Outputs, outcomes and emerging impacts

Results from HRB awards that completed in 2016 and 2017

Maura Hiney

December 2019

Acknowledgements

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Disclaimer

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Executive Summary

Introduction

This report presents a snapshot of the outputs, outcomes and some emerging impacts arising from 187 HRB awards (combined value of €47.2 million) that completed in 2016 and 2017. Further outputs, outcomes and impacts would be expected to occur in the years following the completion of these awards. The outputs and outcomes reported in 2016 and 2017 combined with those from past submission periods provide 10 years of data from completed HRB awards, and where appropriate, trend analysis is provided.

The report demonstrates that HRB-funded researchers are highly productive across the full range of Payback Categories, with increases in many metrics over the last 10 years. Given the HRB's strategic objective to 'generate relevant knowledge and promote its application in policy and practice' it was good to see a significant increase in reported engagement outputs with policy makers, healthcare providers and decision-makers, patient groups and the public, as well as significant collaborations with these actors.

For the first time ever, the amount of additional research funding leveraged by HRB researchers exceeded the original HRB investment in their awards, with €1.2 million leveraged from all sources for every €1 million invested by the HRB with 42.4% of all leveraged funding came from non-exchequer sources in Ireland and overseas. This finding reflects Irish health researchers increased success in winning funding from EU Framework and other programmes.

Continuing HRB emphasis on a multi-disciplinary collaborative funding model, along with the importance placed by international peer review panels on methodological rigour, ensures that only high-quality research is funded with the potential for scientific, health and economic impact. This is reflected in the observed upward trend over the past ten years in almost all Payback Framework indicators. In the next reporting period (2018/2019) outputs, outcomes and emerging impacts from awards funded through the current HRB strategy 2016-2020 will begin to emerge, and it is anticipated that the positive trends observed to date will continue.

Summary of outputs and outcomes

The analysis reported here demonstrates a wide variety of outputs and outcomes produced by HRB-funded research in terms of scientific dissemination, capacity-building, policy and clinical practice influences, and health sector and economic benefits. A more detailed summary of outputs, broken down by Award type is provided in Appendix 2, and by Broad Research Area is provided in Appendix 3.

Key output and outcome statistics for awards ending in 2016/2017 compared to previous years

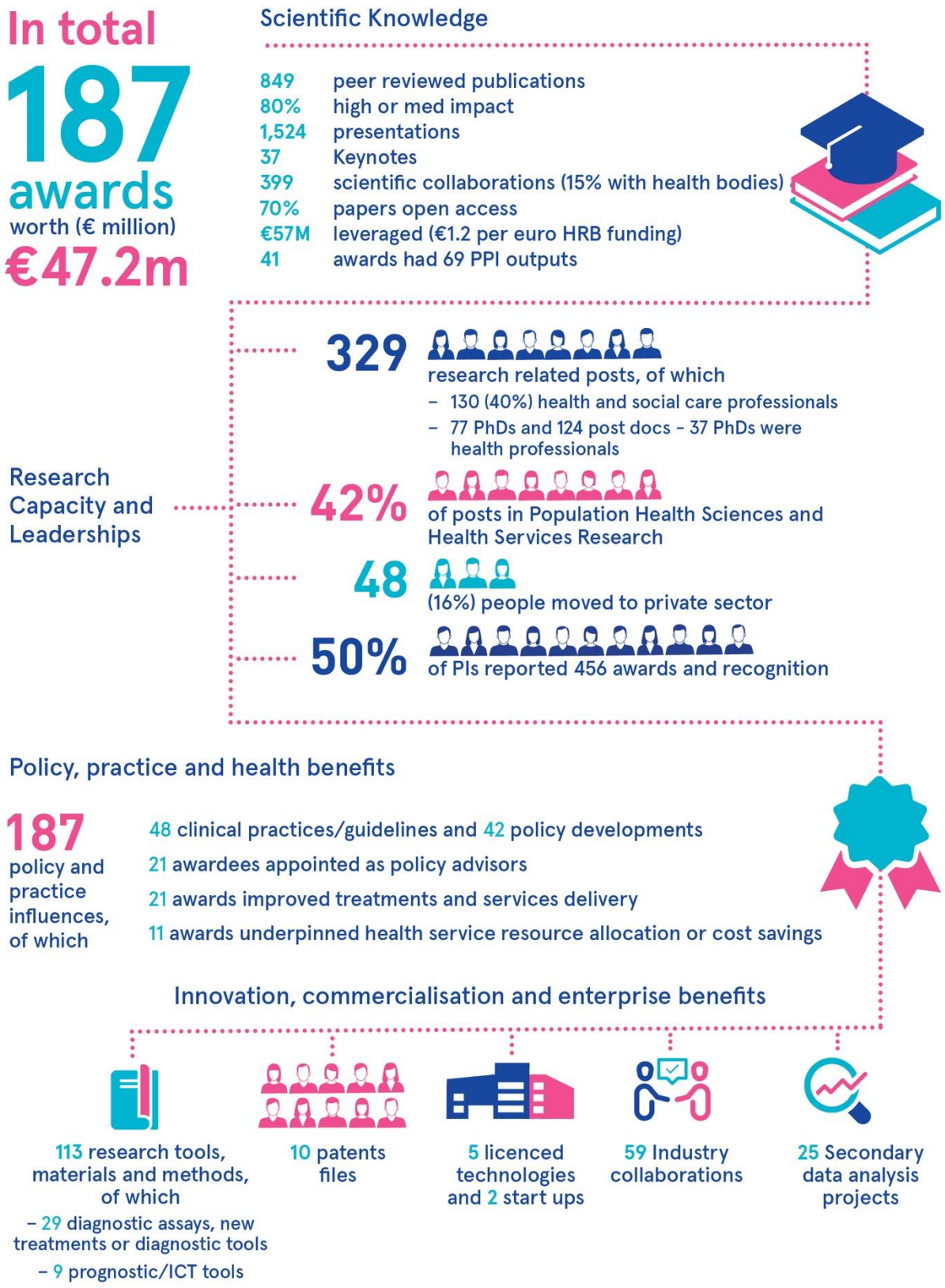
PAYBACK CATEGORY	2016/17 (N=187 awards)	2014/15 (N=198 awards)	2012/13 (N=134 awards)	2010/11 (N=196 awards)	2008/09 (N=204 awards)
Value of investment	**€47.2 M**	**€55 M**	**€44 M**	**€54.5 M**	**€45 M**
1. Knowledge creation outputs					
Total no. peer-reviewed journal publications	849	693	584	470	526
Average no. peer-reviewed papers/award	4.5	3.5	4.5	2.4	2.5
Number of papers in high impact journals*	NA**	15.7%	15.7%	28%	31%
Average no. publications per €1M	17.8	12.6	13.3	8.6	11.6
No. scientific presentations	1,524	1414	940	1427	1118
% PIs reporting scientific dissemination activity	70.1%	72.2%	95.5%	87%	92%
No. keynote presentations internationally	23	21	35	35	51

PAYBACK CATEGORY	2016/17 (N=187 awards)	2014/15 (N=198 awards)	2012/13 (N=134 awards)	2010/11 (N=196 awards)	2008/09 (N=204 awards)
2. Research capacity-building and leadership outputs					
Total no. research related posts created	329	385	422	280	296
No PhD students trained	86	93	133	72	88
No. post-doctoral researchers supported	124	154	130	92	112
% of cohort from health background	32%	43.6%	32.2%	29%	NA
% awards reporting indicator of peer recognition	77%	42.9%	70%	75%	NA
3. Collaboration and leveraged funding outputs					
Total no. collaborations	399	413	278	415	384
% collaborations with health bodies	15.8%	18.6%	14%	10%	NA
No. additional research awards	199	180	149	113	117
Total value of leveraged funding	€57.6 M	€41.8 M	€39.5 M	€34.8 M	NA
Amount leveraged funding per €1 of investment	€1.2	€0.76	€0.89	€0.64	NA
4. Informing policy and practice outputs					
Total no. policy and practice outputs	187	105	127	99	84
% awards reporting policy and practice outputs	44.9%	26.8%	38%	24%	20%
Average no. policy/practice outputs per €1M	3.8	1.9	2.9	1.8	0.9
5. Engagement/involvement with patients and the public					
Total no. non-academic engagement activities	531	258	188	122	NA
% PIs reporting non-academic engagement	70.1%	47.5%	50%	35%	NA
Average no. non-academic engagement outputs per €1M	11.2	4.69	4.6	2.2	NA
% projects reporting PPI outputs	21.9%	NA	NA	NA	NA
No. PPI outputs reported	69	NA	NA	NA	NA
6. Research tools, materials and methods					
Total no. new material/methods developed	113	96	112	85	NA
Average no. outputs per €1M	2.4	1.8	2.9	1.6	0.6
7. Health sector innovations					
Total no. health sector innovations	54	54	43	48	32
% awards reporting health sector innovations	20.7%	20.7%	24.6%	21%	15%
Average no. health sector innovations per €1M	1.0	1.0	1.0	0.9	0.7
8. Economic and commercial activity					
No. patents/copyrights/trademarks filed	10	24	16	11	12
No. licenced technologies developed	5	2	5	3	3
No. start-ups/spin-outs established	2	4	2	2	2
No. industry collaborations established	59	58	88	25	10

**Bibliometric analysis of HRB publications 2013-2016 did not differentiate between years and the mean normalised citation score (MNCS) of more recent papers would be expected to be lower, given that publications take time to accumulate citations.*

*** Not all metrics were collected in every reporting period.*

Some key findings



1. Introduction and methods

1.1 Introduction

This report provides the evidence to inform Health Research Board (HRB) funding strategy and decisions relating to new or existing funding initiatives, and to understand whether the schemes in which it invests are meeting their scientific objectives and are productive across a range of evaluation metrics. It is also important for the HRB to be transparent about the outputs, outcomes and emerging impacts from its research investment. The value of the HRB's current funding commitment is in the region of €180 million. As this is public money, there is an onus on the HRB to account to government and other stakeholders, including the public, for the funds it allocates and the returns on this investment.

This report presents an analysis of the outputs, outcomes and some emerging impacts across a range of metrics and indicators, arising from 187 HRB awards (combined value of €47.2 million) that completed in 2016 and 2017, giving a survey compliance rate of 93%. The outputs and outcomes reported in 2016 and 2017 combined with those from past submission periods together provide 10 years of data from completed HRB awards, and where appropriate, trend analysis is provided.

To understand how well HRB researchers are doing in comparison to their peers internationally, the 2018 quantitative evaluation report of the Medical Research Council UK *Outputs, outcome and impacts of MRC research 2016* [i], who collect a similar evaluation dataset, was used as a benchmark where possible. However, their outputs and outcomes are not always reported in a manner that allows direct comparison with HRB metrics. In addition, this comparison should be cautiously interpreted since the MRC operates in a different context, has different strategic objectives, structures, funding instruments and expected outcomes, and is of far greater scale than the HRB.

An important *proviso* in considering this report is that the analysis presented is not a complete picture of the outputs and outcomes of HRB-funded research. Depending on the research area, there can be a considerable time lag (> 5yrs) for research outputs to manifest in outcomes and ultimate impacts on society and the economy. Therefore, evaluation data collected at the point of end-of-grant (EOG) can only provide a snapshot in time. Further outputs, outcomes and impacts would be expected to occur in the years following the completion of an award.

1.2 The Payback Framework

HRB evaluation data collection is guided by the Buxton-Hanney Payback Framework for Health Research (Buxton and Hanney, 1994 [ii], 1996 [iii], 1997 [iv], 2011 [v]), originally developed to examine the 'payback' of health services research. This framework groups metrics into five payback categories that span short to medium-term outcomes, that is knowledge production, research capacity-building, informing policy and the public, and longer-term impacts effected through policy and clinical practices changes, health sector innovations and economic and commercial activity. The full HRB framework, adapted from Buxton and Hanney and Wooding *et al* (2004 [vi]) is presented in Appendix 1.

For the purposes of this report data on a substantial subset of quantitative metrics set out in the framework were collected using a bespoke online survey instrument (Outcome Tracker). Other metrics in the framework are more qualitative in nature and are not amenable to collection via a survey. However, the metrics that were collected allow the HRB to get a comprehensive overview of how its funding instruments are performing against their original objectives.

2. Number, type and value of awards

In order to achieve outputs and outcomes of benefit to health and wellbeing, the HRB makes investments in research projects and programmes, clinical infrastructure, fellowships and co-funded awards, across a broad spectrum of research areas of relevant to health. This chapter looks at these inputs, and how they were distributed across different funding mechanisms, broad research areas and host institutions.

Key Finding

- The 187 awards that reported on evaluation metrics in 2016/2017, with a combined value of €47.2 million, represented 93% coverage of all awards that completed in this period.
- Most of the analysed awards were granted between 2011 and 2015, within the remit of the *HRB Strategic Business Plan 2010-2014*
- Project and Programme awards accounted for 79% of total awards and 62% total funding, Research Capacity and Leadership awards accounted for 20% of awards but 34% of total funding, and Infrastructure and Networking awards accounted for 1% of awards and 3.3% of total funding.
- Spend on Basic Biomedical Research has been in steady decline since 2008, while spend on awards categorised as Clinical Research has risen sharply since 2008. Applied Biomedical Research has remained relatively constant since 2008/2009. Spend on both Health Services Research and Population Health Sciences has risen since 2008/2009.
- TCD, UCC, RCSI, UCD and NUI Galway, respectively, held the highest proportion of awards by value in 2016/2017.

2.1 Number, value and distribution of awards

In total, 187 awards that completed in 2016 and 2017 are analysed in this report. These awards had a combined value of €47.2 million. The equivalent statistics for awards that completed in 2014/2015, 2012/2013, 2010/2011 and 2008/2009 were 198 awards (€55 million value), 134 awards (€44 million value), 196 awards (€54.5 million value) and 204 awards (€45 million value), respectively. The report does not contain complete information on all awards that finished in 2016/2017, and a small number of award holders did not provide evaluation data. However, this report covers over 93% of awards across all schemes. The year of award of these awards is shown in Figure 2.1.

