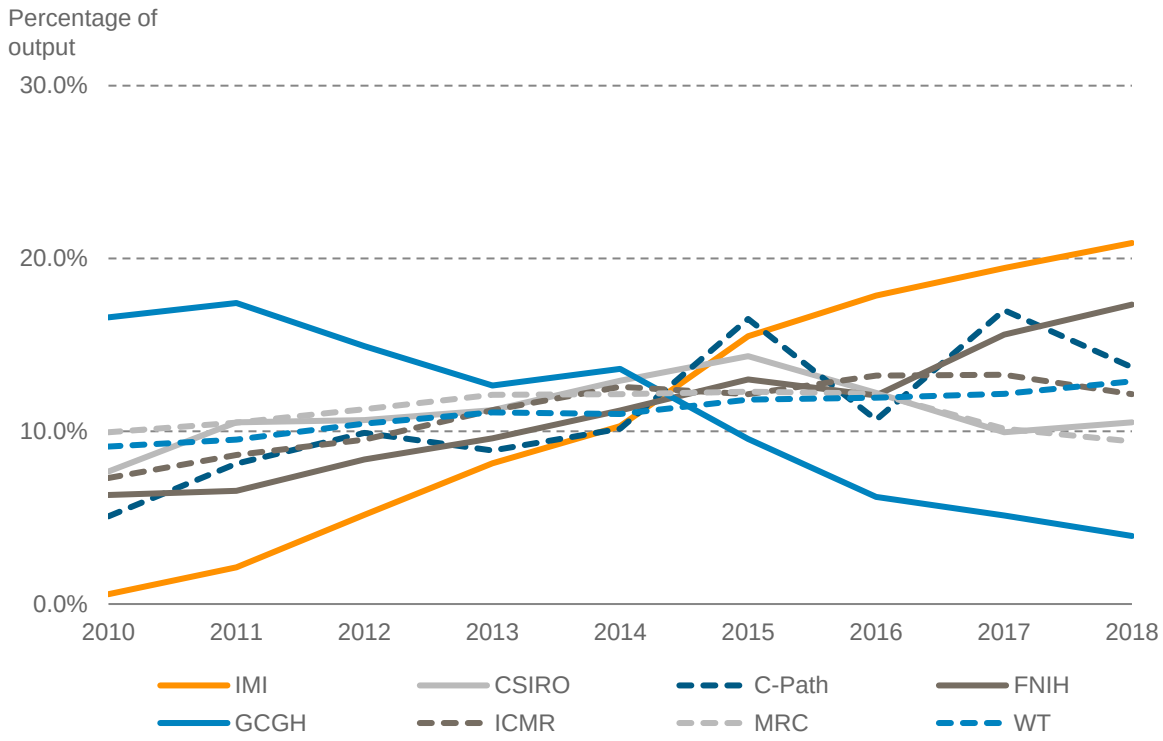
8.2 TRENDS IN OUTPUT: IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS

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

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

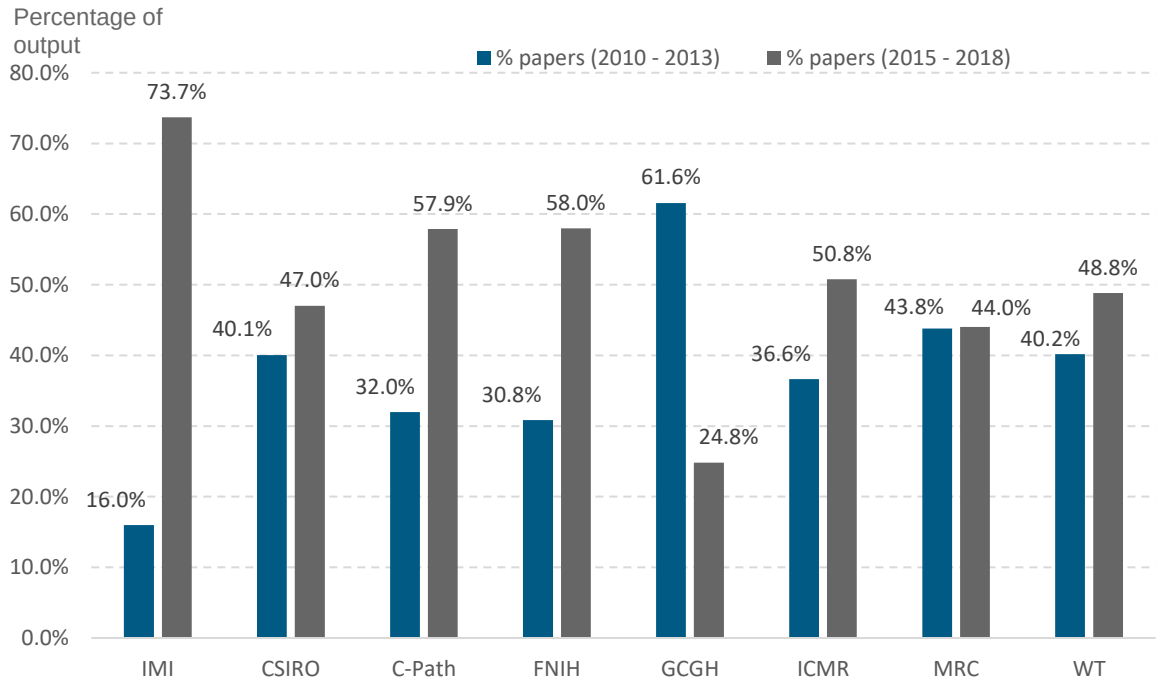
The output of IMI and the comparators varies widely (some produced many papers and some relatively few), therefore a visual comparison of absolute paper counts would not provide an understanding of their growth relative to one another. To provide a more easily interpretable comparison, Figure 8.2.1. shows the percentage of each organisation's total paper count between 2010 and 2018 published in each year. Figure 8.2.1.2 compares the percentage of each organisation's total paper count, between IMI's first four years, 2010 to 2013 and the most recent four years 2015 to 2018. Table 8.2.1.1 shows the same data as in Figure 8.2.1.1 and Table 8.2.1.2 show the number of papers per year for IMI and the selected comparators.

FIGURE 8.2.1.1 TRENDS IN OUTPUT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- The papers that were published in the last two years, 2017 and 2018, account for over 40% of all IMI papers.
- In contrast to other more established funders, IMI had a steady increase in papers since 2010.
- Except GCGH, the output of IMI and the other comparators generally increased between 2010 and 2018.

FIGURE 8.2.1.2 COMPARING OUTPUT IN THE FIRST FOUR YEARS (2010–2013) TO MOST RECENT 4 YEARS (2015-2018) – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018.



Note that 2014 data was removed so two time periods are equal and comparable

- IMI had a four time higher output in the four years between 2015-2018 compared to 2015-2018.
- All the comparators all had higher output in the most recent four years (2015-2018) compared with the first four years (2010-2013). Except GCGH that showed a decrease in output and MRC which had a comparable output,

TABLE 8.2.1.1 SHARE OF OUTPUT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	0.6%	7.7%	5.1%	6.3%	16.6%	7.3%	9.9%	9.1%
2011	2.1%	10.5%	8.1%	6.6%	17.4%	8.6%	10.5%	9.5%
2012	5.2%	10.7%	9.9%	8.4%	14.9%	9.5%	11.3%	10.4%
2013	8.1%	11.2%	8.9%	9.6%	12.6%	11.2%	12.1%	11.1%
2014	10.3%	12.9%	10.2%	11.2%	13.6%	12.6%	12.2%	11.0%
2015	15.5%	14.3%	16.5%	13.0%	9.5%	12.1%	12.3%	11.8%
2016	17.8%	12.2%	10.7%	12.1%	6.2%	13.2%	12.2%	11.9%
2017	19.4%	9.9%	17.0%	15.6%	5.1%	13.3%	10.1%	12.2%
2018	20.9%	10.5%	13.7%	17.3%	3.9%	12.1%	9.4%	12.9%

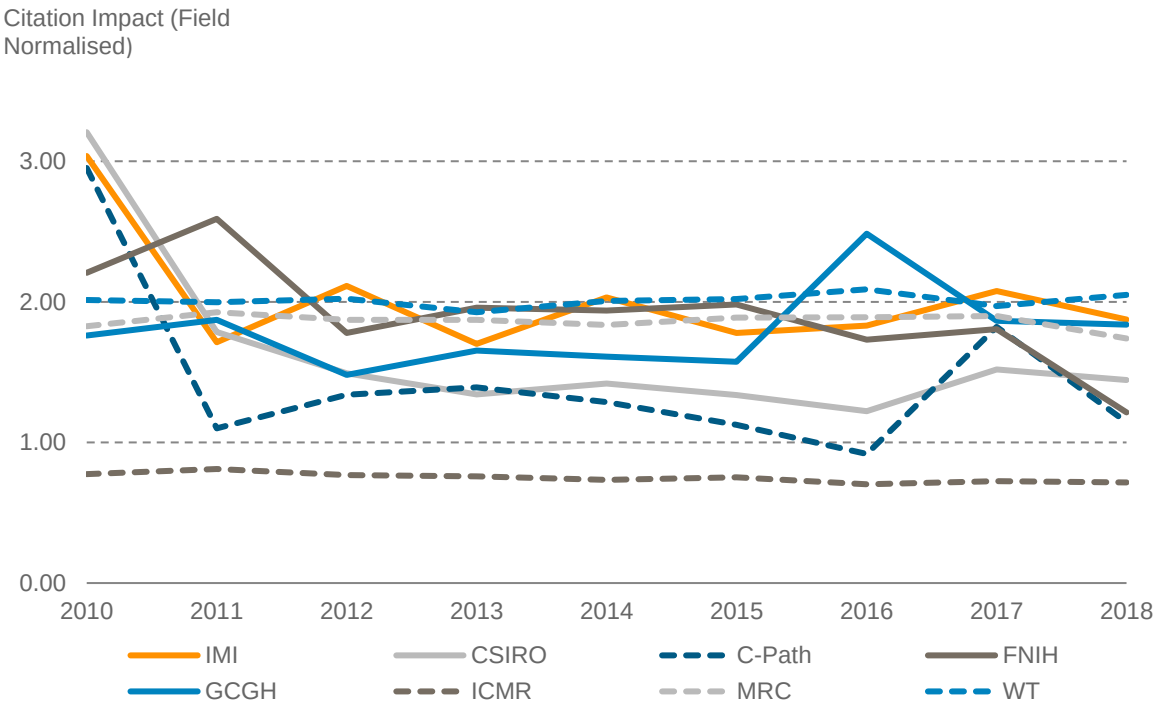
TABLE 8.2.1.2 NUMBER OF PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	26	54	20	181	139	817	8,623	6,148
2011	97	74	32	188	146	966	9,104	6,418
2012	235	75	39	240	125	1,065	9,785	7,039
2013	371	79	35	275	106	1,256	10,510	7,486
2014	469	91	40	321	114	1,407	10,549	7,423
2015	706	101	65	373	80	1,360	10,664	7,985
2016	813	86	42	346	52	1,481	10,580	8,050
2017	886	70	67	447	43	1,486	8,804	8,207
2018	952	74	54	497	33	1,360	8,168	8,693
Total	**4,555**	**704**	**394**	**2,868**	**838**	**11,198**	**86,787**	**67,449**