Figure 2.1: Breakdown of number of awards reporting metrics by start date of award

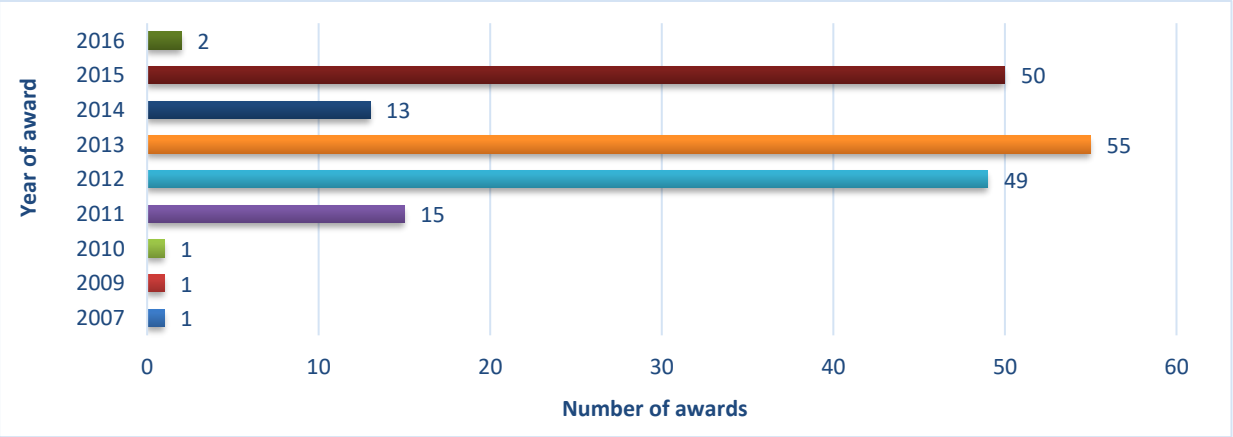


Figure 2.1 shows that almost all the analysed awards were granted between 2011 and 2015, within the remit of the *HRB Strategic Business Plan 2010-2014*. Most of the awards were project grants and fellowships of 2-4 years duration, apart from the 44 Knowledge Exchange and Dissemination (KEDS) awards made in 2015, which were of shorter duration (6-12 months). A breakdown of awards by scheme type and year in which the award was made are shown in in Table 2.1.

Table 2.1: Breakdown of awards by award type and year of award

Scheme	2007	2009	2010	2011	2012	2013	2014	2015	2016	Grand Total
Applied Research Projects in Dementia								1		**1**
Cancer Prevention Fellowship Programme								1		**1**
Cancer Research Nursing Project							1	1		**2**
Clinician Scientist Award					2					**2**
Cochrane Training Fellowship						4	2	1		**7**
Framework for Safe Nurse Staffing and Skill Mix									1	**1**
Health Research Awards			1	3	33	32	3	1		**73**
Interdisciplinary Capacity Enhancement Awards				3	3					**6**
Joint Programme in Neurodegenerative Disease				2		1				**3**
JPI Healthy Diet for a Healthy Life						2				**2**
Knowledge Exchange and Dissemination Scheme								44		**44**
HRB-MRCG Joint Funding Scheme				2	7	7	3		1	**20**
National SpR/SR Academic Fellowship Programme		1		2						**3**
PhD Scholars Programme	1									**1**
Post-Doctoral Fellowship in Translational Medicine				1						**1**
Research Collaborative in Quality and Patient Safety						2	2			**4**
Research Training Fellowship for Healthcare Professionals				2	3	7	2	1		**15**
Structured Research Network					1					**1**
Grand Total	**1**	**1**	**1**	**15**	**49**	**55**	**13**	**50**	**2**	**187**

2.1.1 Distribution of spend by award type

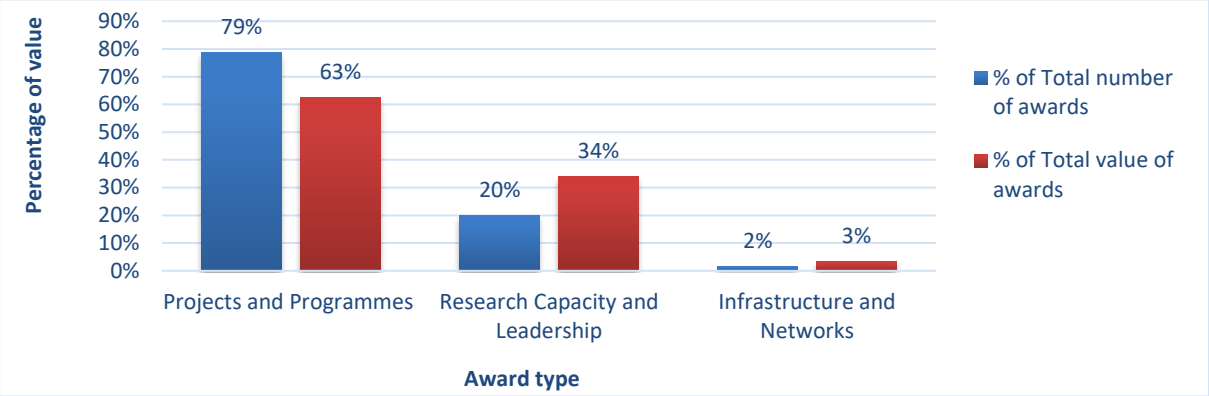
Figure 2.2 shows the breakdown of the 187 awards by award type. Project and Programme awards[1] accounted for the largest number of awards (79%) and received the largest proportion of the total funding (62%). This category included relatively small one-year projects such as the KEDS awards (average value of €40.2K) and larger three-year projects such as the Health Research Awards (average value of €295k).

[1] The Project and Programme Awards category includes: Applied Research Projects in Dementia (N=1), Cancer Research Nursing Projects (N=1), HDHL (N=2), Health Research Awards (N=73), JPND (N=3), KEDs Supplements (N=44), HRB-MRCG Joint Funding (N=20), and RCQPS (N=4).

Capacity Building and Leadership awards[2] accounted for 20% of all awards that completed in 2016/2017 but 34% of the total value of awards. This category included both high value awards such as the PhD Scholars Programme (value €4.2 million), Clinician Scientist Awards (average value €925k) and ICE awards (average value €637k), and smaller individual fellowships with an average value of €221K per award.

The three awards within the Infrastructure and Networks category were network awards. These three awards accounted for 2% of the total number of awards that completed in 2016/2017 and received 4% of the total funding available. One network (the All-Ireland Institute of Hospice and Palliative Care) accounted for almost €1.3 million of the total, while the other two networks, which were part of a European JPI, had an average value of €375k.

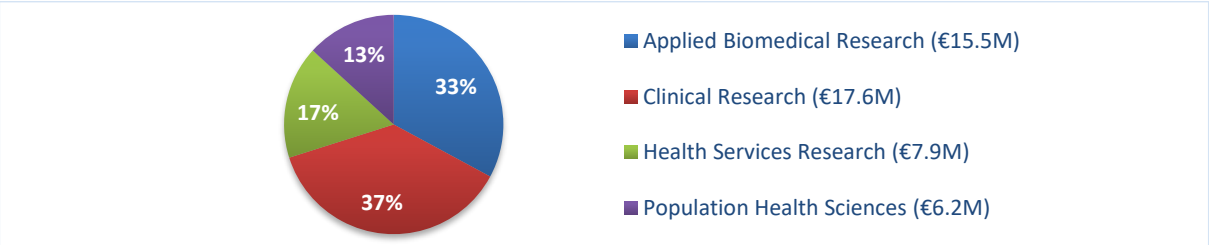
Figure 2.2: Number and value of awards by award type 2016/2017



2.1.2 Distribution of spend by broad research area

Distribution of the €47.2 million investment across four broad research areas is shown in Figure 2.3. For ease of analysis, each award was allocated a single classification to represent the predominant focus of the award. A proportion of awards span more than one broad area of health research (e.g. Clinical Research/Health Services Research) and in these cases the amount awarded was split equally between the two broad research areas. No awards categorised as Basic Research completed in the 2016/2017 period.

Figure 2.3: Distribution of awards across broad research area categories 2016/2017



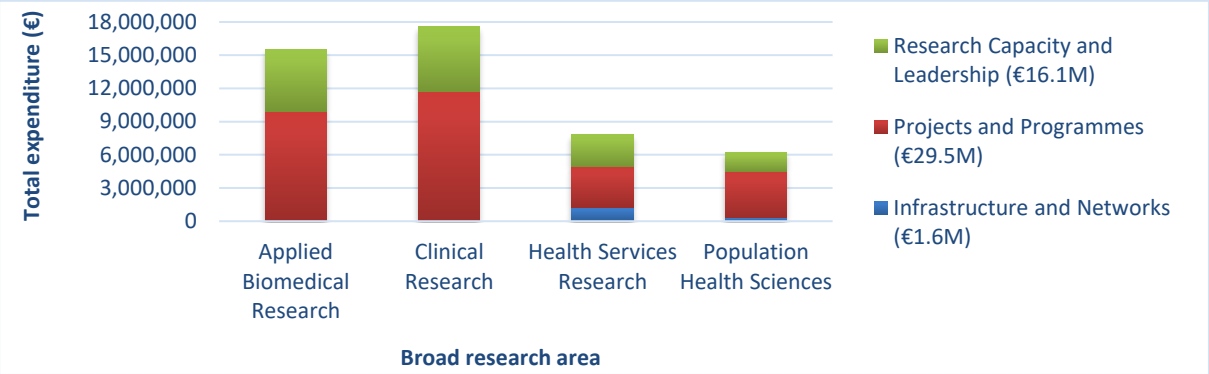
Clinical Research accounted for the largest proportion of funding (37% of total expenditure), closely followed by Applied Biomedical Research (33% of total HRB spend). Health Services Research accounted for 17% of total spend and Population Health Sciences accounted for 17% of total spend. This is an increase reporting periods

[2] The Capacity Building and Leadership category includes: Cancer Prevention Fellowship (N=1), Clinician Scientist Award (N=2), Cochrane Training Fellowship (N=7), Framework for Staff Nursing (N=1), Health Professional Fellowship (N=11), ICE Award (N=6), National SPR Academic Fellowship (N=3), PhD Scholars Programme (N=1), Post-doctoral Fellowship in Translational Medicine (N=1) and Health Professional Fellowship (N=4).

illustrates the positive effect on research support in these areas as a result of the HRB's shift in emphasis to building these broad research pillars to be a significant proportion of the HRB funding portfolio.

The distribution of broad research areas by award type is shown in Figure 2.4. Awards categorised as Projects and Programmes and Research Capacity and Leadership were made across all broad research areas, while Network awards that completed in 2016/2017 were confined to Health Services Research and Population Health Sciences research.

Figure 2.4: Distribution of awards across broad research area categories and scheme type 2016/2017



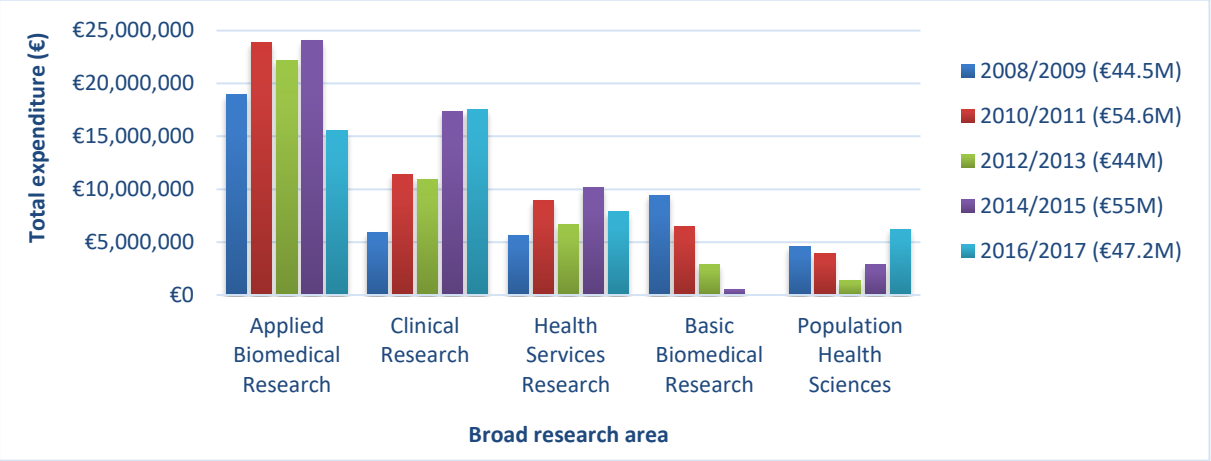
It is also interesting to compare expenditure in the broad research areas over the ten years from 2008 to 2017 (Figure 2.5), although it should be remembered that the data presented here is based on award end dates, rather than start dates, which may explain some of the variability, as large awards end in some years but not others.

Funding of awards categorised as Basic Biomedical Research has been in steady decline since 2008, with no awards that completed in 2016/2017 in this category. This reflects the HRB's gradual shift in funding focus away from basic biomedicine to funding more patient-oriented research (Applied Biomedical Research and Clinical Research), Population Health Sciences and Health Services Research. However, with the advent of co-funding with National and International partners such as Science Foundation Ireland, Wellcome Trust UK, and the National Institutes of Health USA in more recent years, which tend to support basic biomedical research, this category would be expected to feature in future reports.

The distribution of spend on awards categorised as Applied Biomedical Research decreased in the 2016/20017 reporting period relative to previous periods while expenditure on awards categorised as Clinical Research more than trebled between 2008 and 2015 and remained at this level in the 2016/2017 reporting period.

Expenditure on awards categorised as Health Services Research has varied since 2008 and peaked in 2014/2015 with the completion of a Health Research Centre Award made in 2007. Also, in 2014/2015 the declining trend in Population Health Sciences spending reversed and had doubled in the 2016/2017 reporting period. This upwards trend in funding of Population Health Sciences is expected to continue as more awards that benefited from the HRB's push in this area of research are completed.

Figure 2.5: Comparison of expenditure across broad research areas for awards ending 2008 to 2017



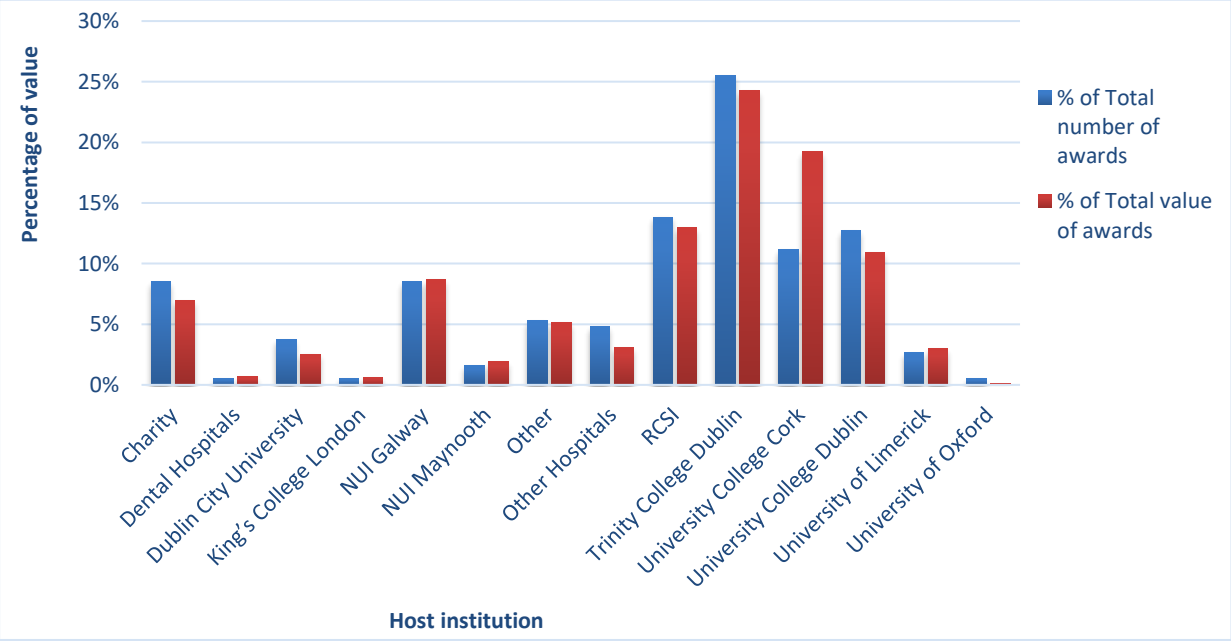
2.1.3 Distribution of spend by host institutions

In relation to the location and hosting of HRB awards, Figure 2.6 shows the host institutions administering awards that completed in the period 2016/2017.

A PhD Scholars Programme in UCC that completed in 2016 explains the difference between total value and number of awards in this host institution.

It should also be noted that the research work of some awards administered by universities was, in reality, carried out in clinical settings, so that the total funding assigned to large teaching hospitals and smaller clinical units in Figure 2.6 is most likely an underestimation of the total funding or number of awards granted to health professionals working in these settings.

Figure 2.6: Distribution of awards across HRB host institutions 2016/2017



3. Achievement of objectives

In their original award application, principal investigators (PIs) outlined specific research objectives that they sought to achieve with their HRB funding. At the completion of their awards, PIs were asked to indicate the extent to which these objectives were fulfilled during the period of the award.[3] The purpose of this question was not punitive, but rather to learn about the impediments HRB researchers experience in carrying out their research. This chapter looks at the response to that question.

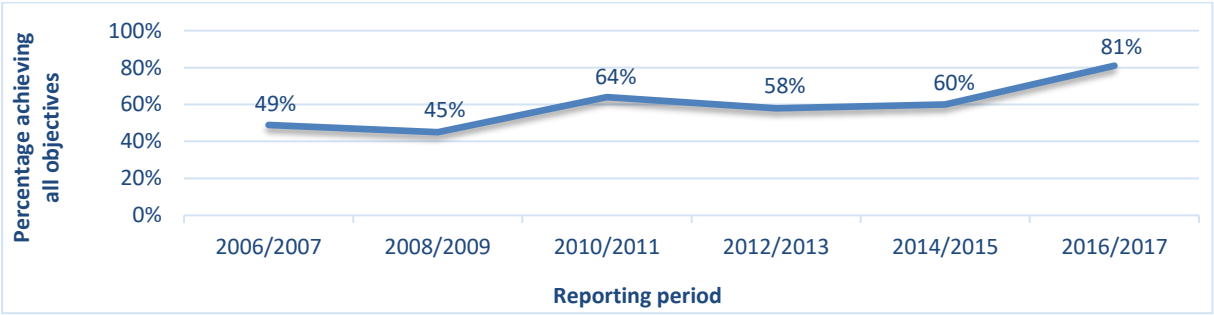
Key Finding

- There has been a steady increase over time in the number of award holders who achieved all their original award objectives, from 43% in 2008 to 81% in 2017.
- The most common reasons cited for non-fulfilment of all of the original award objectives were that aspects of the research took longer than originally anticipated due to factors outside the control of the PI (N=26), technical problems, or lack of access to essential equipment or infrastructure (N=24), early finding led to a shift in focus of the research (N=24), and an original underestimation of the time needed to complete the research (N=21).
- Unlike the previous reporting period (2014/2015) nobody cited insufficient funding to complete the research as a reason not to achieve all objectives.

3.1 Number of awards achieving all objectives

As shown in Figure 3.1, 81% of award holders indicated that they had achieved all the original award objectives by the time of completing their award. There has been a steady increase in this statistic since 2006, when just under half of award holders achieved all objectives by the end of their award. The reasons for this upward trend are difficult to quantify with any certainty. It is most likely due to careful review and improved feedback from international peer review panels on the feasibility of achieving the stated objectives over the period of the award and with the requested resources. It may also be due to growing researcher experience of what can be realistically achieved over the lifetime of an award.

Figure 3.1: Percentage of awards achieving all their objectives in past 12 years



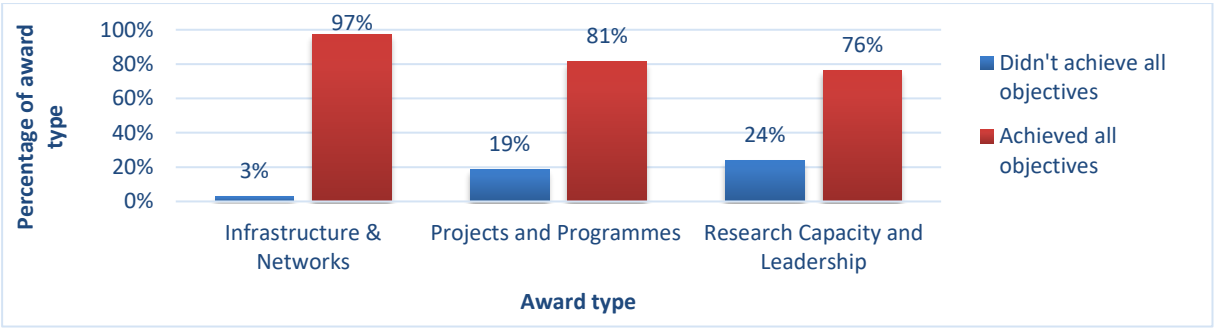
The HRB also adopted more robust award monitoring procedures including the introduction of detailed annual reporting, a requirement to request permission in real-time from the HRB if they need to shift their focus or to

[3] It should be noted that award holders are asked if they achieved all the original award objectives – this does not account for the fact that PIs may have received formal approval from the HRB to change an objective(s) during the award, based on sound scientific rationale.

change objectives and a practice of awarding short no-cost extensions to PIs - when well justified - to complete their research. Given these conditions, it would be expected that the proportion of awards completing all the original objectives would increase over time. As is evident from Figure 3.1, the HRB's emphasis since 2008 on clarity in the application process, international peer review and on-going award monitoring have had a real impact in this regard.

Figure 3.2 provides a breakdown by award type of achievement of objectives. As can be seen, for all award types almost all awards reported that they had achieved all their original objectives. Reported failure to achieve all objectives was lowest for Infrastructure and Networks (but there were very few of these awards) and highest for Research Capacity and Leadership awards, which might be accounted for by the relative inexperience of many of the recipients of this type of award.

Figure 3.2: Achievement of award objectives by award type 2016/2017

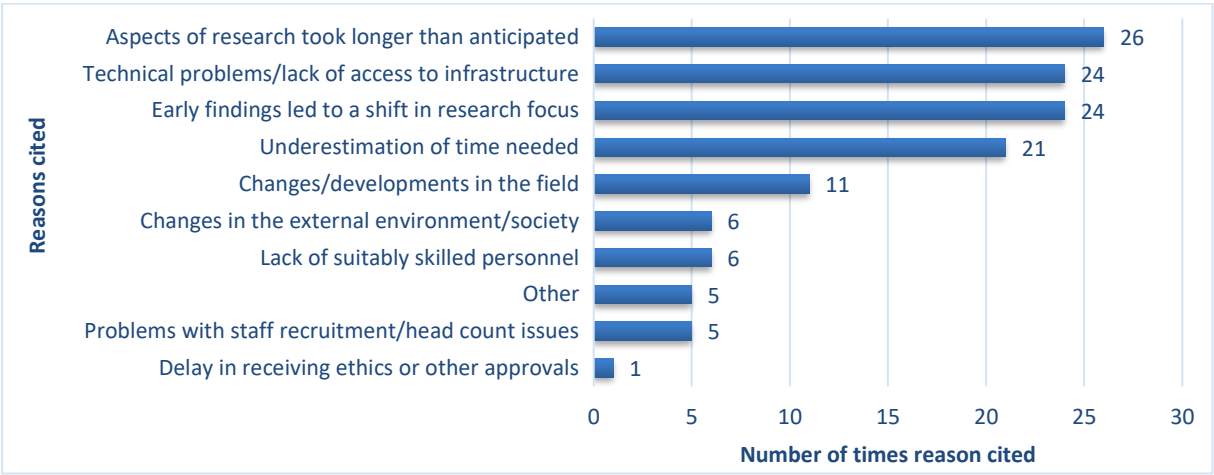


3.2 Reasons for not achieving objectives

Award holders were asked to indicate the reasons behind their inability to fulfil all the original award objectives. 96% of the PIs provided a reason for not doing so and PIs could choose more than one reason. Figure 3.4 shows the number of times each of the given reasons was cited.

The most common reasons cited for non-fulfilment of all of the original award objectives were that aspects of the research took longer than originally anticipated' (26) i.e. delays were encountered due to changes in staff, or their own role, maternity leave absence of key staff and so on; 'Technical problems, or lack of access to essential equipment or infrastructure' (24); 'Early finding led to a shift in focus of the research' (24); and 'Underestimation of the time needed to complete the research' (21), which speaks to poor planning or lack of experience of researchers. Other reasons cited less frequently included 'Research objectives changed due to developments in the field (11) or developments in the external environment/society (6) and lack of suitably skilled personnel (6) or problems with recruitment or headcount (5).

Figure 3.4: Reasons cited for non-fulfilment of original award objectives



Only one project cited difficulties with obtaining ethical or other regulatory approval as a reason. Unlike the previous reporting period (2014/2015) nobody cited insufficient funding to complete the research as a reason not to achieve all objectives.

As can be seen in Table 3.1 the specific reasons offered by PIs for being unable to achieve all the original objectives vary, and there is often more than one reason as to why an award might not obtain all its objectives.

Table 3.1: Examples of explanations cited by researchers for not completing their objectives

Award Type	Reasons for non-completion of all objectives	Description of issue by PI
Fellowship Award	Early findings led to a shift in research focus	Some preliminary early findings led to a shift in research focus. For example, in the course of their research the Fellow found a candidate marker of cardiovascular ageing and mortality that had substantial clinical relevance.
Fellowship Award	Research objectives changed due to changes in the external environment /society	The changes in objectives were precipitated by conditions outside of the PIs control. So, while the initially intended outputs were not achieved, a separate set of outputs were achieved, and a huge amount of knowledge was gained from responding to the real-world situation in which this clinical research took place.
Networking Award	Underestimation of time, or aspects of research took longer than originally anticipated	The time involved to embed theoretical knowledge of social justice theory was underestimated and probably needed further elaboration as the study progressed to ensure that the focus was on social justice and not just palliative care.
Project Award	Insufficient time, or aspects of research took longer than originally anticipated	All objectives of this project were dependent on the analysis of glycated haemoglobin from stored biological samples which had a projected completion date of April 2013. This process was not completed until late 2014 and resulted in delays for each subsequent objective.
Project Award	Problems with staff recruitment/head count issues	Following the departure of the postdoctoral researcher from the project it was not possible to recruit a suitable replacement to facilitate the completion of one objective which required specific skills.
Project Award	Technical problems, or lack of access to essential equipment or infrastructure	It was found once the project was underway that the data for objective five on "current variation in socio-economic inequalities in overall and cause specific cause of death across geographic areas" was flawed and could not be used for analysis.

4. Knowledge creation

Scientific dissemination is at the core of the scientific process. It enables researchers to build on existing scientific knowledge and to develop collaborations with colleagues both nationally and internationally in order to advance particular areas of research. Important indicators of scientific dissemination activity include:

- publication of peer-reviewed scientific journal papers, especially in medium to high-impact international journals which have a wide readership and scientific credibility
- oral presentation of papers and presentation of scientific posters to peers at national and international scientific conferences
- invitations to present keynote papers at national and international scientific conferences

Summary of scientific dissemination outputs in 2016/2017 compared to previous reporting periods

Knowledge Production	2016/2017 (N-187 awards)	2014/2015 (N=198 awards)	2012/2013 (N=134 awards)	2010/2011 (N=196 awards)	2008/2009 (N = 204 awards)
Peer reviewed publications					
Total no. peer-reviewed journal publications	849	693	584	470	526
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Number of papers in high impact journals	70.6%	72.2%	95.5%	87%	92%
Average no. publications per €1 million spend	17.8	12.6	13.3	8.6	11.6
Scientific presentations					
No. scientific presentations	1,524	1414	940	1427	1118
No. of keynote presentations internationally	23	21	35	35	51
% PIs reporting at least one other dissemination activity	68.1%	72.2%	95.5%	87.0%	92.0%

Key Finding

Peer reviewed journal papers

- 70.6% of awards (N=132) reported at least one peer-reviewed publication at EOG, with an average of 17.8 publications per €1 million spent, although there was variation at the level of Award Type and Broad Research Area.
- 70% of papers were published in open-access compliant journals or open research platforms in 2016/2017, an increase from the 2014/2015 figure of 56%.
- Population Health Sciences produced the greatest number of papers per €1 million spend (N=30.4), followed by Health Services Research (N=19), Clinical Research (N=15.8) and Applied Biomedical Research (N=14.1).
- Publications from all award types and broad research areas had an aggregated citation impact that were 1.3 times the world average, and greater than Ireland as a whole. Population Health Sciences publications also fared better than HRB aggregated results in terms of the number of publications in the top 10% of highly rated journals in their field (17.1%.)

Other means of scientific dissemination

- HRB-funded researchers are very active in disseminating their work to peers at both national and international scientific events via conference presentation, keynote addresses, and had participated as invited speakers, conference organisers and session chairs in many national and international events (72.2% of award holders).
- Awards classified as Clinical Research and Population Health Sciences accounted for a significant number of the total keynote invitations reported (68%) and 60% of all invitations to participate in national and international conferences.

4.1 Peer-reviewed scientific publications

Peer reviewed publications are an important primary output from research, since they communication information to peers to build a knowledge base and validate research quality. 70.6% of awards completed in 2016/2017 reported at least one publication at the point of end of award. Of these, 57 awards reported between 2 and 4 publications, 30 awards reported between 5 and 9 publications, and 26 awards reported 10 or more publications. Over time, the number of peer reviewed publications and the number of publications per award would be expected to rise.

In the 2016/2017 period researchers reported a total of 849 peer-reviewed scientific publications[4] at the point of end-of-grant. This was an average of 4.5 papers per award, yielding an average productivity rate of 17.8 publications per €1 million spent (or 1 paper for every €76.2k), which is higher than all pervious reporting periods.

A *Bibliometric Analysis of HRB publications 2013-2016*[vii], that includes a subset (N=304) of the publications from awards that finished in 2016/2017, found that the publications from all award types and broad research areas had an aggregated citation impact that were 1.3 times greater the world average, and also greater than Ireland as a whole (although less than UK MRC and UK NIHR.) HRB-supported publications had almost 16% of the share of publications in the top 10% of highly rated journals in their field, which was higher than Ireland as a whole (11.5%) but lower than the UK MRC (22.9%) and UK NIHR (20.4%).