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

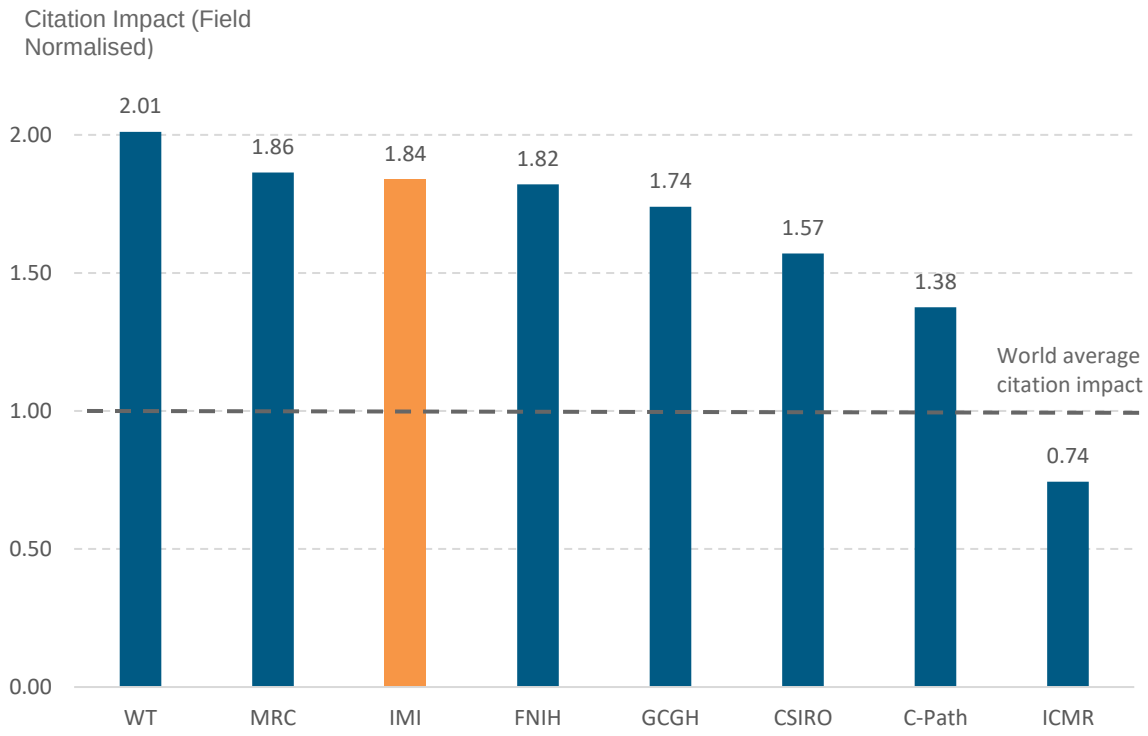
As discussed in Section 3, citations accumulate over time at a rate that is dependent upon the field of research. Therefore, it is standard bibliometric practice to normalise citation counts for these two factors. In this report, field-normalised citation impact (NCI_F) has been calculated by dividing the citations received by each publication by the world average citations per publication for the relevant year and field. Figure 8.2.2.1 shows the annual trends in field-normalised citation impact of IMI and the comparators between 2010 and 2018 and Figure 8.2.2.2 shows the average field-normalised citation impact of IMI and the comparators between 2010 and 2018. Table 8.2.2.1 has the same data as in Figure 8.2.2.1 and Figure 8.2.2.2.

FIGURE 8.2.2.1 TRENDS IN FIELD-NORMALISED CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- The field-normalised citation impact of MRC and the WT were stable at close to twice the world average between 2010 and 2018, indicating highly-cited, internationally significant research.
- The exceptionally high field-normalised citation impact of IMI, CSIRO and C-Path project research in 2010 was driven by a small number of highly-cited papers.

FIGURE 8.2.2.2 AVERAGE FIELD-NORMALISED CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- The average field-normalised citation impact IMI between 2010 and 2018 was below the WT and just below MRC.
- Only ICMR average field-normalised citation impact was below world average impact.

TABLE 8.2.2.1 FIELD-NORMALISED CITATION IMPACT (NCI_F) – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018

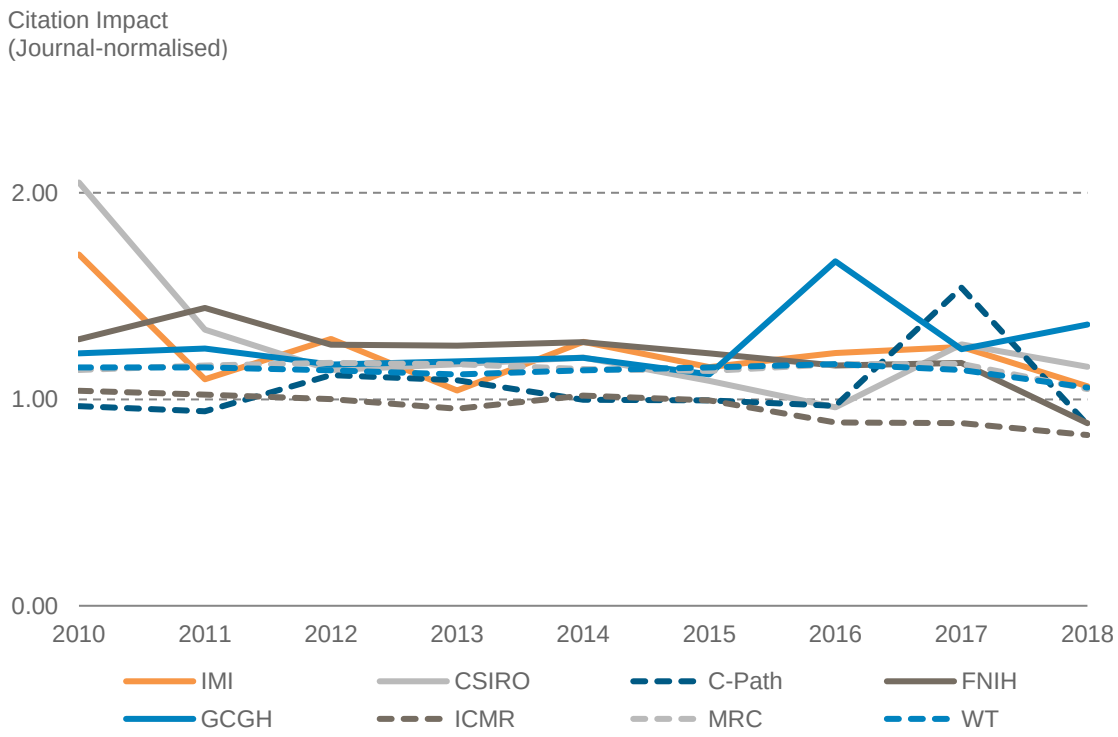
Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	3.04	3.21	2.95	2.21	1.76	0.77	1.83	2.01
2011	1.71	1.79	1.10	2.59	1.87	0.81	1.93	2.00
2012	2.11	1.49	1.34	1.78	1.48	0.77	1.87	2.02
2013	1.70	1.34	1.39	1.96	1.65	0.76	1.87	1.93
2014	2.03	1.42	1.29	1.94	1.61	0.73	1.84	2.01
2015	1.78	1.34	1.12	1.98	1.57	0.75	1.89	2.02
2016	1.83	1.22	0.92	1.73	2.48	0.70	1.89	2.09
2017	2.08	1.52	1.82	1.81	1.86	0.72	1.90	1.97
2018	1.87	1.44	1.14	1.21	1.84	0.72	1.74	2.05
Average	**1.84**	**1.57**	**1.38**	**1.82**	**1.74**	**0.74**	**1.86**	**2.01**

- In 2012, 2014 and 2017 IMI had the highest field-normalised citation impact (2.11, 2.03 and 2.08 respectively) of the funding organisations analysed.

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

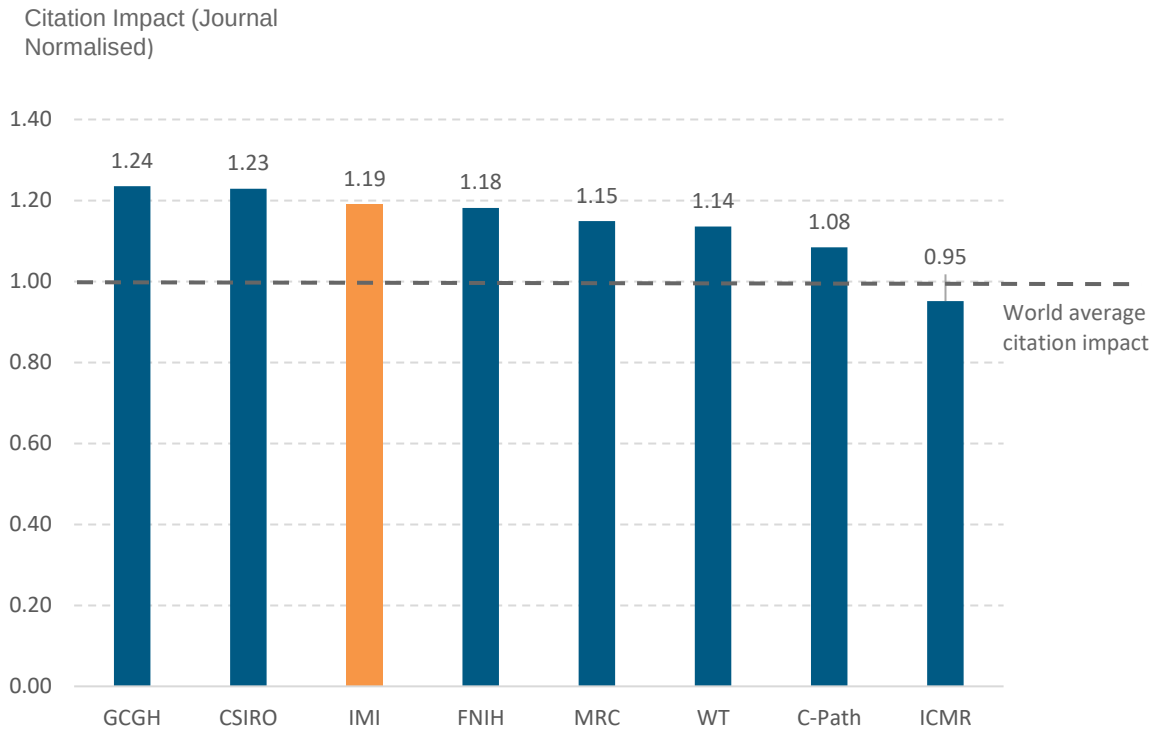
As discussed in Section 3, an alternative indicator to field-normalised citation impact (NCI_F) is citation impact normalised at the journal level (NCI_J). This is calculated by dividing the number of citations a paper received by the average number of citations for the year and the journal in which the paper is published. Figure 8.2.3.1 shows the annual trends in journal-normalised citation impact of IMI and the comparators between 2010 and 2018. Figure 8.2.2.2 shows the average field-normalised citation impact of IMI and the comparators between 2010 and 2018. Table 8.2.3.1 shows the same data as in Figure 8.2.3.1 and Figure 8.2.3.2.

FIGURE 8.2.3.1 TRENDS IN JOURNAL-NORMALISED CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- The journal-normalised citation impact of ICMR, MRC and WT remained relatively stable, while that of CSIRO and GCGH showed greater variability. This is to be expected given the smaller number of papers funded by CSIRO and GCGH relative to the output of more established research institutions like the MRC and WT.

FIGURE 8.2.3.2 AVERAGE JOURNAL-NORMALISED CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- IMI had the third highest average journal-normalised citation impact (1.19) between 2010 and 2018, below those of CSIRO and GCGH.