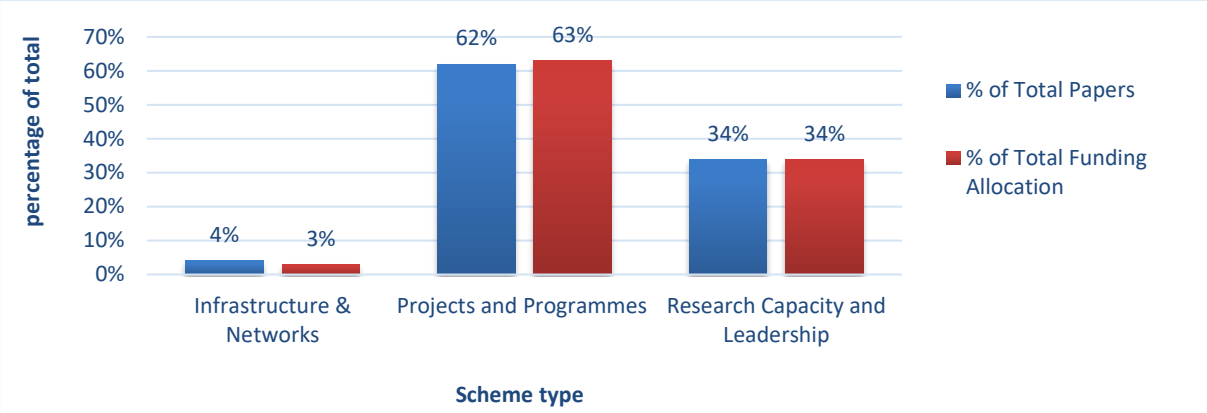
The journal impact score was also greater than the world average across all award types and broad research areas (1.2 times) and was above the journal impact score for Ireland as a whole, but lower than the MRC (1.75) and NIHR (1.51). It was found that for all award types, their citation impact was less than their journal impact score, indicating that the citation impact of these papers was greater than the citation impact of other publications in the same journal.

4.1.1 Distribution of peer-reviewed publications by award type

Figure 4.1 shows the distribution of peer-reviewed publications by award type for awards that completed in 2016/2017 and the proportion of the total investment of €47.2 million that each award type received. Table 4.1 looks more closely at the cost of producing these publications as per €1 million spend and the cost per paper.

[4] Publications reported by award holders in end-of-grant reports were excluded from the analysis if the date of publication preceded the award start date, if the paper was cited as in preparation, revision, accepted, or in press or if the subject matter of the paper was clearly unrelated to the award objectives.

Figure 4.1: Breakdown of peer-reviewed publications by award type 2016/2017



As can be seen from Figure 4.1 the level of funding was proportionate to the level of publication across all award types. The average number of peer reviewed papers, number of papers per €1 million spend, and the cost per paper per award type are shown in Table 4.1.

Table 4.1: Breakdown of publication rate and productivity by award type 2016/2017

Award type	Average no. papers per award	No. papers per €1 million spend	Cost per paper
Infrastructure and Network Awards	18.5	18.4	€54,227
Project and Programme Awards	3.9	17.4	€57,215
Research Capacity and Leadership Awards	7.6	17.9	€55,773

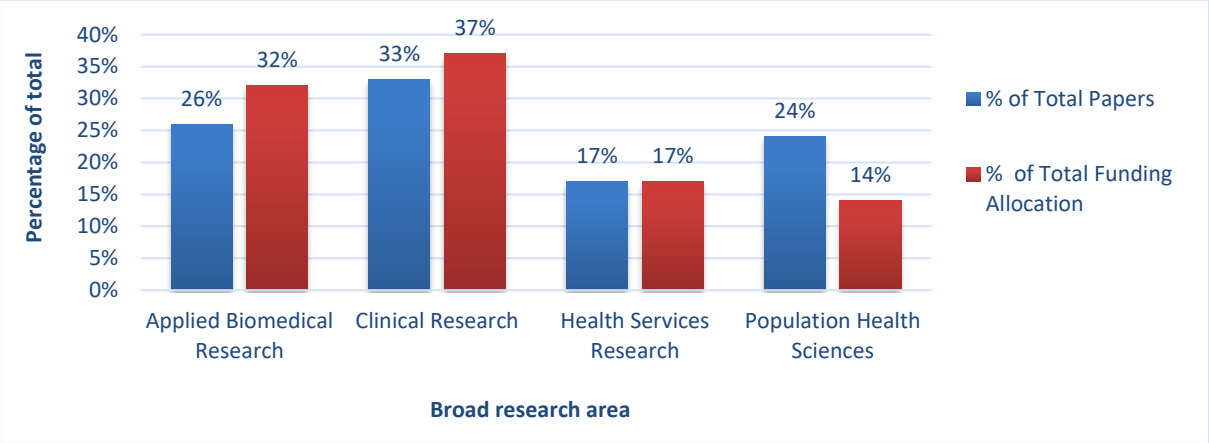
A *Bibliometric Analysis of HRB publications 2013-2016* found that publications associated with Infrastructure awards had an average citation impact of 1.75 times the world average, and that almost 20% of publications associated with this award type were in the top 10% of highly rated journals in their field. The ratio of citation impact to journal impact was particularly strong for Infrastructure awards, which suggests that publications arising from this award type are regarded highly by peers, who site them in their own work more often than other papers in the same journals.

4.1.2 Distribution of peer reviewed publications by broad research area

Figure 4.2 shows the distribution of peer-reviewed publications by broad research area for awards that completed in 2016/2017 and the proportion of the total investment of €47.2 million that each award type received. Of note from Figure 4.2 is the high number of papers produced by Population Health Sciences awards relative the funding allocated for this area.

Table 4.2 illustrates the average number of peer reviewed publications per broad research area for all awards and looks at the publication productivity in each area. This shows that the broad research area accounting for the most publications were Clinical Research (32.7%), followed by Applied Biomedical Research (25.7%), Population Health Sciences (23.9%) and Health Services research (17.6%).

Figure 4.2: Breakdown of peer-reviewed publications by broad research area 2016/2017



In terms of productivity, that is, the number of papers produced per €1 million spend on awards classified according to the broad research areas, Population Health Sciences produced the greatest number of papers per €1 million spend (N=30.4), which was significantly higher than the number of papers per €1 million spend produced by awards made in other broad research areas.

Table 4.2: Breakdown of publication rate and productivity by broad research areas 2016/2017

Broad Research Area	Total number of papers	Average no. papers per award	No. papers per €1 million spend	Cost per paper
Applied Biomedical Research	218.5	4.9	14.1	€71,002
Clinical Research	278	3.7	15.8	€63,180
Population Health Sciences	203	6.5	30.4	€32,848
Health Services Research	149.5	3.9	19.0	€52,643

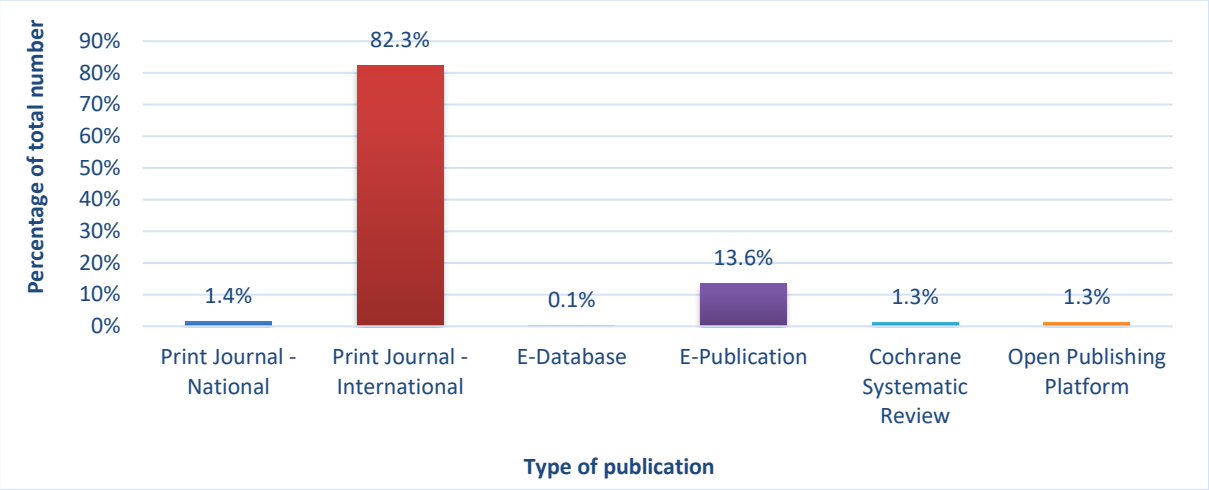
A *Bibliometric Analysis of HRB publications 2013-2016*found that publications associated with Population Health Sciences awards fared better than HRB aggregated results in terms of the number of publications in the top 10% of highly rated journals in their field (17.5%). Publications associated with Health Service Research awards had an average citation impact of 1.55 times the world average, that over one fifth of publications associated with this broad research area were in the top 10% of highly rated journals in their field, and these publications also had a higher journal impact score than other HRB funded publications.

4.1.3 Publishing platforms used

Figure 4.3 presents the type of publications that emerged from awards that completed in 2016/2017. Most researchers published in international peer reviewed journals (82.3% of total publications) and to a much lesser extent in national peer reviewed journals (1.4% of total publications.)

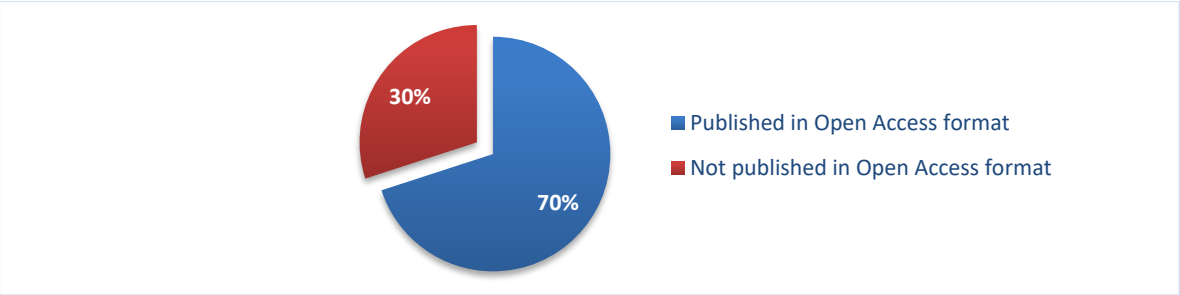
ePublications accounted for 13.6% of total publications, and since all International Journals are now available online, this figure represents predominantly articles that are published online ahead of print. Eleven systematic reviews were published in the Cochrane Library, primarily by holders of Cochrane Training Fellowships. PIs reported 1.3% of publications (N=11) as being published on Open Publishing Platforms, although they were really referring to Open Access Journals.

Figure 4.3: Breakdown of peer-reviewed publications by publication type 2016/2017



As seen in Figure 4.4, 70% of papers were published in open-access compliant journals or open research platforms in 2016/2017, an increase from the 2014/2015 figure of 56%. This increase is confirmed by the *Bibliometric Analysis of HRB publications 2013-2016*, which found that the top three journals used by HRB researchers in the 2013-2016 period were PLoS One (72 papers), BMJ Open (34 papers) and Cochrane Database of Systematic Reviews (26 papers). In some journals, HRB-funded publications were a considerable share of all Irish research output (e.g. BMJ Open, BMC Health Services Research).

Figure 4.4: Papers available via open access



4.2 Other scientific publications

In addition to publications in peer reviewed journals, HRB-supported researchers published the outcomes of their research in a variety of ways at both national and international level (Table 4.3). Some of these publications, such as chapters in edited books, were reviewed by peers, while others, such as articles in professional bulletins, journal editorials, blogs and reviews for popular magazines and industry bulletins were not. However, even when the publication output was not peer reviewed, it still served to disseminate the results of the research to a wider audience. Many of the non-journal publications have a significant policy or clinical practice focus.

Table 4.3: Other scientific publications emerging from awards that completed in 2014/2015

Publication type	National	International	Total
Book chapter	7	36	**43**
Invited review	1	6	**7**
Editorial	2	6	**8**
Technical Report	10	2	**12**
Other	6	5	**11**
Article	7	2	**9**
Bulletin	6	2	**8**
Practice Manual	1	0	**1**
Media Contribution	2	0	**2**
Film Production	2	0	**2**
Report	9	1	**10**
Book	0	1	**1**
Blog	0	1	**1**
Guidelines	0	0	**0**
Handbook	0	0	**0**
Total	**53**	**62**	**115**

Table 4.4 provides a comparison between 2016/2017, 2014/2015 and 2012/2013 output of other scientific publications. While not all categories were included in previous analysis, this data does illustrate that the most common types of other scientific publications were book chapters, technical and other health reports, although these are declining in favour of other forms of dissemination.

Table 4.4: Comparison of other scientific publications emerging from awards that completed in 2016/2017, 2014/2015 and 2012/2013

Publication type	2016/2017	2014/2015	2012/2013
Book chapter	37.3%	52.5%	44.9%
Technical Report	10.4%	N/A	N/A
Other	9.6%	N/A	N/A
(Health) Report	8.7%	18.6%	18.8%
Article	7.8%	N/A	N/A
Editorial	7.0%	3.4%	5.8%
Bulletin	7.0%	11.9%	14.5%
Invited review	6.1%	5.1%	7.2%
Film Production	1.7%	N/A	N/A
Media Contribution	1.7%	N/A	N/A
Practice Manual	0.9%	0.0%	1.4%
Book	0.9%	N/A	N/A
Blog	0.9%	N/A	N/A
Guidelines	N/A	8.50%	4.30%
Handbook	N/A	N/A	1.40%

Table 4.5 provides examples types of other scientific publications reported by awards that completed in 2016/2017.

Table 4.5: Examples of other publications linked to HRB-funded awards

Grant Type	Type of Publication	Description
Research Capacity and Leadership	Book Chapter	Slattery, B.W., O'Higgins, S., Dwyer, C.P., O'Connor, L., McGuire BE. (2015). How to write an abstract. In M.J. Byrne (Ed.), How to Conduct Research for Service Improvement: A Guidebook for Health and Social Care Professionals, Second Edition (pp. 167-173). Dublin: Health Service Executive.
Projects and Programmes	Industry Bulletin	Featured Article by SA Cryan "Designing the magic bullet: a convergence between biomedical engineering and pharmaceutical sciences" in Engineers Ireland, May 2013.
Projects and Programmes	Report	Burke, EA., McCallion, P. and McCarron M., Advancing Years, Different Challenges: Wave 2 IDS-TILDA Findings on the ageing of people with an intellectual disability. Dublin: School of Nursing & Midwifery, Trinity College Dublin., Trinity College Dublin, The University of Dublin Trinity College, 2015 | Notes: [http://www.idstilda.tcd.ie/assets/pdf/Wave_2_Report_October_2014.pdf]
Research Capacity and Leadership	Book Chapter	Siobhan L., Donoghue O., O'Connell M, O'Hare C. & Nolan H; | Obesity and Health Outcomes in Older Irish Adults. In: A. Nolan et al. (eds) The Over 50's in a Changing Ireland: Economic Circumstances, Health and Wellbeing, 154-185.
Research Capacity and Leadership	Textbook	Elliott JA, le Roux CW "Glycaemic Control and Reduction of Cardiovascular Risk following Bariatric Surgery" in "Obesity, Bariatric and Metabolic Surgery: A Practical Guide", Springer, 2015. DOI: 10.1007/978-3-319-04343-2
Projects and Programmes	Invited Review	Toomey E, Hardeman W. Addressing Intervention Fidelity Within Physical Therapy Research and Clinical Practice. J Orthop Sports Phys Ther. 2017 Dec;47(12):895-898.
Projects and Programmes	Handbook	Arensman E, McCarthy S. Emerging Survivor Populations – Support After Suicide Clusters and Murder-Suicide Events. In: Andriessen K, Krysinska K, Grad O (Eds.). Postvention in Action: The International Handbook of Suicide Bereavement Support. 2017. Boston: Hogrefe.
Projects and Programmes	Article	G Jane Farrar, Sophia Millington-Ward. 2017. Inherited retinal disorders and gene therapies. The Irish Medical Times.
Projects and Programmes	Other	Murphy C (2017) Hypertension in older adults in the community in Ireland: evidence of the burden and implications for community nursing practice. Institute of Community Health Nursing, Dublin, Dublin.
Projects and Programmes	Technical Report	Medical Workforce Evidence 2013-18. (2018). Ruairi Brugha, Frances Cronin, Nick Clarke.
Projects and Programmes	Media contribution	Brugha R, Crowe S, Humphries N. Irish trainees continuing to emigrate. (2015) Irish Medical Journal.;108(9)

4.3 Conference presentations (oral and poster)

The extent to which researchers present their work to peers at national and international scientific conferences is an indicator of international involvement and recognition, and the desire to disseminate their research results. It also facilitates networking amongst peers and the potential for future collaboration.

Of the 187 awards completing in 2016/2017 that reported on their activities, 72.2% of award holders reported some type of scientific dissemination event to present their HRB-funded research findings. This is lower that figures from 2008/2009, 2010/2011 and 2012/13 awards, where a total of 92%, 87% and 95.5%, respectively, of award holders had presented the results of their HRB-funded research at scientific meetings. However, it is important to note that the overall number of scientific presentations was significantly increased from 940 in 2012/2013 to 1,524 in 2016/2017 highlighting that HRB-funded researchers are very active in sharing their work.

Importantly for networking and academic recognition, HRB-funded researchers are very active on both the national and international scientific stage.

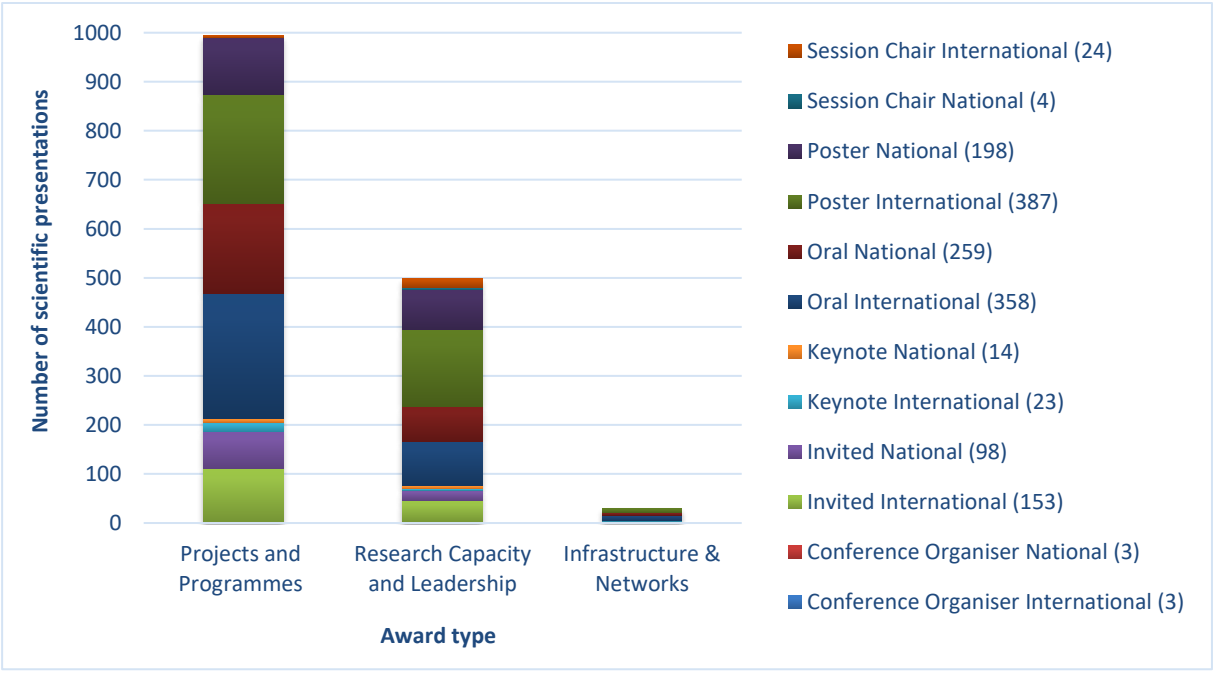
4.3.1 Distribution of conference presentations by award type

Figure 4.5 looks at the number of dissemination activities per award type, and Figure 4.6 looks at number of dissemination activities per €1 million spend per award type (both oral and poster) at national and international conferences.

Presentations (both oral and poster) at scientific meetings were the most common scientific dissemination type reported. Recipients of the MRCG Co-fund and Infrastructure awards were the most active in this regard.

Invitations to deliver keynote talks at international conferences are also an important indicator of scientific recognition and prestige among the international community. HRB award holders whose awards completed in 2016/2017 delivered 37 keynote talks at national and international scientific conferences. These keynote talks reported in 2016/2017 were predominantly (N=27) reported by Project Awards with Research Capacity and Leadership Awards accounting for the rest (N=9).

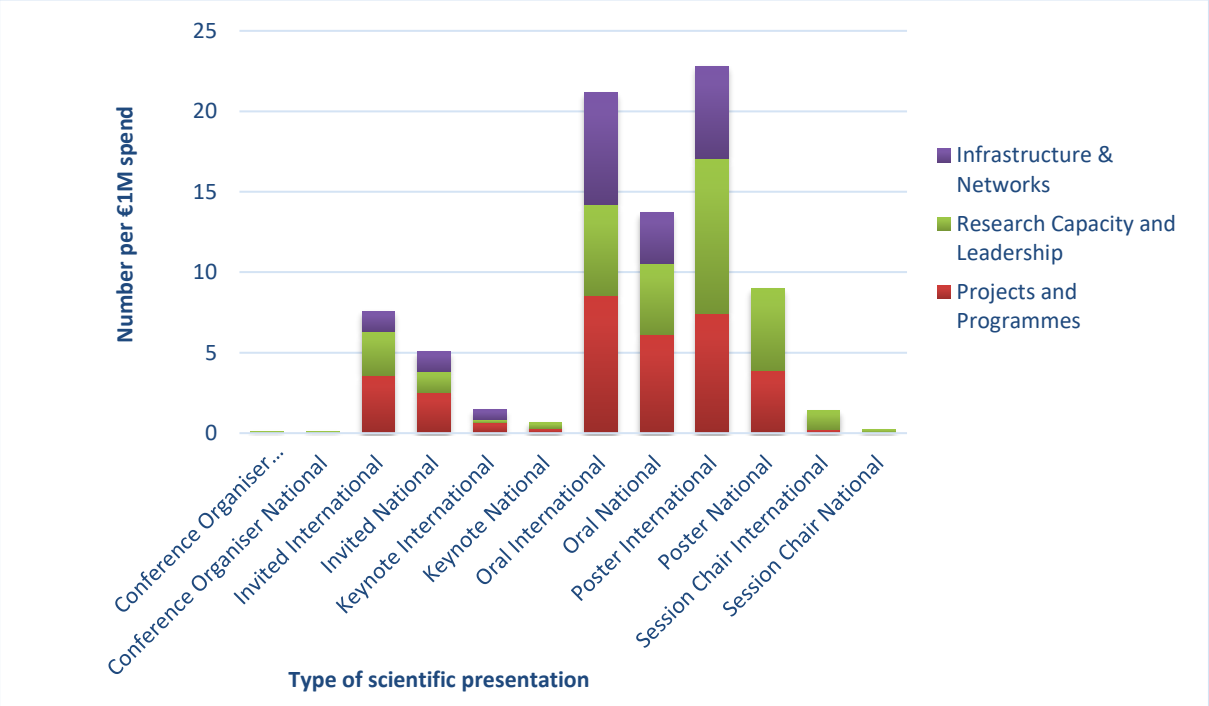
Figure 4.5: Number and type of scientific presentations per award type



Other indicators of scientific recognition and prestige are being invited to participate in a conference, to chair a scientific session or to become involved in the organising committee for a conference. In all these indicators HRB researchers performed well, both nationally and internationally across all award types. In total, HRB researchers reported invitations to speak at 98 national and 152 international scientific meetings, chairing of four national and 24 international scientific sessions, and involvement in the organising committee of six national and six international scientific conferences.

In terms of scientific productivity, Figure 4.6 shows that across all award types oral presentations at national and international conferences (N=617) yielded the most dissemination outputs per €1 million spend, followed by poster presentations at national and international conferences (N=585).

Figure 4.6: Number and type of scientific presentations per €1 million spend per award type



4.3.2 Distribution of conference presentations by broad research area

Figure 4.7 looks at the number of scientific dissemination outputs per broad research area, while Figure 4.8 looks at number of scientific dissemination outputs per €1 million spend per broad research area (both oral and poster) at national and international conferences.

In terms of areas of strength, awards classified as Clinical Research (N=567) and Applied Biomedical (N=384) reported the most outputs across all dissemination types, especially oral and poster presentations at national and international conferences.

In terms of keynote invitations which are an important indicator of international credibility and prestige, awards classified as Population Health Sciences reported the highest number of outputs (N=13.5), followed by Clinical Research (N=11.5), Health Services Research (N=6.5) and Applied Biomedical (N=5.5.) Awardees reported a small number of invitations to speak at both national and international conference.

In terms of productivity, the pattern was quite similar. Awards classified as Population Health Sciences were twice as productive per €1 million spend in terms of oral presentations at national and international conferences. Awards classified as Clinical Research and Health Services Research were less productive per €1 million spend although very similar in level. Awards classified as Biomedical Research were the least productive per €1 million spend across all categories of outputs.

Figure 4.7: Number and type of scientific presentations per broad research area

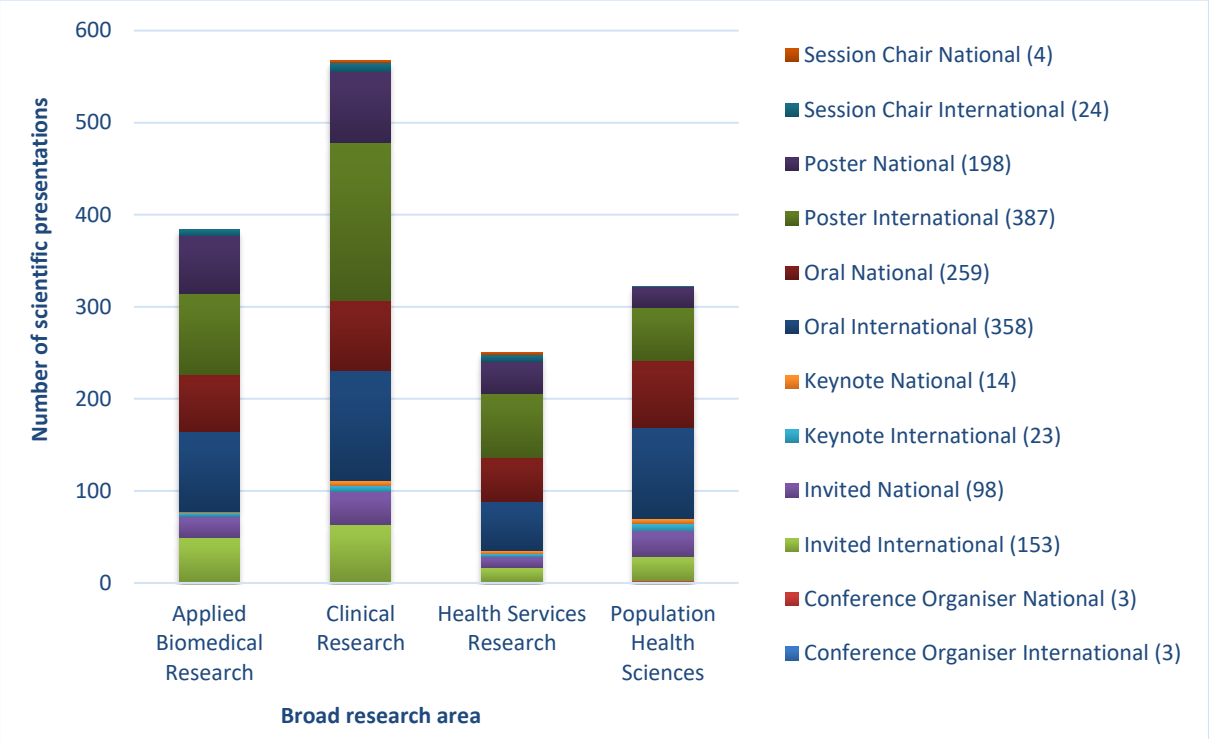
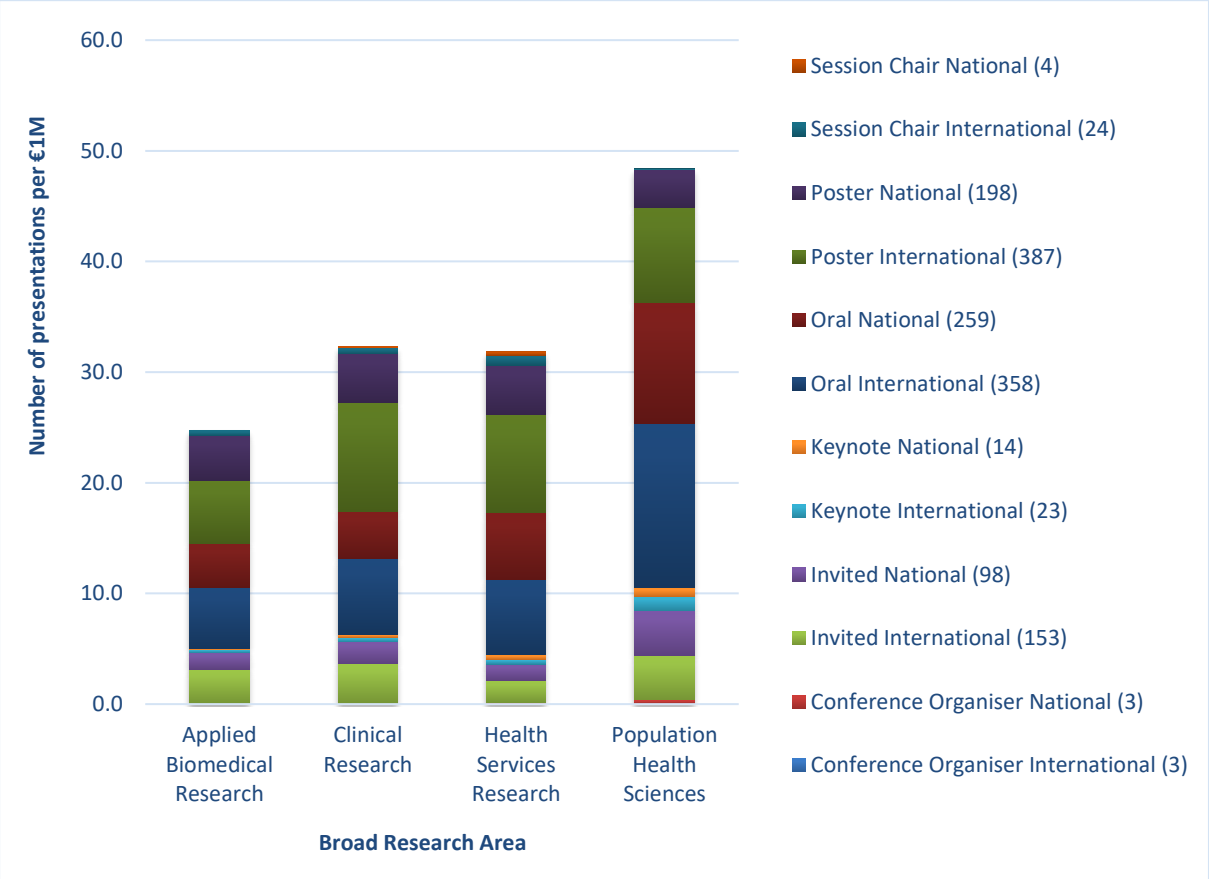


Figure 4.8: Number and type of scientific presentations per €1 million spend per broad research area



5. Capacity-building and leadership

A key strategic objective for the HRB is to embed research in the health system by:

- building capacity for research at some level among health professionals and other professional backgrounds who can contribute to a multi-disciplinary research environment
- supporting young researchers as they progress towards independent investigators

Measures of success in terms of capacity-building include not only the development of human capacity but indicators of the extent to which HRB researchers are advancing their field, and of the quality and impact of award holder's research as perceived by their peers through recognition and academic awards.