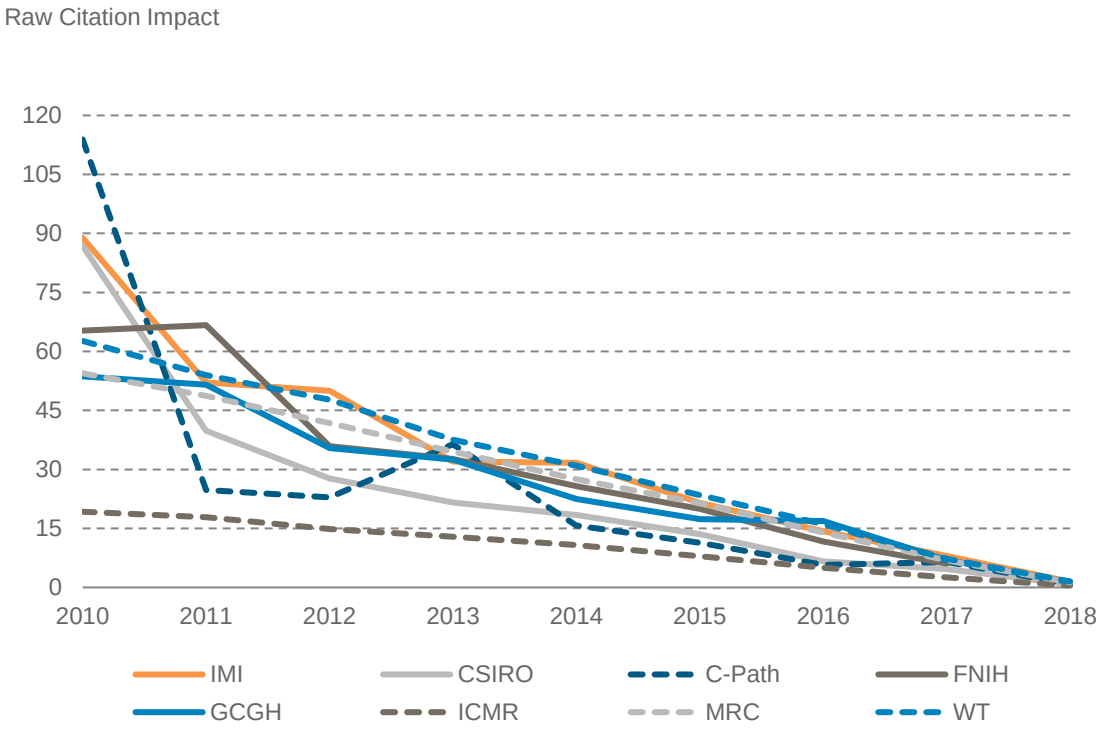
TABLE 8.2.3.1 JOURNAL-NORMALISED CITATION IMPACT (NCI_J) – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	1.70	2.05	0.97	1.29	1.22	1.04	1.14	1.15
2011	1.10	1.34	0.94	1.44	1.25	1.02	1.16	1.15
2012	1.29	1.14	1.12	1.26	1.17	1.00	1.18	1.14
2013	1.04	1.17	1.09	1.26	1.18	0.95	1.17	1.12
2014	1.28	1.20	1.00	1.28	1.20	1.02	1.15	1.14
2015	1.16	1.09	0.99	1.22	1.12	0.99	1.14	1.15
2016	1.22	0.96	0.97	1.16	1.67	0.89	1.17	1.17
2017	1.25	1.27	1.54	1.18	1.24	0.88	1.17	1.14
2018	1.06	1.16	0.88	0.88	1.36	0.83	1.05	1.06
Average	**1.19**	**1.23**	**1.08**	**1.18**	**1.24**	**0.95**	**1.15**	**1.14**

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

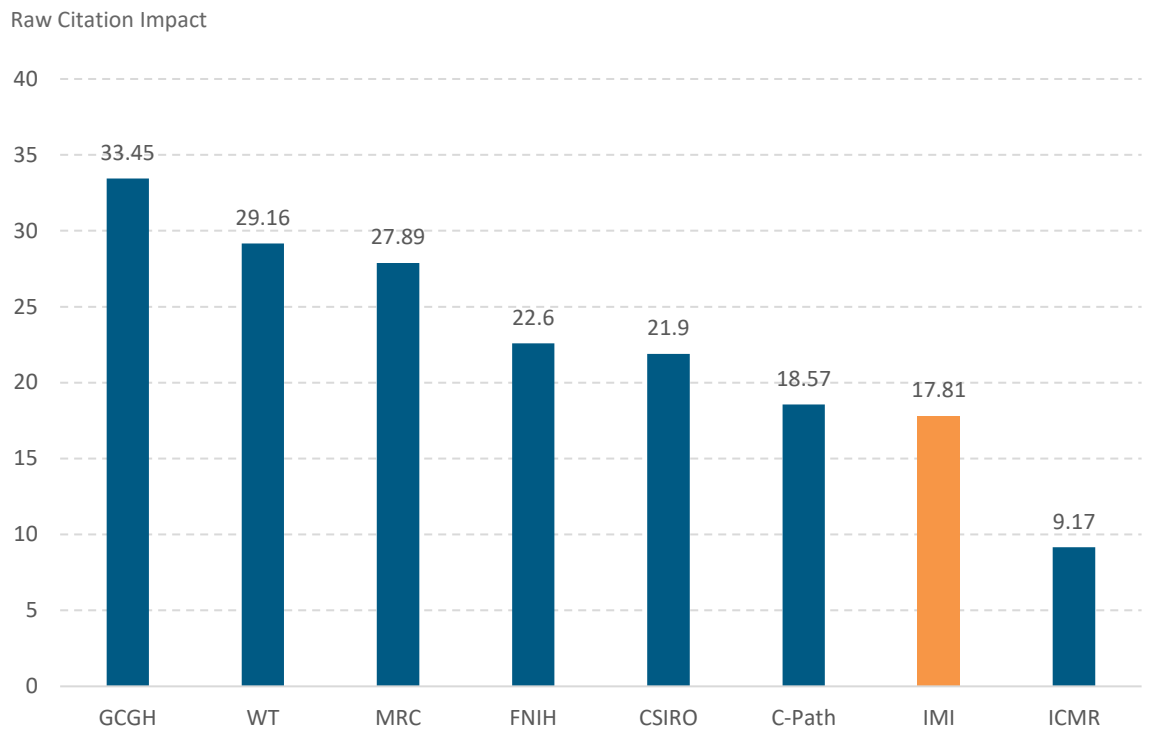
The raw (un-normalised) citation impact of a group of papers is calculated by dividing the sum of citations by the total number of papers published. This indicator must be used with caution as it is not normalised to field or year. Figure 8.2.4.1 shows the annual trends in average raw citation impact of IMI and the comparators for papers published each year between 2010 and 2018. Figure 8.2.4.2 shows the average raw citation impact of IMI and the comparators for papers published between 2010 and 2018.Table 8.2.4.1 has the same data as in Figure 8.2.4.1 and Figure 8.2.4.2.

FIGURE 8.2.4.1 TRENDS IN RAW CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- The raw citation impact of all organisations decreased from 2010 to 2018. This is expected as more recent publications have had less time to accumulate citations, and the raw citation impact is not normalised.
- IMI's 2018 raw citation impact (1.43) is only exceeded by the WT (1.52).

FIGURE 8.2.4.2 AVERAGE RAW CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- IMI's average raw citation impact (17.81) is similar to C-Path (18.57) and nearly double ICMR (9.17).

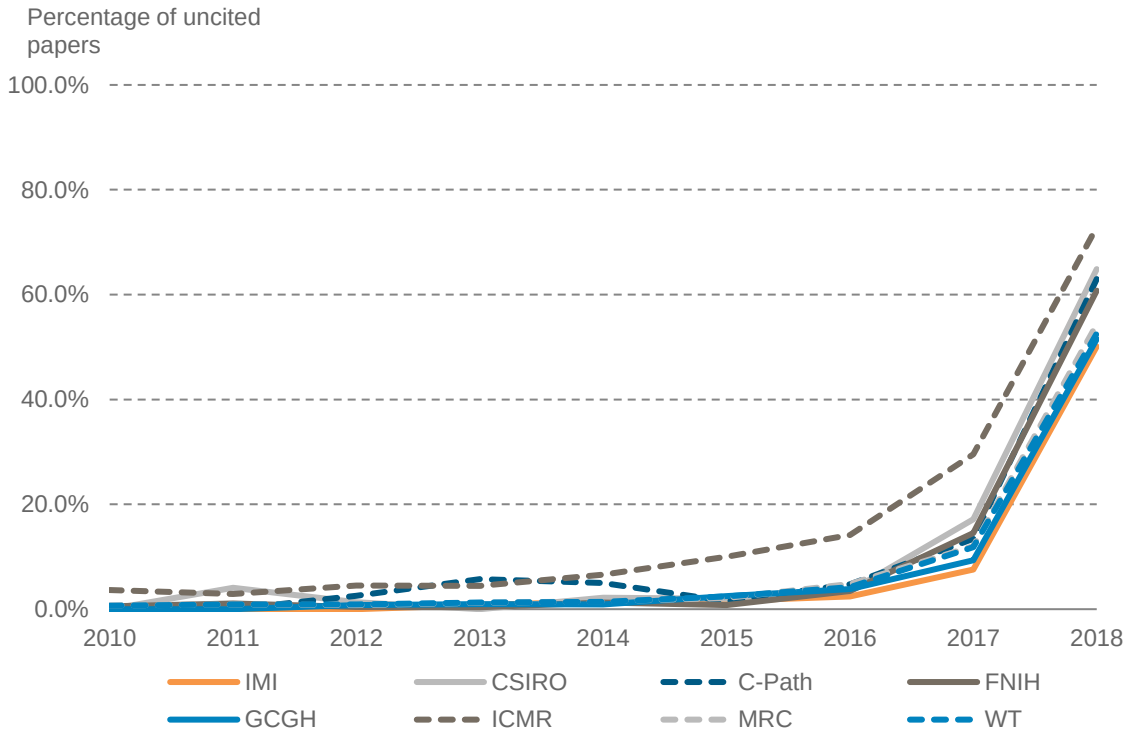
TABLE 8.2.4.1 RAW CITATION IMPACT – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	88.88	86.83	113.90	65.31	53.66	19.24	54.43	62.67
2011	52.09	39.80	24.75	66.68	51.53	17.83	48.67	53.95
2012	49.99	27.69	22.92	35.95	35.44	14.82	41.81	47.72
2013	32.00	21.57	36.37	32.70	32.49	12.91	34.52	37.51
2014	31.65	18.43	15.72	25.77	22.49	10.78	27.51	30.92
2015	21.53	13.54	11.32	19.98	17.36	7.91	21.36	23.44
2016	14.30	6.66	5.74	11.67	16.88	5.00	13.94	16.03
2017	8.00	4.63	6.43	6.06	6.93	2.52	6.84	7.27
2018	1.46	0.80	0.81	0.76	1.33	0.48	1.28	1.52
Average	**17.81**	**21.90**	**18.57**	**22.60**	**33.45**	**9.17**	**27.89**	**29.16**