Summary of capacity building outputs 2016/2017 compared to previous reporting periods

Research Capacity Building	2016/2017 (N=187 awards)	2014/2015 (N=198 awards)	2012/2013 (N=134 awards)	2010/2011 (N=196 awards)	2008/2009 (N=204 awards)
Human capacity outputs					
Total no. research related posts created	329	385	422	280	296
No. PhD students trained	77	93	133	72	88
No. post-doctoral researchers supported	124	154	130	92	112
% of cohort from health professional background	40.1%	43.6%	32.2%	29%	NA*
Recognition and academic awards					
% of awards reporting indicator of peer recognition	53.5%	42.9%	70%	75% (2011 only)	NA*

** NA – data on all metrics is not available for every reporting period.*

Key Finding

Posts created via HRB awards

- In total, 329 research-related posts were supported. Of these, 40.1% of positions were filled by people from a health professional background (medical doctors, nurses and allied health professionals).
- Project and Programme awards accounted for 75% of the posts created, representing 8.5 posts per €1 million spend at an average cost of €120k per post. However, Infrastructure and Network awards supported 14 posts per €1 million spend (N=14).
- Clinical Research awards accounted for most posts (38%), followed by Health Services Research (28%), Applied Biomedical Research (21%) and Population Health Sciences (14%).
- In terms of academic level at which people were employed post-doctoral researchers accounted for 126 posts, compared to 93 research assistants and 64 post-graduate students.

Next destination

- By far the most common follow-on employment role reported was as a post-doctoral researcher or a research role (as a research assistant, research nurse or midwife, or research associate).
- 32 personnel were reported to be back working in full time clinical practice and 10 had taken up other health services roles. 27 people had secured lectureship posts, while four more obtained dual lecturer/clinical appointments. 26 people had moved into research management, science communication or outreach.

- 48 people had secured employment in the private sector (a significant increase on previous reporting periods.) These roles included IT or informatics specialists, marketing, on-line learning and pharma/medical devices R&D. This is a strong indicator that the skills development and training acquired by people who participated in HRB awards had value outside of academia and the health system.
- Most personnel (268) were employed in Ireland or Northern Ireland, while the remainder were based overseas.

Awards, prizes and other recognition

- Research prizes, medals or other acclaim were the most common types of recognition reported. HRB-supported researchers were also invited to contribute as keynote speakers internationally, to sit on organising committees of international scientific conferences and to participate in international scientific bodies such as advisory scientific committees.
- Researchers were invited to be authors of review papers or clinical guidelines or to contribute to journal and book editorial boards.
- The type of award and recognition that HRB and UK MRC researchers attract is very similar, despite the different scales and remits of these organisations

5.1 Personnel outputs

5.1.1 Types of personnel funded

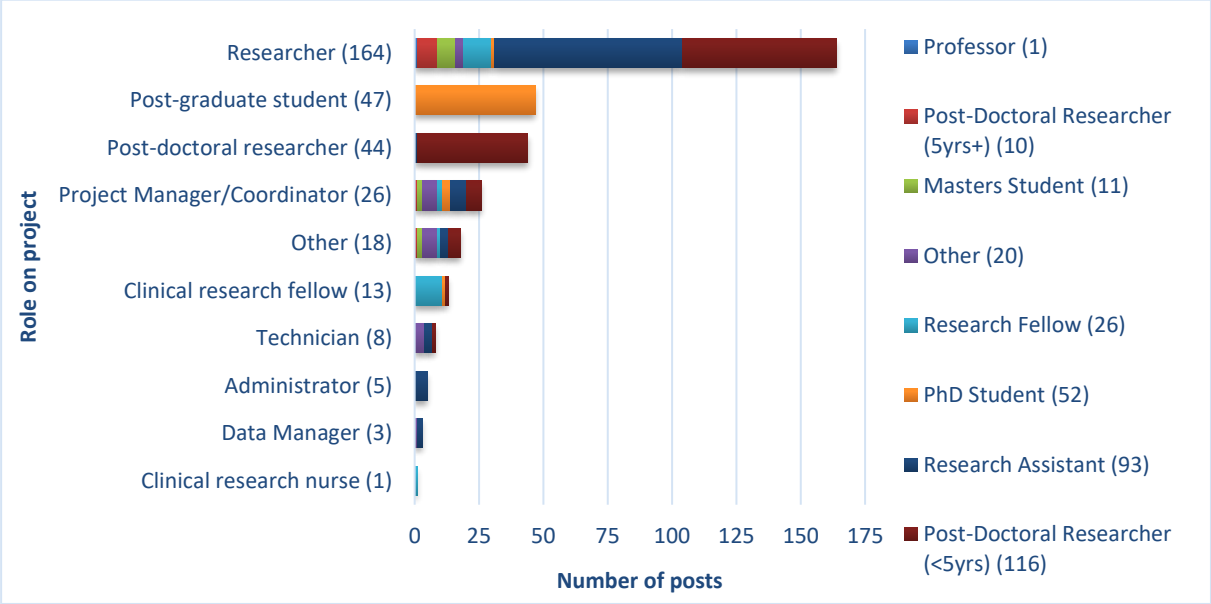
In total, 329 research-related posts were supported by the 187 HRB awards analysed that completed in 2016 and 2017. A breakdown of the role and academic level of personnel on these awards is shown in Figure 5.1.

'Researcher' was the most common role reported (49.9%). This role profile consisted primarily of research assistants (44.5%), and post-doctoral level researchers of varying experience (41.8%). Staff employed at research assistant level (N=78) served several roles in addition to being researchers on awards, including project manager/coordinators (N=7), data managers (N=5), technicians (N=3), administrators (N=3) and other non-specified roles. Staff employed at the academic level of Post-Doc (N=63), did not all hold a PhD, especially medical and allied health professionals. As well as being employed as researchers, some post-docs functioned as project managers/coordinators (N=7) and two had clinical roles (once medical, one nursing).

Personnel whose role was reported as 'Post-graduate student' accounted for 14.3% of total personnel and were completing both PhD (N=76) and Masters (N=8) degrees. Post-graduate students also functioned as project managers/coordinators (N=8), technicians or administrators (N=1 each).

21 people were categorised by the PI as having clinical research fellow, research fellow or clinical research nurse roles on their project. This group consisted of medical doctors, clinical nurses and midwives, and one allied health professional.

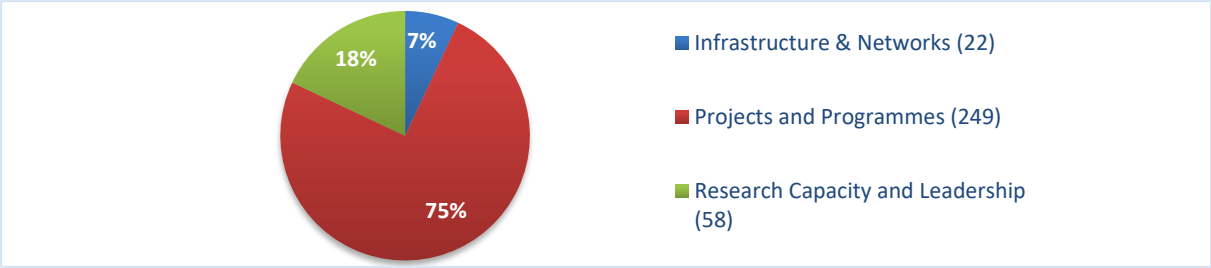
Figure 5.1: Academic level and role of personnel supported by HRB awards 2016/2017



5.1.2 Distribution of posts by scheme type

Figure 5.2 shows the broad distribution of posts across HRB scheme types in 2016/2017 while Figure 5.3 shows the distribution of posts supported by HRB awards, broken down by role on award and scheme type. Table 5.1 shows the breakdown of the average cost of posts per €1 million spend, to provide a normalised picture of post-creation by scheme type.

Figure 5.2: Breakdown of total number of posts created by scheme type 2016/2017



Overall, Project and Programme Awards accounted for 75% (n=249) of the posts created through HRB awards that completed in 2016/2017. Posts were primarily researchers (N=123), post-doctoral researchers (N=44), post-graduate students (N=30) and project managers/coordinators (N=20), although Project and Programme Awards supported roles in all categories. In terms of the costs of these posts, there were 8.3 posts created per €1 million spend, at an average cost of €120k per post.

Capacity Building and Leadership Awards created 58 posts for an investment of €16.1 million, or 3.6 posts per €1 million spend. While this might appear low, it should be remembered that many of these were high value awards to individual PIs in senior positions, to allow them to build capacity in a specific research field in either the academic or health system. Most of these posts were researchers (N=23), post-graduate students (N=13), clinical research fellows and other unspecified roles (N=8 each)

Infrastructure and Network Awards created 22 posts for an investment of €1.6 million, or 14 posts per €1 million spend. Given that all awards of this scheme type that completed in 2016/2017 were Networks, this high

level of posts would be expected. These posts were primarily researchers (N=16), with some post-graduate students (N=4) and project managers/coordinators (N=2).

Figure 5.3: Number and role of personnel funded on HRB awards per award type

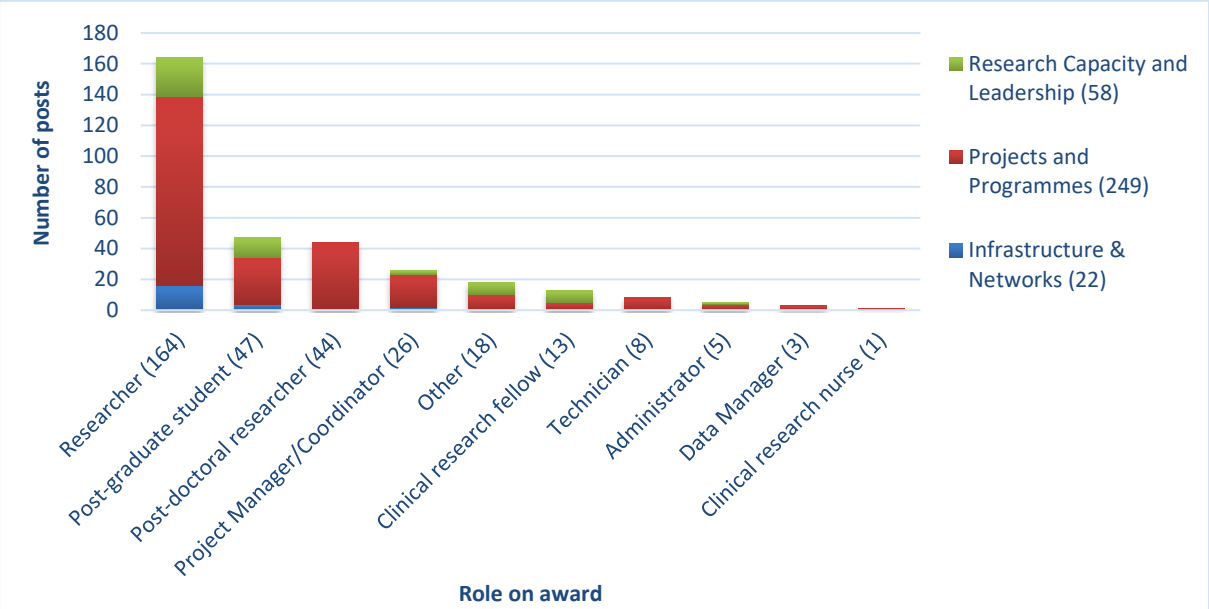


Table 5.1: Breakdown of posts by award type and per €1 million spend

Award type	Award total (€)	% Total spend	No of posts	Posts per €1M spend	Average cost (€) per post
Projects and Programmes	€29,923,538	63%	249	8.3	€120,175
Research Capacity and Leadership	€16,118,451	34%	58	3.6	€277,904
Infrastructure & Networks	€1,574,168	3%	22	14	€71,553

5.1.3 Distribution of posts by broad research area

Figure 5.4 shows the distribution of total numbers of posts created distributed by broad research area. When compared to the number of posts in each broad research area in previous reporting periods, the number of posts in Health Service Research and Clinical Research are increasing year on year, Population Health Services research posts remain steady, and there is a decrease in the number of posts in Applied Biomedical Research. This reflects the areas in which the HRB has been making investments over the past 10 years.

Figure 5.4: Breakdown of total number of posts created by broad research area 2016/2017

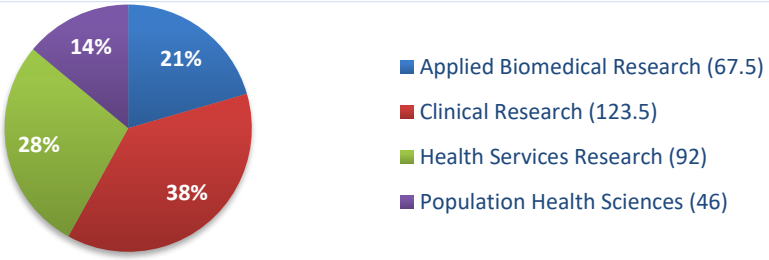


Figure 5.5 shows the kind of roles being supported by HRB awards across broad research area. Table 5.2 shows the breakdown of post types by broad research area and number per €1 million spend.