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

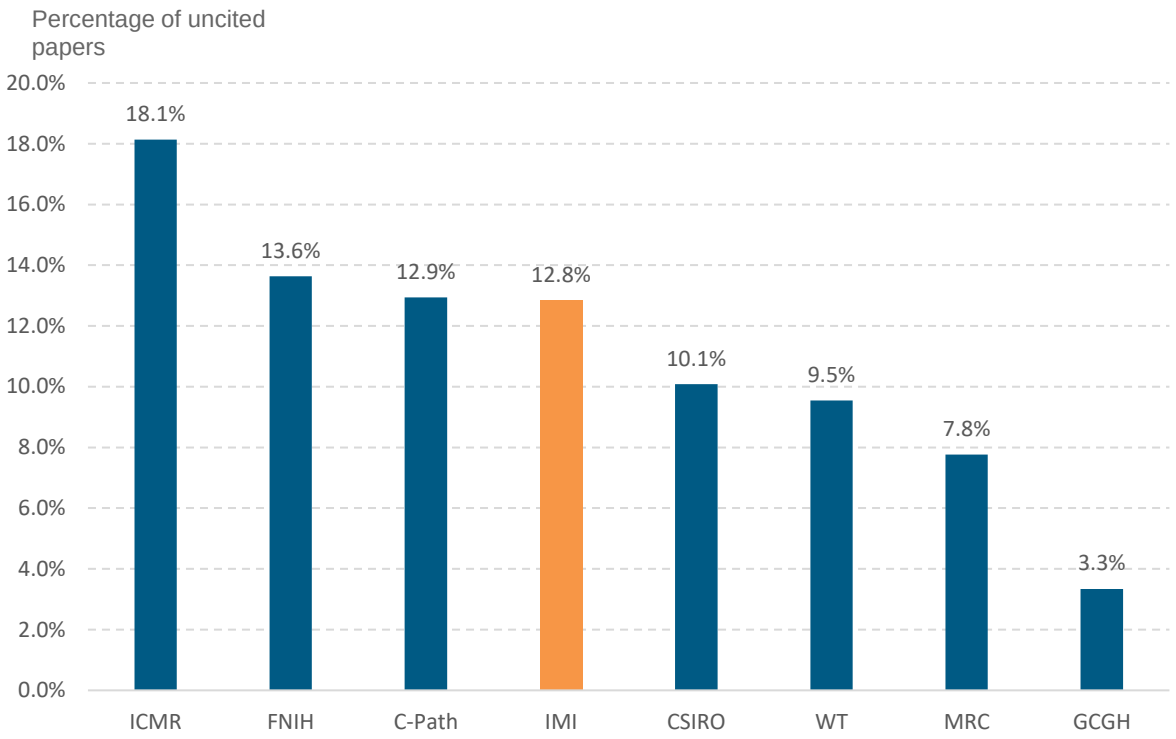
Most publication datasets will include papers which have no citations. Figure 8.2.5.1 shows the percentage of uncited papers between 2010 and 2018 for IMI and the selected comparators. Figure 8.2.5.1 shows the trend in average percentage of uncited papers between 2010 and 2018 for IMI and the selected comparators. Figure 8.2.5.2 shows the average percentage of uncited papers between 2010 and 2018 for IMI and the selected comparators. Table 8.2.5.1 has the same data as in Figure 8.2.5.1 and Figure 8.2.5.2.

FIGURE 8.2.5.1 TRENDS IN UNCITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- The similar trends in uncited papers indicate the similar citation life-cycle for biomedical research funded across all the benchmarking organisations. More recent publications are less likely to be cited than older publications. Therefore, the higher percentage of uncited papers in most recent years should not be taken as evidence that these articles are more likely to remain uncited.

FIGURE 8.2.5.1 AVERAGE PERCENTAGE OF UNCITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- Around 13% of papers published as a result of IMI project research were uncited, similar to the comparator organisations, with MRC and WT having a slightly lower proportion. GCGH is an exception; between 2010 and 2018 GCGH had less than 4% of papers uncited.

TABLE 8.2.5.1 PERCENTAGE OF UNCITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018

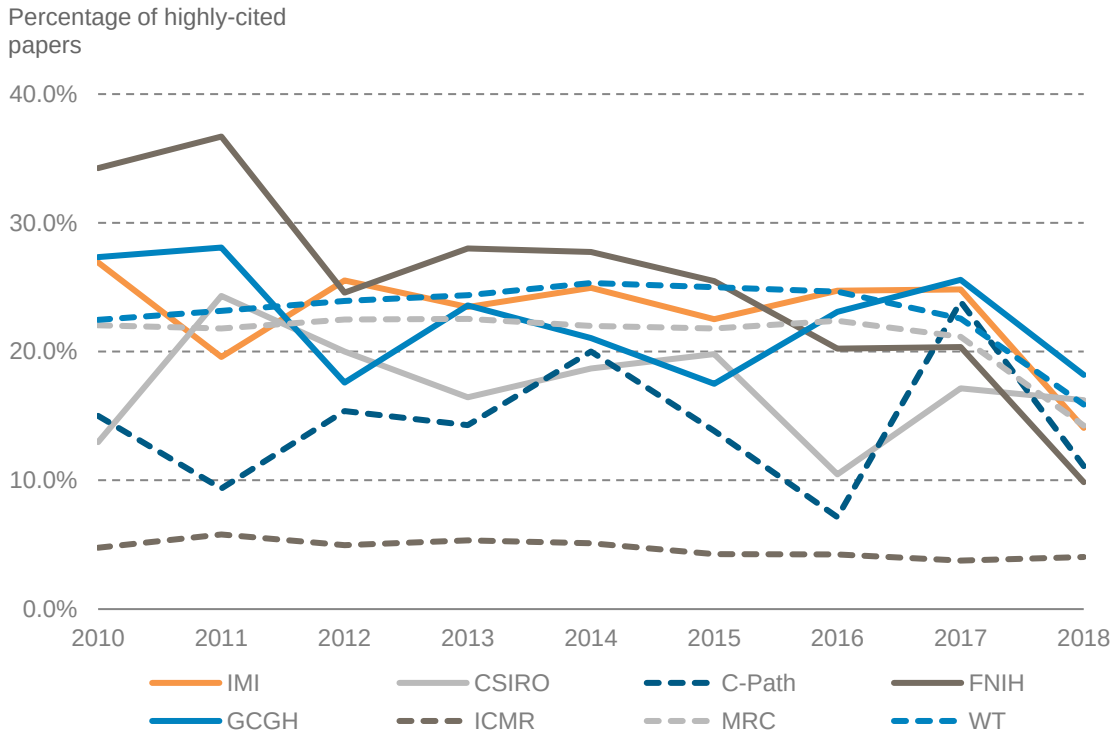
Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	0.0%	0.0%	0.0%	0.6%	0.0%	3.7%	0.7%	0.7%
2011	0.0%	4.1%	0.0%	1.1%	0.0%	2.9%	0.9%	0.9%
2012	0.0%	1.3%	2.6%	0.4%	0.8%	4.5%	0.8%	0.9%
2013	0.8%	0.0%	5.7%	0.4%	0.9%	4.5%	1.2%	1.3%
2014	1.5%	2.2%	5.0%	1.2%	0.9%	6.6%	1.5%	1.4%
2015	1.6%	2.0%	1.5%	0.8%	2.5%	10.0%	2.1%	2.4%
2016	2.5%	3.5%	4.8%	3.5%	3.8%	14.2%	4.8%	4.2%
2017	7.6%	17.1%	13.4%	14.5%	9.3%	29.5%	12.0%	11.8%
2018	50.1%	64.9%	63.0%	60.8%	51.5%	72.9%	54.3%	52.6%
Total	**12.8%**	**10.1%**	**12.9%**	**13.6%**	**3.3%**	**18.1%**	**7.8%**	**9.5%**

- No IMI project papers published between 2010 and 2012 are uncited. Its share of uncited research in the most recent year, 2018, is the lowest of the comparators.

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

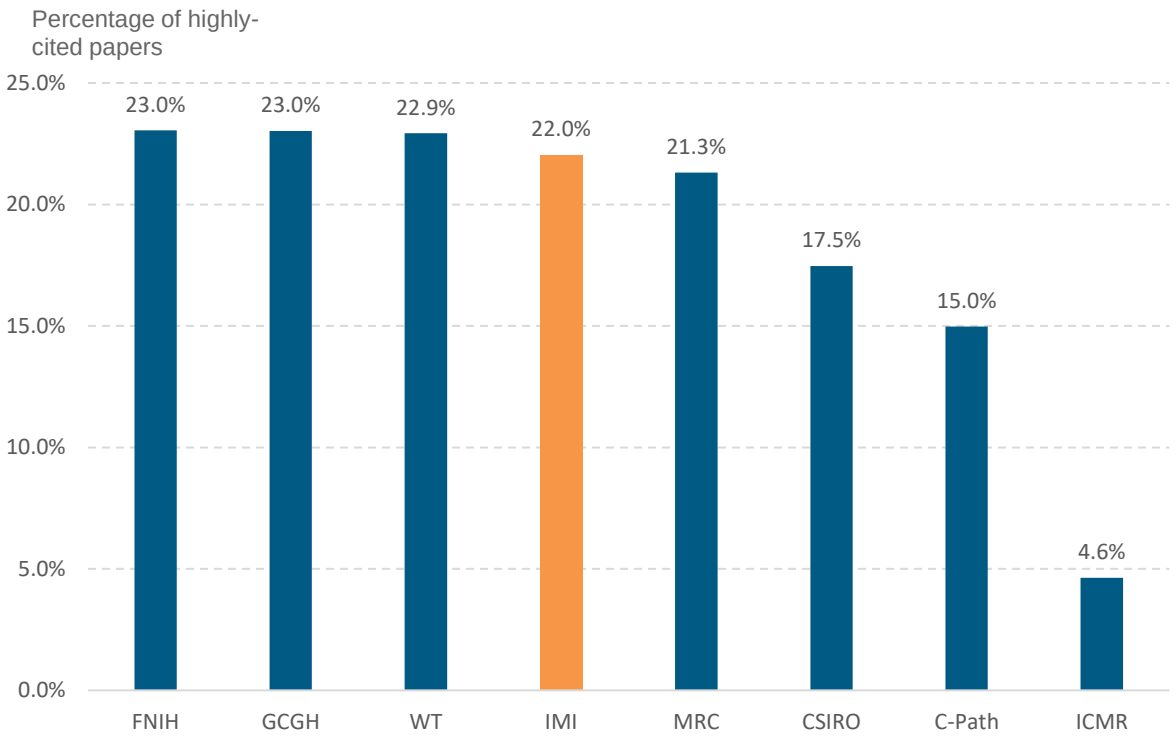
As discussed in Section 3, highly-cited work is recognised as having a greater impact, and Clarivate Analytics correlates this with other qualitative evaluations of research performance, such as peer review. For institutional research evaluation, we have found that the world's top 10% of most highly-cited papers is often a suitable definition of highly-cited work. Therefore, if more than 10% of an entity's publications are in the top 10% of the world's most highly-cited papers, then it has performed better than expected. Figure 8.2.6.1 shows the annual trends in percentage of highly-cited papers between 2010 and 2018 for IMI and the selected comparators. Figure 8.2.6.2 shows the total percentage of highly-cited papers between 2010 and 2018 for IMI and the selected comparators. Table 8.2.6.1 has the same data as in Figure 8.2.6.1 and Figure 8.2.6.2.

FIGURE 8.2.6.1 TRENDS IN HIGHLY CITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- In 2012, IMI had the highest share of highly-cited papers in the group. In 2016 it had the joint highest proportion of highly-cited papers, shared with WT.

FIGURE 8.2.6.2 PERCENTAGE OF HIGHLY CITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- Slightly less than one quarter of papers published by IMI and most of the comparators between 2010 and 2018 were highly cited. C-Path and CSIRO had slightly lower proportions of highly cited papers while ICMR was well below world average performance.

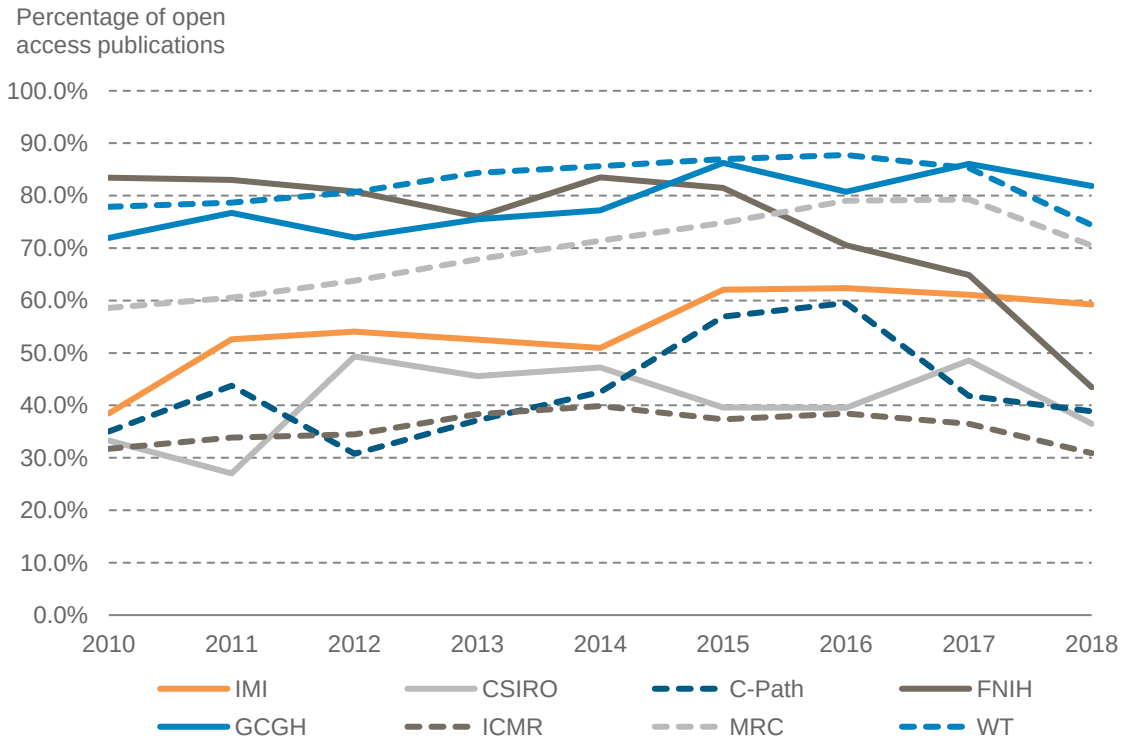
TABLE 8.2.6.1 PERCENTAGE OF HIGHLY CITED PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	26.9%	13.0%	15.0%	34.3%	27.3%	4.8%	22.0%	22.5%
2011	19.6%	24.3%	9.4%	36.7%	28.1%	5.8%	21.8%	23.2%
2012	25.5%	20.0%	15.4%	24.6%	17.6%	5.0%	22.5%	23.9%
2013	23.5%	16.5%	14.3%	28.0%	23.6%	5.3%	22.5%	24.4%
2014	24.9%	18.7%	20.0%	27.7%	21.1%	5.1%	22.0%	25.3%
2015	22.5%	19.8%	13.8%	25.5%	17.5%	4.3%	21.8%	25.0%
2016	24.7%	10.5%	7.1%	20.2%	23.1%	4.3%	22.4%	24.7%
2017	24.8%	17.1%	23.9%	20.4%	25.6%	3.8%	21.1%	22.6%
2018	14.1%	16.2%	11.1%	9.9%	18.2%	4.0%	14.3%	15.9%
Total	**22.0%**	**17.5%**	**15.0%**	**23.0%**	**23.0%**	**4.6%**	**21.3%**	**22.9%**

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

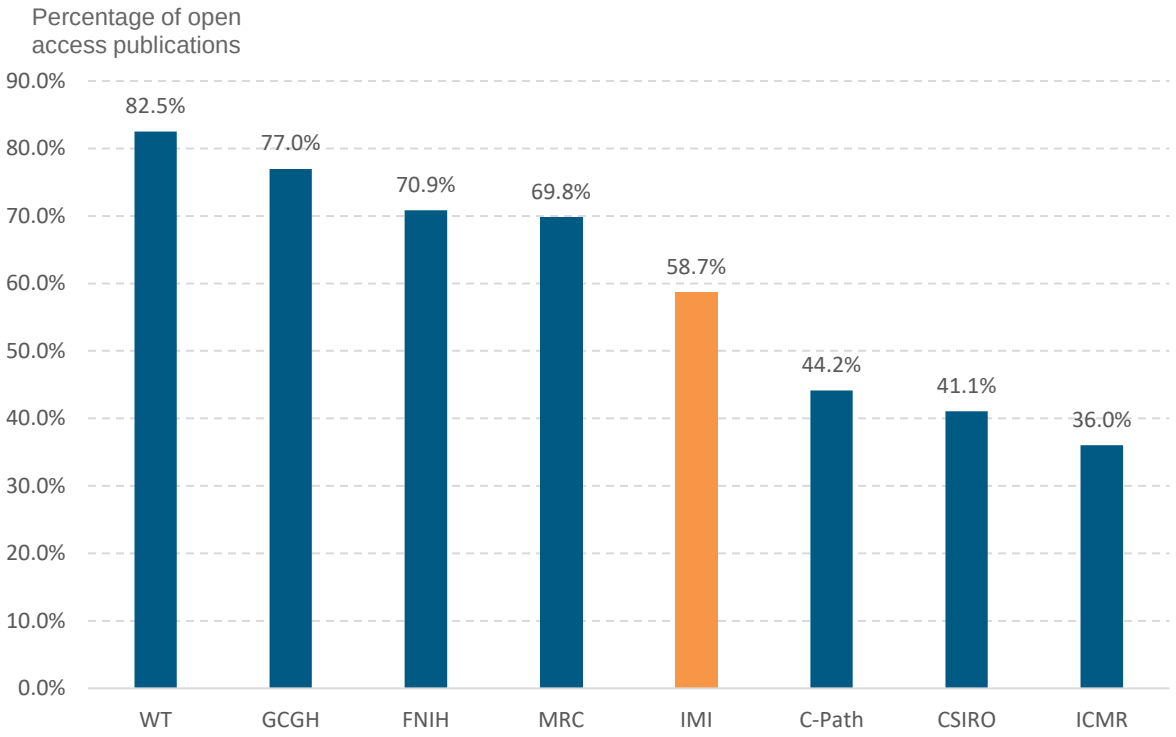
Figure 8.2.7.1 shows annual trends in the percentage of open access publications between 2010 and 2018 for IMI and the selected comparators. Figure 8.2.7.2 shows the total percentage of open access publications between 2010 and 2018 for IMI and the selected comparators. Table 8.2.7.1 shows the same data as in Figure 8.2.7.1 and Figure 8.2.7.2.

FIGURE 8.2.7.1 TRENDS IN OPEN ACCESS PUBLICATIONS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- IMI has slightly increased its percentage of open access publication between 2010 and 2018.

FIGURE 8.2.7.2 TOTAL PERCENTAGE OF OPEN ACCESS PUBLICATIONS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018



- The majority of organisations, including IMI, have published more than 40% of papers as open access. IMI had a 10% lower share of open access papers compared to FNIH, GCFH, MCR and WT.
- WT has the highest percentage of open access papers in all years between 2010 and 2018, with an average of 82.5% of all papers.

TABLE 8.2.7.1 PERCENTAGE OF OPEN ACCESS PAPERS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018

Year	IMI	CSIRO	C-Path	FNIH	GCGH	ICMR	MRC	WT
2010	38.5%	33.3%	35.0%	83.4%	71.9%	31.7%	58.6%	77.9%
2011	52.6%	27.0%	43.8%	83.0%	76.7%	33.9%	60.6%	78.7%
2012	54.0%	49.3%	30.8%	80.8%	72.0%	34.5%	63.8%	80.7%
2013	52.6%	45.6%	37.1%	76.0%	75.5%	38.3%	67.8%	84.3%
2014	51.0%	47.3%	42.5%	83.5%	77.2%	39.9%	71.4%	85.6%
2015	62.0%	39.6%	56.9%	81.5%	86.3%	37.4%	74.8%	87.0%
2016	62.4%	39.5%	59.5%	70.5%	80.8%	38.4%	79.0%	87.8%
2017	61.1%	48.6%	41.8%	64.9%	86.0%	36.5%	79.3%	85.3%
2018	59.2%	36.5%	38.9%	43.5%	81.8%	30.9%	70.5%	74.4%
Total	**58.7%**	**41.1%**	**44.2%**	**70.9%**	**77.0%**	**36.0%**	**69.8%**	**82.5%**

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

Even though IMI has only been funding research for around ten years, its performance is on par with well-established funding bodies that have been operating for decades, like the MRC and Wellcome Trust, as indicated by comparable citation impact, and percentage of highly-cited papers (Table 8.3.1).

TABLE 8.3.1 SUMMARY OF BIBLIOMETRIC INDICATORS – IMI PROJECT RESEARCH COMPARED WITH SELECTED COMPARATORS, 2010-2018

	Number of papers	Citation impact (normalised at field level)	Percentage of uncited papers	Percentage of highly-cited papers
IMI	4,555	1.84	12.8%	22.0%
CSIRO	704	1.57	10.1%	17.5%
C-Path	394	1.38	12.9%	15.0%
FNIH	2,868	1.82	13.6%	23.0%
GCGH	838	1.74	3.3%	23.0%
ICMR	11,198	0.74	18.1%	4.6%
MRC	86,787	1.86	7.8%	21.3%
WT	67,449	2.01	9.5%	22.9%
EU-28[20]	1,619,279	1.10	11.2%	12.7%
World	14,524,624	1.00	17.7%	10.0%

[20] EU-28 grouping of countries: Clarivate Analytics National Science Indicators 2018 database; similar research has been defined as including the same journal categories as in the IMI project dataset, as listed in Annex 2.

ANNEX 1: BIBLIOMETRICS AND CITATION ANALYSIS

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

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

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

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

The origins of citation analysis as a tool that could be applied to research performance can be traced to the mid-1950s, when Eugene Garfield proposed the concept of citation indexing and introduced the Science Citation Index, the Social Sciences Citation Index and the Arts & Humanities Citation Index, produced by the Institute of Scientific Information (now Clarivate Analytics).[21]

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

Data source

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

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

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

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

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

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

Database categories

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

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

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

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

Assigning papers to addresses

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

For example, a paper has five authors, thus:

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

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

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

Citation counts

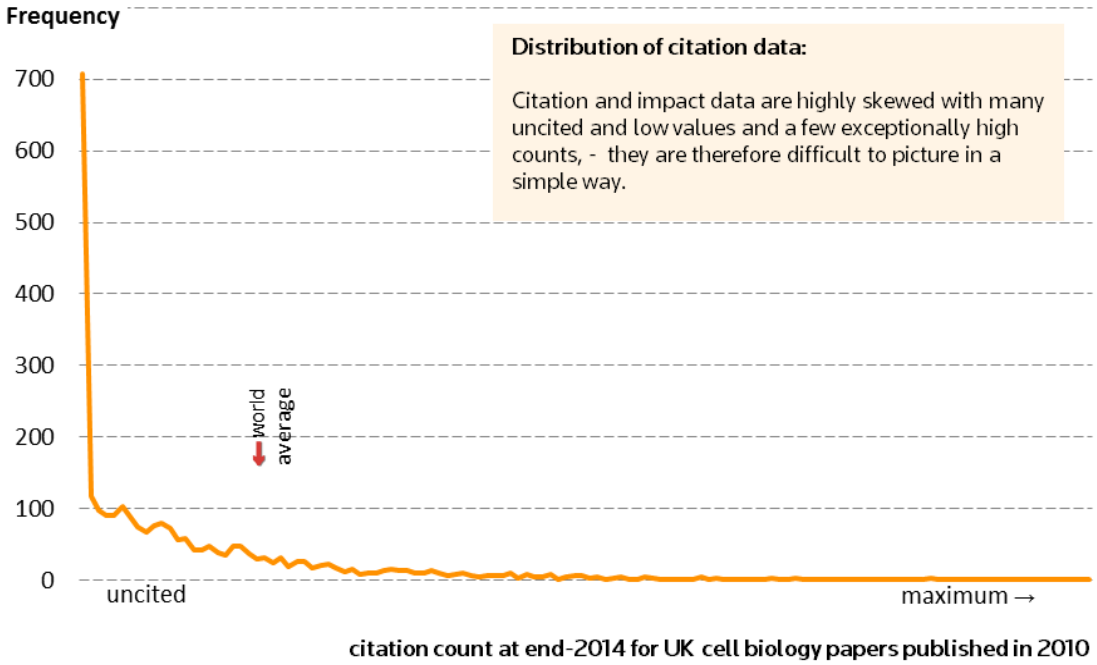
A publication accumulates citation counts when it is referred to by more recent publications. Some papers get cited frequently and many get cited rarely or never, so the distribution of citations is highly skewed.