Researcher roles were the most common designation reported (49.8%), followed by post-graduate student posts (14.3%), post-doctoral role (13.4%) and project manager/coordinator role (7.9%). In terms of their association with broad research areas, Clinical Research accounted for 37.5% of posts created through HRB awards, followed by Health Services Research (28%), Applied Biomedical Research (20.5%) and Population Health Sciences (14%). However, in terms of productivity (Table 5.2), that is number of posts created per €1 million spend, awards classified as Health Sciences Research accounted for 11.7 posts per €1 million spend, which was considerably higher than the 2014/2015 reporting period (9.9 posts per €1 million spend). Clinical Research and Population Health Sciences awards produced 7.0 and 6.9 posts per €1 million spend respectively, while Applied Biomedical Research awards produced 4.4 posts per €1 million spend.

Figure 5.5: Number and role of personnel funded on HRB awards per broad research area 2016/2017

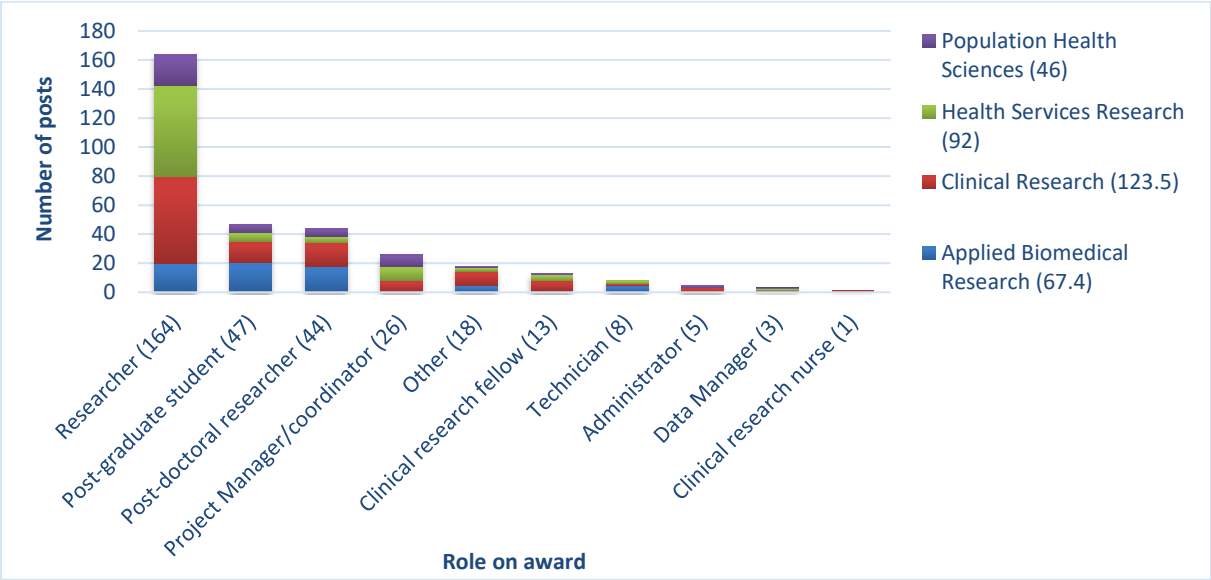


Table 5.2: Breakdown of posts by broad research area and number per €1 million spend 2016/2017

Award type	Award total (€)	% Total spend	No of posts	Posts per €1M spend	Average cost (€) per post
Applied Biomedical Research	€15,513,943	32%	67.5	4.4	€229,836.19
Clinical Research	€17,563,997	37%	123.5	7.0	€142,218.60
Health Services Research	€7,870,057	17%	92	11.7	€85,544.09
Population Health Sciences	€6,668,161	14%	46	6.9	€144,960.02
Grand Total	**€47,616,157**	**100%**	**329**	**7.0**	**€144,729.96**

Table 5.3 provides a comparison from 2008 to 2017, by broad research area of the total number of PhD students (Table 5.3a) and post-doctoral researchers (Table 5.3b) associated with HRB awards. The figures are presented as a percentage of the total numbers for each two-year period. The data shows a continuing and significant decrease in the proportion of post-graduates and post-doctoral researchers funded in Basic Biomedical Research across the eight-year period.

The number of post-graduate students, categorised as being involved in Applied Biomedical Research in 2016/2017 and 2014/2015 reporting periods was similar, and is accounted for by the completion of three PhD Scholars Programmes over that period that were categorised as Applied Biomedical Research. This contrasts

with the year-on-year decline in the number of post-doctoral researchers working in awards categorised as Applied Biomedical Research.

The number of both post-graduate students and post-doctoral researchers in Clinical Research has been steadily increasing since 2008.

Table 5.3a: Comparison of post-graduate students* supported by HRB awards, by broad research area, from 2008-2017

Broad research area	2016/2017	2014/2015	2012/2013	2010/2011	2008/2009
Basic Biomedical	0%	0%	4.1%	11%	15%
Applied Biomedical	26.2%	26.0%	63.1%	39%	39%
Clinical Research	33.7%	21.5%	17.9%	18%	18%
Health Services Research	25.6%	27.5%	13.8%	24%	17%
Population Health	14.5%	14%	1%	8%	11%

** Includes all people registered for a PhD or MSc regardless of whether they were categorised as post-graduate students or another personnel type by the PI at the time of reporting.*

Table 5.3b: Comparison of post-doctoral researchers* supported by HRB awards, by broad research area, from 2008-2017

Broad research area	2016/2017	2014/2015	2012/2013	2010/2011	2008/2009
Basic Biomedical	0%	1.3%	11.8%	24%	29%
Applied Biomedical	27.8%	40.3%	44.1%	59%	55%
Clinical Research	37.1%	30.8%	21.8%	11%	11%
Health Services Research	21.0%	19.2%	17.7%	4%	2%
Population Health	14.1%	8.4%	4.5%	2%	4%

** Excludes all people registered for a PhD or MSc (even if categorised as a post-doc by the PI at the time of reporting), and people categorised as administrators, technicians or research assistants.*

Tables 5.3a and 5.3b also suggest that the HRB's efforts to promote research in the areas of Population Health Sciences and Health Service research are driving job creation. The proportion of post-graduate student and post-doctoral researcher posts in these broad research areas have shown a steady increase over the last 10 years, although this is more obvious at post-doctoral level.

5.1.4 Professional background of personnel

An ambition of the *HRB Strategy 2016-2020* is to increase the number of non-biomedical researchers (health professionals, economists, biostatisticians, systems engineers, epidemiologists etc) engaged in research at some level, either in training or as researchers. Table 5.4 presents a breakdown of the professional background of personnel employed on HRB-funded awards that completed in 2016/2017 by the type of scheme through which these personnel were employed.

Of the 329 personnel reported, 132 came from a health and care professional background (medical doctor, nursing and midwifery and allied health professionals), representing 40.1% of the total personnel cohort. This is in line with the numbers reported in 2014/2015 (43.6%) and an increase on the numbers reported for the 2010/2011 (32.2%) and 2010/2011 (29%) reporting periods. Of the 132 health professionals 41 were registered for a higher degree, either PhD (N=37), MD (N=3) or MSc (N=1). Most health professionals were employed on Project and Programme awards (N=86), with 34 employed through Research Capacity and Leadership awards and 12 employed on Infrastructure and Network awards.

Personnel with a biomedical sciences background (N=101) were the largest group reported. However, reflecting the HRBs increased emphasis on Population Health Sciences and Health Services Research, there were 14 epidemiologists, nine health economists and seven statisticians engaged in HRB projects over the reporting period. Interestingly, in the 2016/2017 reporting there was a broad selection of non-biological backgrounds represented (Engineering (N =10), Project Management (N=7), Sociology and Politics (N=6), Information Technology (N=6), Chemistry/Physics (N=5), Humanities (N=4), Law (N=2) and one each of Environmental Science and Primary teaching.

Table 5.4: Professional background of personnel employed on HRB-funded awards by award type

Background	Research Capacity & Leadership Awards	Project & Programme Awards	Infrastructure & Network Awards	Total
Biomedical Science	11	88	2	**101**
Psychology or behavioural science	8	37	6	**51**
Medical/Surgical Doctor	18	17		**35**
Other	1	15	2	**18**
Nursing or Midwife (Including Clinical Research Nurse)	6	8	3	**17**
Epidemiology & Public Health	1	10	3	**14**
Engineering	2	8		**10**
Health Economics	3	4	2	**9**
Pharmacy or Pharmacology	1	7		**8**
Statistics or Mathematics	2	5		**7**
Project management/ Administration	1	6		**7**
Politics/Academic Sociology		5	1	**6**
Information Technology		6		**6**
Physiotherapy		4	1	**5**
Chemistry or Physics	1	4		**5**
Dentistry		5		**5**
Humanities	1	3		**4**
Speech and Language Therapy		4		**4**
Sport & Exercise Science		3		**3**
Dietetics/Nutrition		1	2	**3**
Social Care or Social Service	1	1		**2**
Law	1	1		**2**
Laboratory technical		2		**2**
Environmental Science		1		**1**
Teaching		1		**1**
Social sciences		1		**1**
Optomology/Visual Science		1		**1**
Occupational Therapy		1		**1**
Total	**58**	**249**	**22**	**329**

It is also interesting to look at the professional backgrounds of personnel employed across the broad research areas (Table 5.5).

In line with previous trends, personnel with a biomedical background were primarily employed in awards categorised as Applied Biomedical Research (N=53.5) and Clinical Research (N=35). Personnel with a health professional background were primarily employed on awards categorised as Clinical Research (N=51.5) and Health Services Research (N=50), with 20 employed on awards categorised as Population Health Sciences and only 9.5 employed on Applied Biomedical Research awards.

For personnel who came from non-biological or non-health backgrounds, the majority were employed on awards categorised as Clinical Research (N=23) and Health Services Research (N=23), with fewer being employed on awards categorised as Population Health Sciences (N=6.5) or Applied Biomedical Research (N=2.5).

Table 5.5: Professional background of personnel on HRB-funded awards by broad research area

Background	Applied Biomedical Research	Clinical Research	Health Services Research	Population Health Sciences	Total
Biomedical Science	53.5	35	8.5	4	**101**
Psychology or behavioural science		16	27	8	**51**
Medical/Surgical Doctor	4.5	21	7.5	2	**35**
Other	1	9	4.5	3.5	**18**
Nursing or Midwife (Including Clinical Research Nurse)		7	5	5	**17**
Epidemiology & Public Health		0.5	3.5	10	**14**
Engineering		8.5	1.5		**10**
Health Economics		1	6	2	**9**
Pharmacy or Pharmacology	4	1	2	1	**8**
Statistics or Mathematics	0.5	3	2	1.5	**7**
Project management/Administration		4.5	1.5	1	**7**
Politics/Academic Sociology			6		**6**
Information Technology	1	0.5	3	1.5	**6**
Physiotherapy		2.5	1	1.5	**5**
Chemistry or Physics	1	3.5	0.5		**5**
Dentistry			5		**5**
Humanities		2	2		**4**
Speech and Language Therapy		3	1		**4**
Sport & Exercise Science		3			**3**
Dietetics/Nutrition		0.5		2.5	**3**
Social Care or Social Services		0.5	0.5	1	**2**
Law		0.5	0.5	1	**2**
Laboratory technical	1		1		**2**
Social science		0.5		0.5	**1**
Teaching			1		**1**
Occupational Therapy			1		**1**
Environmental Science		0.5	0.5		**1**
Optomology/Visual Science	1				**1**
Total	**67.5**	**123.5**	92	**46**	**329**

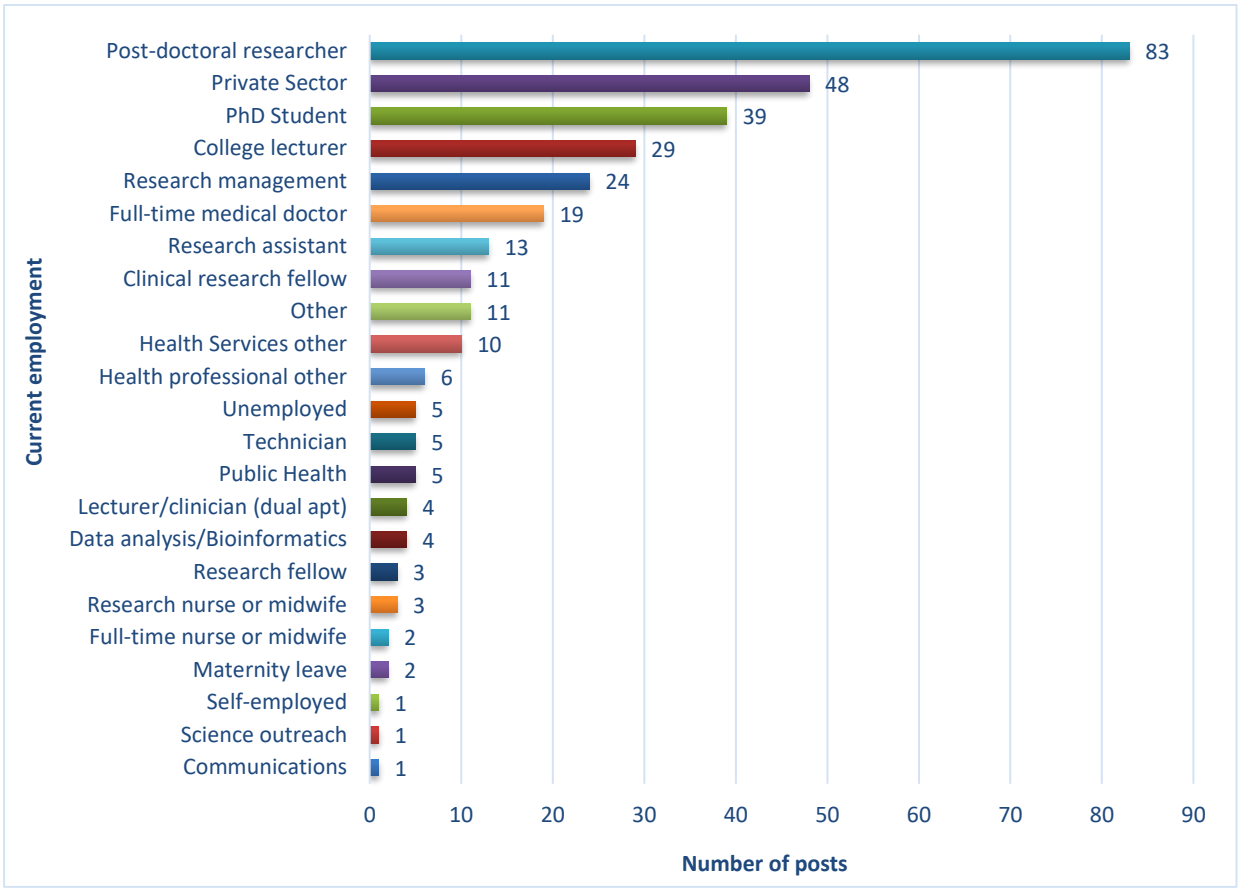
5.2 Current employment destination of personnel

Award holders were asked to provide information on the current employment of research personnel supported by HRB awards. Figure 5.6 shows the overall breakdown these current employment posts.