Why are many papers never cited? Certainly some papers remain uncited because their content is of little or no impact, but that is not the only reason. It might be because they have been published in a

journal not read by researchers to whom the paper might be interesting. It might be that they represent important but 'negative' work reporting a blind alley to be avoided by others. The publication may be a commentary in an editorial, rather than a normal journal article and thus of general rather than research interest. Or it might be that the work is a 'sleeping beauty' that has yet to be recognised for its significance.

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

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



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

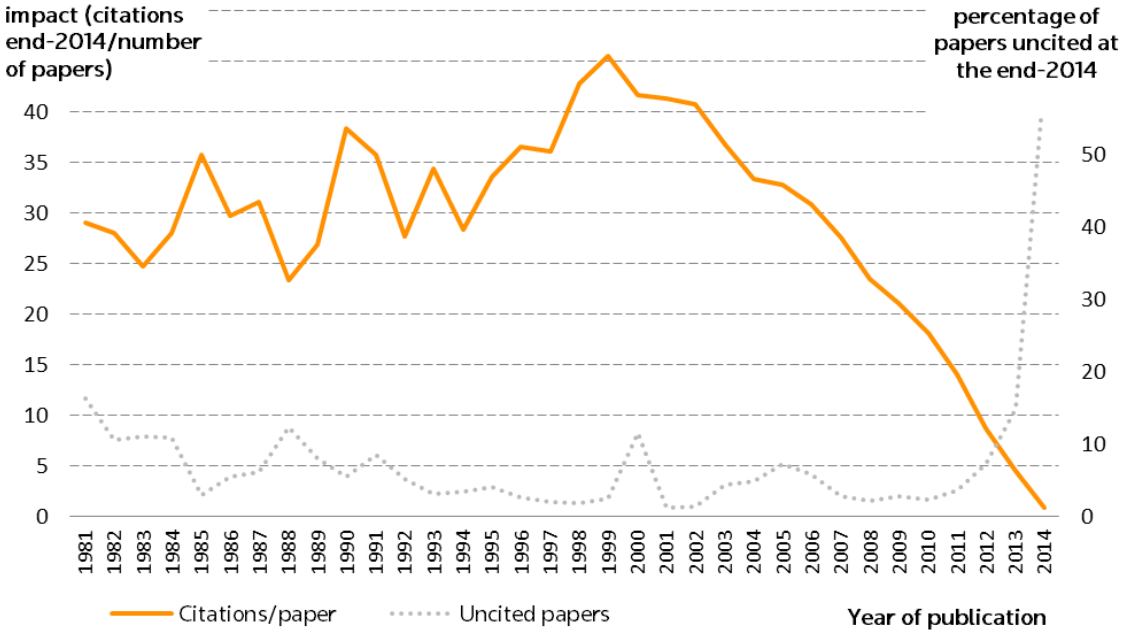
We do not seek to account separately for the effect of self-citation. If the citation count is significantly affected by self-citation then the paper is likely to have been infrequently cited. This is therefore only of consequence for low impact activity. Studies show that for large samples at national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

Time factors

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

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

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



Discipline factors

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

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

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

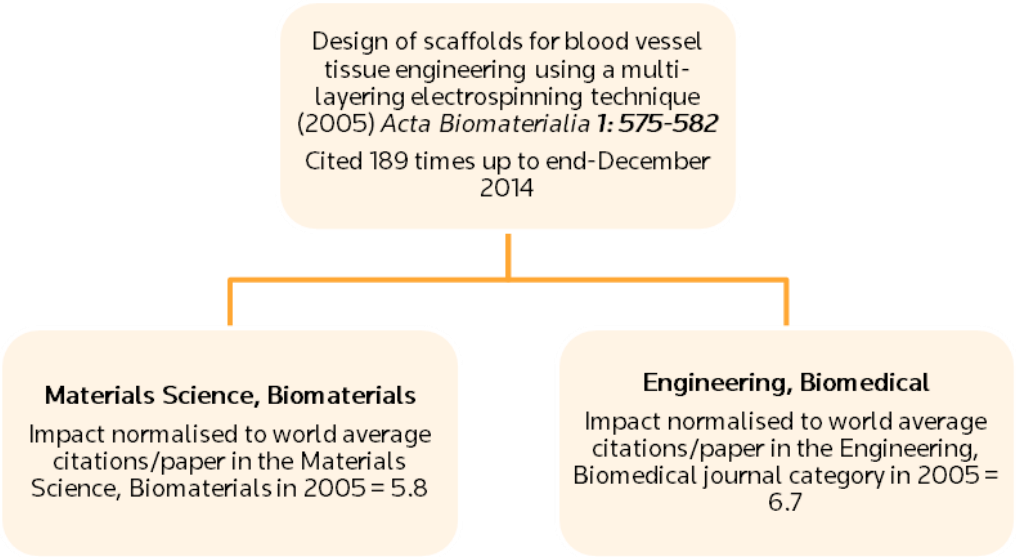
Very few papers are not assigned to any research field and as such will not be included in specific analyses using normalised citation impact data. The journals included in the Clarivate Analytics databases and how they are selected are detailed heremjl.clarivate.com/.
Some journals with a very diverse content, including the prestigious journals *Nature* and *Science* were classified as ***Multidisciplinary*** in databases created prior to 2007. The papers from these ***Multidisciplinary*** journals are now re-assigned to more specific research fields using an algorithm based on the research area(s) of the references cited by the article.

Normalised citation impact

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

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

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



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

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

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

Mean normalised citation impact

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

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

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

Impact Profiles®

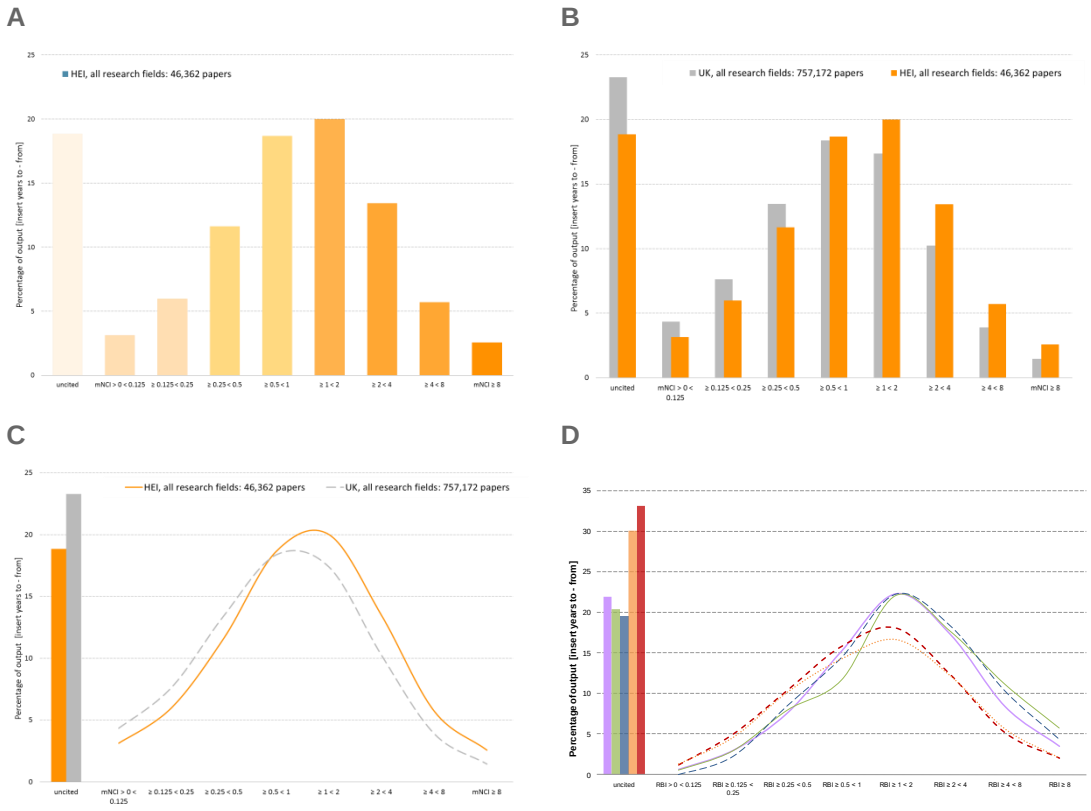
We have developed a bibliometric methodology[22] that shows the proportion of papers that are uncited and the proportion that lie in each of eight categories of relative citation rates, normalised (rebased) to world average. An Impact Profile® enables an examination and analysis of the strengths and weaknesses of published outputs relative to world average and relative to a reference profile. This provides much more information about the basis and structure of research performance than conventionally reported averages in citation indices.

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

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

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

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

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

Attention should be paid to:

- The proportion of uncited papers on the left of the chart
- The proportion of cited papers either side of world average (1.0)
- The location of the most common (modal) group near the centre
- The proportion of papers in the most highly-cited categories to the right, (≥4 x world, ≥8 x world).

What are uncited papers?

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

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

What is the threshold for 'highly cited'?

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

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

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

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

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

Journal category systems used in our analyses

WEB OF SCIENCE

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

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

Metallurgy & metallurgical engineering	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: BIOMEDICALLY 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: TOTAL NUMBER OF WEB OF SCIENCE PUBLICATIONS FROM IMI PROJECTS BETWEEN 2010 AND 2018 BY COUNTRY

Country	Number of publications
United Kingdom	1,921
Germany	1,476
Netherlands	1,099
USA	1,090
Sweden	829
France	790
Italy	607
Switzerland	598
Spain	509
Belgium	420
Denmark	347
Canada	290
Austria	268
Finland	209
Greece	157
Australia	128
China	121
Ireland	107
Poland	103
Norway	99
Japan	88
Israel	61
Portugal	61
Brazil	60
Estonia	46
South Africa	43
Hungary	37
Singapore	30
Saudi Arabia	29
Czech Republic	28
Taiwan	26
Iceland	26
Luxembourg	23
Cyprus	23
India	23
Turkey	23
South Korea	21
Croatia	20
New Zealand	19

Country	Number of publications
Slovenia	18
Argentina	17
Russia	12
Egypt	12
Iran	11
Qatar	11
Romania	11
Serbia	11
Thailand	8
Lebanon	7
Bulgaria	7
Tanzania	5
Lithuania	5
Mexico	5
Malta	4
Kuwait	4
Uruguay	4
Ukraine	4
Nigeria	4
Tunisia	4
Kenya	4
Chile	3
Latvia	3
Vietnam	3
Macedonia	3
Pakistan	3
Sierra Leone	3
Uganda	2
Malaysia	2
Oman	2
Peru	2
Gabon	2
Slovakia	2
Sri Lanka	2
Bosnia & Herzeg	2
Ecuador	1
Morocco	1
Cote Ivoire	1
Cook Islands	1
Colombia	1
Ghana	1
Moldova	1
Cameroon	1
Guadeloupe	1

Country	Number of publications
Botswana	1
Philippines	1
Guinea	1
Algeria	1
Malawi	1
U Arab Emirates	1
Liberia	1
Bolivia	1
Iraq	1
Jordan	1
Ethiopia	1
Uzbekistan	1
Belarus	1

ANNEX 4: TOTAL NUMBER OF WEB OF SCIENCE PUBLICATIONS, PAPER AND OPEN-ACCESS PUBLICATIONS FROM IMI PROJECTS BETWEEN 2010 AND 2018 BY PROJECT

Project	Number of publications	Number of papers	Number of open access publications	% of open access publications
BTCure	645	603	388	60.2
EU-AIMS	346	337	220	63.6
EMIF	229	214	157	68.6
NEWMEDS	187	183	96	51.3
ULTRA-DD	182	177	107	58.8
EUROPAIN	167	167	49	29.3
IMIDIA	141	132	102	72.3
ORBITO	130	128	26	20.0
CHEM21	119	116	32	26.9
TRANSLOCATION	116	116	59	50.9
U-BIOPRED	112	68	33	29.5
SUMMIT	110	107	75	68.2
MIP-DILI	105	98	55	52.4
CANCER-ID	105	90	61	58.1
STEMBANCC	103	100	76	73.8
ELF	103	102	47	45.6
PROTECT	97	95	37	38.1
PreDiCT-TB	95	91	73	76.8
eTOX	95	91	57	60.0
Quic-Concept	94	93	65	69.1
Pharma-Cog	76	70	21	27.6
DDMoRe	76	71	48	63.2
Open PHACTS	73	70	59	80.8
ABIRISK	70	56	29	41.4
COMPACT	70	70	26	37.1
DIRECT	68	47	34	50.0
SPRINTT	65	63	26	40.0
INNODIA	64	55	34	53.1
BioVacSafe	60	58	42	70.0
Onco Track	57	53	34	59.6
COMBACTE-NET	56	53	37	66.1
K4DD	53	53	29	54.7
MARCAR	53	52	38	71.7
COMBACTE-MAGNET	48	40	29	60.4
AETIONOMY	46	45	33	71.7
Predect	43	40	31	72.1
PRECISESADS	42	27	20	47.6
DRIVE-AB	41	35	29	70.7

Project	Number of publications	Number of papers	Number of open access publications	% of open access publications
RAPP-ID	41	40	21	51.2
GETREAL	40	34	23	57.5
eTRIKS	35	30	23	65.7
BEAT-DKD	34	33	26	76.5
ZAPI	31	29	27	87.1
COMBACTE-CARE	31	28	18	58.1
PROACTIVE	31	26	21	67.7
iPiE	28	27	17	60.7
RADAR-CNS	27	11	7	25.9
APPROACH	27	22	14	51.9
FLUCOP	25	25	18	72.0
ND4BB	25	25	15	60.0
ENABLE	23	23	16	69.6
EPAD	22	18	10	45.5
SAFE-T	20	18	5	25.0
EBiSC	19	15	13	68.4
EHR4CR	19	17	11	57.9
RHAPSODY	19	15	10	52.6
EBOVAC1	17	15	15	88.2
iABC	16	6	5	31.3
COMBACTE	16	15	9	56.3
IMPRiND	15	15	10	66.7
HARMONY	15	5	7	46.7
RTCure	15	15	12	80.0
EbolaMoDRAD	15	14	9	60.0
ADVANCE	13	12	9	69.2
ROADMAP	12	8	6	50.0
VSV-EBOVAC	10	9	4	40.0
ADAPTED	10	9	8	80.0
WEB-RADR	10	9	7	70.0
BigData@Heart	9	8	7	77.8
EBOVAC2	7	7	7	100.0
PRISM	7	7	4	57.1
PHAGO	7	7	7	100.0
PREFER	7	0	1	14.3
VSV-EBOPLUS	7	6	2	28.6
AMYPAD	7	4	4	57.1
EUPATI	7	6	7	100.0
TransQST	6	6	4	66.7
SafeSciMET	5	4	2	40.0
AIMS-2-TRIALS	4	3	3	75.0
eTRANSAFE	4	4	3	75.0
TRISTAN	3	3	3	100.0
Eu2P	3	3	1	33.3

Project	Number of publications	Number of papers	Number of open access publications	% of open access publications
DRIVE	3	2	2	66.7
RESCEU	3	2	3	100.0
LITMUS	2	0	1	50.0
EQIPD	2	0	1	50.0
MACUSTAR	2	1	1	50.0
EMTRAIN	2	1	0	0.0
PERISCOPE	2	2	2	100.0
ADAPT-SMART	2	2	0	0.0
FILODIAG	1	0	1	100.0
Pharmatrain	1	1	1	100.0
Ebola+	1	1	0	0.0
c4c	1	0	1	100.0
VAC2VAC	1	1	0	0.0
EBODAC	1	1	1	100.0

ANNEX 5: COLLABORATION INDEX FOR ALL IMI SUPPORTED RESEARCH PROJECTS

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

Project	X-sector score	International score	Stability score	Collaboration Index	Total papers	Citation impact (field-normalised)
BTCure	0.63	0.50	0.79	1.93	603	2.10
EU-AIMS	0.68	0.64	0.74	2.05	337	2.41
EMIF	0.79	0.66	0.80	2.26	214	3.21
NEWMEDS	0.64	0.58	0.77	1.99	183	2.35
ULTRA-DD	0.62	0.64	0.70	1.97	177	2.33
EUROPAIN	0.54	0.36	0.83	1.73	167	2.37
IMIDIA	0.52	0.49	0.81	1.83	132	1.70
ORBITO	0.59	0.46	0.70	1.75	128	1.93
TRANSLOCATION	0.32	0.50	0.78	1.59	116	1.72
CHEM21	0.23	0.30	0.72	1.25	116	1.94
SUMMIT	0.73	0.64	0.76	2.13	107	1.65
ELF	0.37	0.50	0.66	1.53	102	1.40
STEMBANCC	0.55	0.49	0.83	1.87	100	2.17
MIP-DILI	0.66	0.45	0.79	1.91	98	2.01
PROTECT	0.98	0.64	0.82	2.44	95	1.08
Quic-Concept	0.75	0.58	0.76	2.09	93	3.00
PreDiCT-TB	0.55	0.52	0.86	1.93	91	1.80
eTOX	0.29	0.36	0.83	1.47	91	1.67
CANCER-ID	0.73	0.42	0.62	1.77	90	3.81
DDMoRe	0.62	0.54	0.76	1.92	71	1.27
Pharma-Cog	0.84	0.74	0.82	2.40	70	1.36
Open PHACTS	0.60	0.56	0.77	1.93	70	3.43
COMPACT	0.23	0.40	0.63	1.26	70	2.21
U-BIOPRED	0.78	0.64	0.86	2.28	68	2.63
SPRINTT	0.57	0.54	0.74	1.85	63	2.50
BioVacSafe	0.43	0.43	0.70	1.56	58	1.63
ABIRISK	0.75	0.41	0.82	1.98	56	1.61
INNODIA	0.78	0.66	0.92	2.36	55	2.13
K4DD	0.53	0.53	0.82	1.88	53	2.27
COMBACTE-NET	0.70	0.50	0.75	1.96	53	1.35
Onco Track	0.60	0.43	0.80	1.83	53	2.48
MARCAR	0.44	0.44	0.77	1.65	52	1.21
DIRECT	0.77	0.68	0.77	2.21	52	3.09
AETIONOMY	0.62	0.39	0.74	1.75	47	1.90
COMBACTE-MAGNET	0.65	0.66	0.70	2.01	45	2.20
Predect	0.68	0.60	0.76	2.03	40	2.07
RAPP-ID	0.33	0.41	0.83	1.56	40	0.98
DRIVE-AB	0.71	0.62	0.73	2.07	40	2.32

Project	X-sector score	International score	Stability score	Collaboration Index	Total papers	Citation impact (field-normalised)
GETREAL	0.88	0.76	0.61	2.26	35	2.39
BEAT-DKD	0.76	0.70	0.00	1.46	34	1.48
eTRIKS	0.83	0.86	0.67	2.37	33	2.97
ZAPI	0.66	0.63	0.54	1.83	30	1.93
COMBACTE-CARE	0.96	0.73	0.58	2.28	29	2.57
PRECISESADS	0.74	0.68	0.57	1.98	28	1.35
iPiE	0.59	0.25	0.66	1.50	27	1.61
PROACTIVE	1.00	0.79	0.82	2.61	27	1.92
FLUCOP	0.92	0.58	0.55	2.05	26	2.10
ND4BB	0.48	0.44	0.81	1.73	25	1.47
ENABLE	0.48	0.48	0.77	1.73	25	1.50
APPROACH	0.82	0.85	0.62	2.29	23	2.49
EPAD	0.78	0.68	0.62	2.08	22	2.11
SAFE-T	0.94	0.53	0.83	2.30	18	1.26
EHR4CR	0.94	0.65	0.67	2.26	18	1.08
EBiSC	0.67	0.68	0.79	2.14	17	12.13
RHAPSODY	0.60	0.63	0.64	1.88	15	3.27
EBOVAC1	0.53	0.58	0.57	1.69	15	3.06
IMPRiND	0.40	0.52	0.00	0.92	15	7.07
RTCure	0.40	0.47	0.00	0.87	15	3.04
COMBACTE	0.47	0.12	0.77	1.35	15	2.18
EbolaMoDRAD	0.57	0.55	0.56	1.68	15	2.15
ADVANCE	0.75	0.83	0.78	2.36	14	1.95
RADAR-CNS	0.36	0.64	0.56	1.56	12	1.49
ADAPTED	0.89	0.81	0.00	1.69	11	3.29
WEB-RADR	0.89	0.81	0.83	2.53	9	2.42
VSV-EBOVAC	0.44	0.56	0.46	1.46	9	1.62
BigData@Heart	0.88	0.78	0.00	1.66	9	1.58
ROADMAP	0.88	0.81	0.00	1.69	8	3.49
PHAGO	0.71	0.86	0.00	1.57	8	2.11
EBOVAC2	0.43	0.68	0.00	1.11	7	1.71
PRISM	0.71	0.64	0.00	1.36	7	3.33
EUPATI	1.00	1.00	0.72	2.72	7	0.71
iABC	0.83	0.58	0.78	2.19	6	2.12
VSV-EBOPLUS	0.50	0.50	0.00	1.00	6	1.36
TransQST	0.50	0.46	0.00	0.96	6	2.69
HARMONY	1.00	0.90	0.00	1.90	6	1.93
SafeSciMET	1.00	1.00	0.00	2.00	5	0.85
AMYPAD	0.75	0.50	0.00	1.25	4	1.82
eTRANSAFE	0.25	0.25	0.00	0.50	4	0.79
TRISTAN	0.67	0.83	0.00	1.50	4	1.04
Eu2P	0.33	0.67	0.00	1.00	3	1.88
AIMS-2-TRIALS	0.33	0.58	0.00	0.92	3	0.61

Project	X-sector score	International score	Stability score	Collaboration Index	Total papers	Citation impact (field-normalised)
ADAPT-SMART	1.00	0.50	0.00	1.50	3	0.67
RESCEU	1.00	0.38	0.00	1.38	2	0.00
DRIVE	1.00	0.50	0.00	1.50	2	0.77
PERISCOPE	0.00	0.00	0.00	0.00	2	0.00
EBODAC	0.00	1.00	0.00	1.00	1	0.51
Ebola+	1.00	1.00	0.00	2.00	1	3.62
EMTRAIN	1.00	1.00	0.00	2.00	1	0.07
VAC2VAC	1.00	1.00	0.00	2.00	1	0.00
MACUSTAR	0.00	0.00	0.00	0.00	1	0.00
c4c	0.00	0.00	0.00	0.00	0	0.00
EQIPD	0.00	0.00	0.00	0.00	0	0.00
LITMUS	0.00	0.00	0.00	0.00	0	0.00
PREFER	0.00	0.00	0.00	0.00	0	0.00
FILODIAG	0.00	0.00	0.00	0.00	0	0.00

ANNEX 6: BIBLIOGRAPHY OF HOT PAPERS AND HIGHLY-CITED PAPERS

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

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

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

HOT PAPERS ASSOCIATED WITH IMI PROJECTS

CANCER-ID: Siravegna, G et al. Integrating liquid biopsies into the management of cancer, NATURE REVIEWS CLINICAL ONCOLOGY 14: 531-548
COMBACTE-CARE: Rodriguez-Bano, J et al. Treatment of Infections Caused by Extended-Spectrum-Beta-Lactamase-, AmpC-, and Carbapenemase-Producing Enterobacteriaceae, CLINICAL MICROBIOLOGY REVIEWS 31
EBiSC: Zerbino, DR et al. Ensembl 2018, NUCLEIC ACIDS RESEARCH 46: D754-D761
EMIF: Frisoni, GB et al. Strategic roadmap for an early diagnosis of Alzheimer's disease based on biomarkers, LANCET NEUROLOGY 16: 661-676
EMIF: Lewczuk, P et al. Cerebrospinal fluid and blood biomarkers for neurodegenerative dementias: An update of the Consensus of the Task Force on Biological Markers in Psychiatry of the World Federation of Societies of Biological Psychiatry, WORLD JOURNAL OF BIOLOGICAL PSYCHIATRY 19: 244-328
IMPRiND: Fitzpatrick, AWP et al. Cryo-EM structures of tau filaments from Alzheimer's disease, NATURE 547: 185-+
IMPRiND: Falcon, B et al. Structures of filaments from Pick's disease reveal a novel tau protein fold, NATURE 561: 137-+
Open PHACTS: Gaulton, A et al. The ChEMBL database in 2017, NUCLEIC ACIDS RESEARCH 45: D945-D954
Quic-Concept: O'Connor, JPB et al. Imaging biomarker roadmap for cancer studies, NATURE REVIEWS CLINICAL ONCOLOGY 14: 169-186
Quic-Concept: Lambin, P et al. Radiomics: the bridge between medical imaging and personalized medicine, NATURE REVIEWS CLINICAL ONCOLOGY 14: 749-762
RHAPSODY: Falcon, B et al. Structures of filaments from Pick's disease reveal a novel tau protein fold, NATURE 561: 137-+
Visscher, PM et al. 10 Years of GWAS Discovery: Biology, Function, and Translation, AMERICAN JOURNAL OF HUMAN GENETICS 101: 5-22
Ahlqvist, E et al. Novel subgroups of adult-onset diabetes and their association with outcomes: a data-driven cluster analysis of six variables, LANCET DIABETES & ENDOCRINOLOGY 6: 361-369

HIGHLY-CITED PAPERS ASSOCIATED WITH IMI PROJECTS

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

ABIRISK: Kieseier, BC et al. Disease Amelioration With Tocilizumab in a Treatment-Resistant Patient With Neuromyelitis Optica Implication for Cellular Immune Responses, JAMA NEUROLOGY 70: 390-393

ABIRISK: Wenniger, LJMD et al. Immunoglobulin G4+clones identified by next-generation sequencing dominate the B cell receptor repertoire in immunoglobulin G4 associated cholangitis, HEPATOLOGY 57: 2390-2398

ABIRISK: Warnke, C et al. Changes to anti-JCV antibody levels in a Swedish national MS cohort, JOURNAL OF NEUROLOGY NEUROSURGERY AND PSYCHIATRY 84: 1199-1205

ABIRISK: Shankar, G et al. Assessment and Reporting of the Clinical Immunogenicity of Therapeutic Proteins and Peptides-Harmonized Terminology and Tactical Recommendations, AAPS JOURNAL 16: 658-673

ABIRISK: Ungar, B et al. The temporal evolution of antidrug antibodies in patients with inflammatory bowel disease treated with infliximab, GUT 63: 1258-1264

ABIRISK: Warnke, C et al. Cerebrospinal Fluid JC Virus Antibody Index for Diagnosis of Natalizumab-Associated Progressive Multifocal Leukoencephalopathy, ANNALS OF NEUROLOGY 76: 792-801

ABIRISK: Hemmer, B et al. Role of the innate and adaptive immune responses in the course of multiple sclerosis, LANCET NEUROLOGY 14: 406-419

ABIRISK: Warnke, C et al. Natalizumab exerts a suppressive effect on surrogates of B cell function in blood and CSF, MULTIPLE SCLEROSIS JOURNAL 21: 1036-1044

ABIRISK: Ringelstein, M et al. Long-term Therapy With Interleukin 6 Receptor Blockade in Highly Active Neuromyelitis Optica Spectrum Disorder, JAMA NEUROLOGY 72: 756-763

ABIRISK: Diebold, M et al. Dimethyl fumarate influences innate and adaptive immunity in multiple sclerosis, JOURNAL OF AUTOIMMUNITY 86: 39-50

ADAPTED: van der Lee, SJ et al. The effect of &ITAPOE&IT and other common genetic variants on the onset of Alzheimer's disease and dementia: a community-based cohort study, LANCET NEUROLOGY 17: 434-444

ADAPTED: Wevers, NR et al. A perfused human blood-brain barrier on-a-chip for high-throughput assessment of barrier function and antibody transport, FLUIDS AND BARRIERS OF THE CNS 15:

ADVANCE: Pebody, R et al. Effectiveness of seasonal influenza vaccine for adults and children in preventing laboratory-confirmed influenza in primary care in the United Kingdom: 2015/16 end-of-season results, EUROSURVEILLANCE 21: 41-51

ADVANCE: Lehtinen, M et al. Impact of gender-neutral or girls-only vaccination against human papillomavirus-Results of a community-randomized clinical trial (I), INTERNATIONAL JOURNAL OF CANCER 142: 949-958

AETIONOMY: Molinuevo, JL et al. White matter changes in preclinical Alzheimer's disease: a magnetic resonance imaging-diffusion tensor imaging study on cognitively normal older people with positive amyloid beta protein 42 levels, NEUROBIOLOGY OF AGING 35: 2671-2680

AETIONOMY: Gispert, JD et al. CSF YKL-40 and pTau181 are related to different cerebral morphometric patterns in early AD, NEUROBIOLOGY OF AGING 38: 47-55

AETIONOMY: Auffray, C et al. Making sense of big data in health research: Towards an EU action plan, GENOME MEDICINE 8:

AETIONOMY: Gispert, JD et al. Cerebrospinal fluid sTREM2 levels are associated with gray matter volume increases and reduced diffusivity in early Alzheimer's disease, ALZHEIMERS & DEMENTIA 12: 1259-1272

AETIONOMY: Kaut, O et al. Epigenome-wide DNA methylation analysis in siblings and monozygotic twins discordant for sporadic Parkinson's disease revealed different epigenetic patterns in peripheral blood mononuclear cells, NEUROGENETICS 18: 7-22

AETIONOMY: Gautier, CA et al. The endoplasmic reticulum-mitochondria interface is perturbed in PARK2 knockout mice and patients with PARK2 mutations, HUMAN MOLECULAR GENETICS 25: 2972-2984

AETIONOMY: Bedarf, JR et al. Functional implications of microbial and viral gut metagenome changes in early stage L-DOPA-naive Parkinson's disease patients, GENOME MEDICINE 9:

AETIONOMY: Brosseron, F et al. Characterization and clinical use of inflammatory cerebrospinal fluid protein markers in Alzheimer's disease, ALZHEIMERS RESEARCH & THERAPY 10:

AMYPAD: Tur, C et al. Assessing treatment outcomes in multiple sclerosis trials and in the clinical setting, NATURE REVIEWS NEUROLOGY 14: 75-93

APPROACH: Rahmati, M et al. Inflammatory mediators in osteoarthritis: A critical review of the state-of-the-art, current prospects, and future challenges, BONE 85: 81-90

APPROACH: Richardson, SM et al. Mesenchymal stem cells in regenerative medicine: Focus on articular cartilage and intervertebral disc regeneration, METHODS 99: 69-80

APPROACH: Mobasheri, A et al. Osteoarthritis Year in Review 2016: biomarkers (biochemical markers), OSTEOARTHRITIS AND CARTILAGE 25: 199-208

APPROACH: Mobasheri, A et al. The role of metabolism in the pathogenesis of osteoarthritis, NATURE REVIEWS RHEUMATOLOGY 13: 302-311

APPROACH: Rahmati, M et al. Aging and osteoarthritis: Central role of the extracellular matrix, AGEING RESEARCH REVIEWS 40: 20-30

APPROACH: Henrotin, Y et al. Osteoarthritis biomarkers derived from cartilage extracellular matrix: Current status and future perspectives, ANNALS OF PHYSICAL AND REHABILITATION MEDICINE 59: 145-148

APPROACH: Mobasheri, A et al. An update on the pathophysiology of osteoarthritis, ANNALS OF PHYSICAL AND REHABILITATION MEDICINE 59: 333-339

BEAT-DKD: Rinschen, MM et al. YAP-mediated mechanotransduction determines the podocyte's response to damage, SCIENCE SIGNALING 10:

BEAT-DKD: Zschiedrich, S et al. Targeting mTOR Signaling Can Prevent the Progression of FSGS, JOURNAL OF THE AMERICAN SOCIETY OF NEPHROLOGY 28: 2144-2157

BigData@Heart: Gho, JMIH et al. An electronic health records cohort study on heart failure following myocardial infarction in England: incidence and predictors, BMJ OPEN 8:

BioVacSafe: Kaufmann, SHE et al. Tuberculosis vaccines: Time to think about the next generation, SEMINARS IN IMMUNOLOGY 25: 172-181

BioVacSafe: Weiner, J et al. Recent advances towards tuberculosis control: vaccines and biomarkers, JOURNAL OF INTERNAL MEDICINE 275: 467-480

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BioVacSafe: Kaufmann, SHE et al. Molecular Determinants in Phagocyte-Bacteria Interactions, IMMUNITY 44: 476-491

BioVacSafe: Kaufmann, SHE et al. Host-directed therapies for bacterial and viral infections, NATURE REVIEWS DRUG DISCOVERY 17: 35-56

BTCure: Cope, A et al. The Th1 life cycle: molecular control of IFN-gamma to IL-10 switching, TRENDS IN IMMUNOLOGY 32: 278-286

BTCure: Finzel, S et al. Repair of bone erosions in rheumatoid arthritis treated with tumour necrosis factor inhibitors is based on bone apposition at the base of the erosion, ANNALS OF THE RHEUMATIC DISEASES 70: 1587-1593

BTCure: Shi, J et al. Autoantibodies recognizing carbamylated proteins are present in sera of patients with rheumatoid arthritis and predict joint damage, PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA 108: 17372-17377

BTCure: Heiland, GR et al. High level of functional dickkopf-1 predicts protection from syndesmophyte formation in patients with ankylosing spondylitis, ANNALS OF THE RHEUMATIC DISEASES 71: 572-574

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BTCure: Harre, U et al. Induction of osteoclastogenesis and bone loss by human autoantibodies against citrullinated vimentin, JOURNAL OF CLINICAL INVESTIGATION 122: 1791-1802

BTCure: Pizzolla, A et al. Reactive Oxygen Species Produced by the NADPH Oxidase 2 Complex in Monocytes Protect Mice from Bacterial Infections, JOURNAL OF IMMUNOLOGY 188: 5003-5011

BTCure: Nikitopoulou, I et al. Autotaxin expression from synovial fibroblasts is essential for the pathogenesis of modeled arthritis, JOURNAL OF EXPERIMENTAL MEDICINE 209: 923-931

BTCure: Klarenbeek, PL et al. Inflamed target tissue provides a specific niche for highly expanded T-cell clones in early human autoimmune disease, ANNALS OF THE RHEUMATIC DISEASES 71: 1088-1093

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BTCure: Giera, M et al. Lipid and lipid mediator profiling of human synovial fluid in rheumatoid arthritis patients by means of LC-MS/MS, BIOCHIMICA ET BIOPHYSICA ACTA-MOLECULAR AND CELL BIOLOGY OF LIPIDS 1821: 1415-1424

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BTCure: Kiechl, S et al. Blockade of receptor activator of nuclear factor-kappa B (RANKL) signaling improves hepatic insulin resistance and prevents development of diabetes mellitus, NATURE MEDICINE 19: 358-363

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BTCure: Shi, J et al. Brief Report: AntiCarbamylated Protein Antibodies Are Present in Arthralgia Patients and Predict the Development of Rheumatoid Arthritis, ARTHRITIS AND RHEUMATISM 65: 911-915

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