Consistent with the previous reporting periods, by far the most common follow-on employment role reported was as a post-doctoral researcher (25.2%) or another research role (for example as a research assistant, research fellow, research nurse or midwife – 11.6% of total personnel). 11.6% of personnel were still completing (or had just commenced) a PhD degree, which was also consistent with figures from the previous reporting periods.

32 personnel were reported to be back working in full time clinical practice (either as a medical doctor, a nurse/midwife, allied health professional, public health specialist or dentist) and 10 had taken up other health services roles. 27 people had secured lectureship posts, while four obtained dual lecturer/clinical appointments. 26 people had moved into research management, science communication or outreach.

Figure 5.6: Current employment of HRB award personnel



Interestingly, in the 2016/2017 reporting period, 48 people (15.8%) had secured employment in the private sector (a significant increase on previous reporting periods.) These roles included IT or informatics specialists, marketing, on-line learning and pharma/medical devices R&D. This is a strong indicator that the skills development and training acquired by people who participated in HRB awards had value outside of academia and the health system.

Figure 5.7: Type of award and schemes from which people moved to the private sector

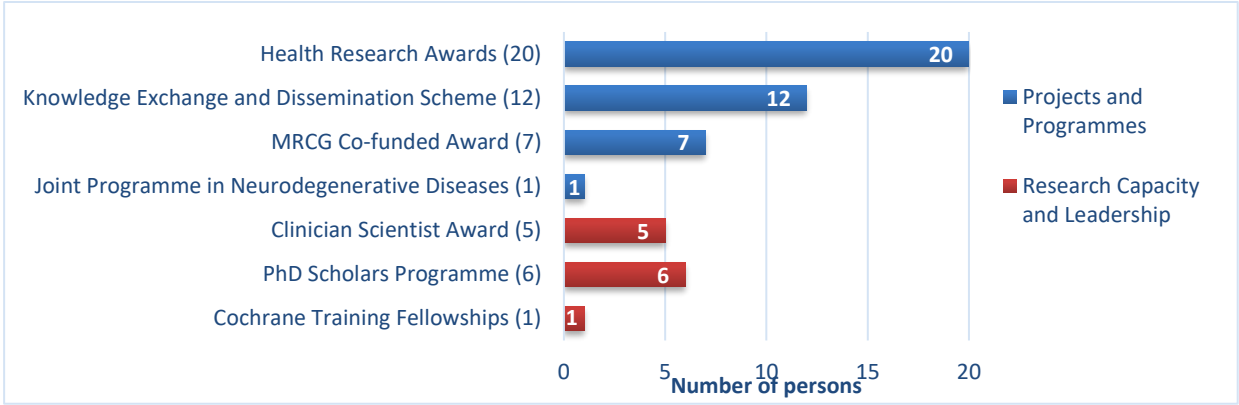
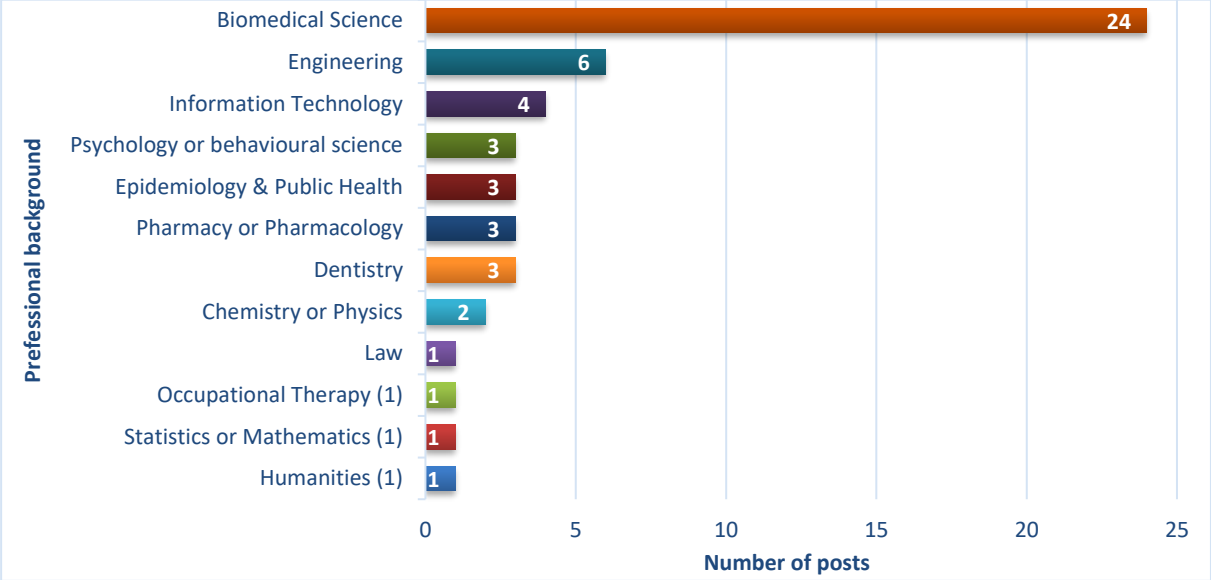


Figure 5.7 shows the type of award and the schemes on which the 48 people who moved to the private sector were employed, which Figure 5.8 shows the professional background of these people. While half of these people (N=24) were from a biomedical background, a number came from a variety of health backgrounds (11 allied health professionals, four with epidemiology or statistics background), and non-biological or health backgrounds (10 from engineering or ICT, two from chemistry or physics and one each from law and humanities.)

Figure 5.8: Professional background of people who moved into the private sector following their employment on a HRB award



5.2.1 Current location of personnel

Table 5.6 looks at the country of current employment for personnel supported by HRB awards that completed in 2016/2017. As might be expected most personnel (268) were employed in Ireland or Northern Ireland, while the remainder were based overseas. The most common overseas locations were the UK (N=28), North America (N=21), European Countries (N=8), Australia / New Zealand (N=2) and Asia / China (N=2).

Table 5.6: Country in which personnel are currently working /residing

Country of employment or residence	Number
Ireland/Northern Ireland	268
United Kingdom	28
United States of America/Canada	21
Other European	3
Australia/New Zealand	2
Spain	1
Belgium	1
Asia/China	2
Sweden	1
Italy	1
Netherlands	1

Table 5.7 provides a comparison between the awards that completed in 2016/2017 and those that completed in in previous reporting periods. From this it is evident that the proportion of researchers staying in Ireland or Northern Ireland has been consistent over time, while the numbers moving to the USA and Canada has increased slightly since 2010. The number of people moving to European countries has decreased since 2010.

Table 5.7: Country in which personnel are currently working/residing - comparing 2014/2015, 2012/2013 and 2010/2011

Country of employment or residence	2016/2017	2014/2015	2012/2013	2010/2011
Ireland/Northern Ireland	81.5%	80.8%	71.3%	77.5%
United Kingdom	8.5%	6%	4.5%	5.7%
United States of America	5.2%	3.9%	4.3%	4.6%
Other European Country	2.1%	2.3%	0.7%	1.4%
Germany	0	1.6%	0.5%	1.8%
Australia/New Zealand	0.3%	1%	2.1%	0.4%
France	0	1%	1.2%	1.1%
Spain	0.3%	1%	0	0.7%
Africa	0	0.8%	2.1%	4.6%
Asia	0.3%	0.5%	1.2%	1.4%
Canada	1.2%	0.5%	0	0
Unknown	0	0.5%	11.8%	0.4%
South America	0	0	0.2%	0
China	0.3%	0	0.	0.4%

5.3 Recognition and research awards

Award-holders whose awards completed in 2016/2017 were asked if they, or any members of their HRB-funded team, had received any awards or recognition related to their research during the period of the award. Awards and recognition received gives an indication of the quality and potential impact of award-holders' research as perceived by their peers nationally and internationally.

In this context, it was encouraging that 53.5% of PIs reported that either they or a member of their team received at least one type of award or recognition and a total of 456 awards or recognition were reported. Of the 100 awards that reported recognition and awards 36 had one incident, 28 had between two and four incidents, 23 had between five and nine incidents and 13 had more than ten incidents.

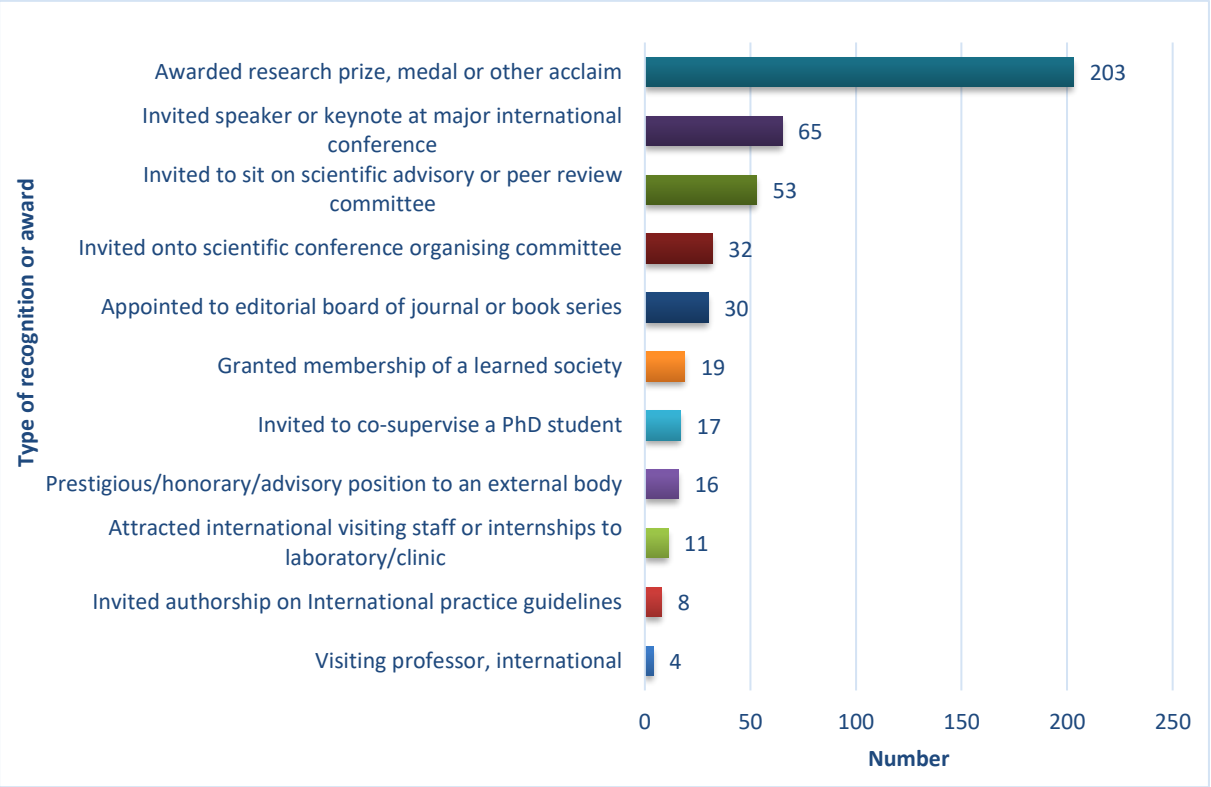
A similar percentage of PIs reporting awards and recognition was reported by the UK MRC during the same reporting period (52%).

The type of recognition or award reported by HRB researchers is shown in Figure 5.9. The most common form of recognition was a research prize, medal or other acclaim (N=203). This category includes, for example, travel awards and bursaries, and prizes for best paper or poster at a national or international scientific conference. HRB-supported researchers were also invited to contribute as keynote speakers (N=65), to sit on organising committees of international scientific conferences (N=32), and to participate in international scientific bodies such as advisory scientific committees (N=72)

Researchers were invited to be authors of papers or guideline documents, or to contribute to journal and book editorial boards (N=38). 19 researchers were granted membership of learned societies. Other less common, but

nonetheless important recognitions included being invited to co-supervise a PhD, host a visiting academic or be granted visiting academic funding.

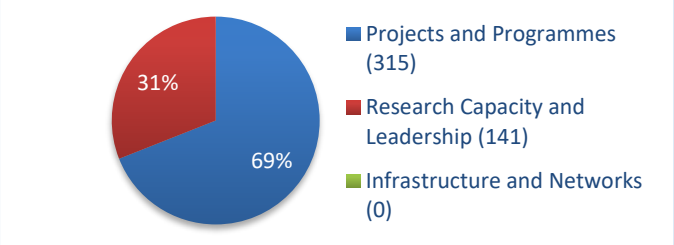
Figure 5.9: Number of awards reporting different types of research awards and recognition



5.3.1 Distribution of awards and recognition by award type

Figure 5.10 looks at the number of awards and recognitions by award type. It shows that Project and Programme awards accounted for 69% of all reported awards, prizes and peer recognition and had outputs of 10.5 awards per €1 million spent, an increase on the previous reporting period. Research Capacity and Leadership awards accounted for 31% of reported awards and had outputs of 8.7 awards per €1 million spent, also an increase on the previous reporting period. Infrastructure and Network Awards did not report any instances of awards, prizes or peer recognition, but given the all these awards completing in 2016/2017 were Networks, this is hardly unexpected.

Figure 5.10: Research awards and recognition broken down by award type and number per €1 million spend



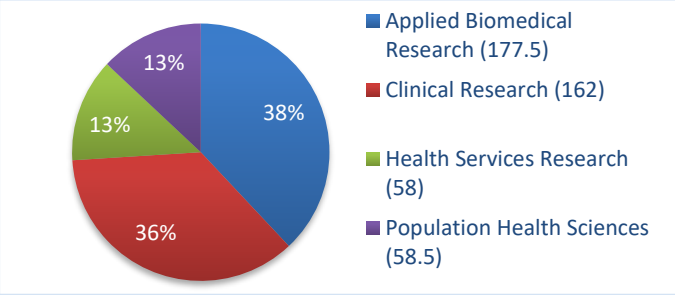
No. awards/prizes/recognition per 1 million spend	
Projects and Programmes	10.5
Research Capacity and Leadership	8.7
Infrastructure and Networks	0

5.3.2 Distribution of awards and recognition by broad research area

Figure 5.11 looks at the number of awards and recognitions by broad research area. It shows that awards classified as Applied Biomedical accounted for 38% of all reports of recognition and awards, and 11.4 instances

per €1 million spend. Awards classified as Clinical research accounted for 36% of reported recognition or 9.2 instances per €1 million spend. Health Services Research and Population Health Sciences awards each accounted for 13% of reported recognition and were also similar in the number of instances per €1 million spend (7.4 and 8.9, respectively.)

Figure 5.11: Research awards and recognition broken down by broad research area and number per €1 million spend



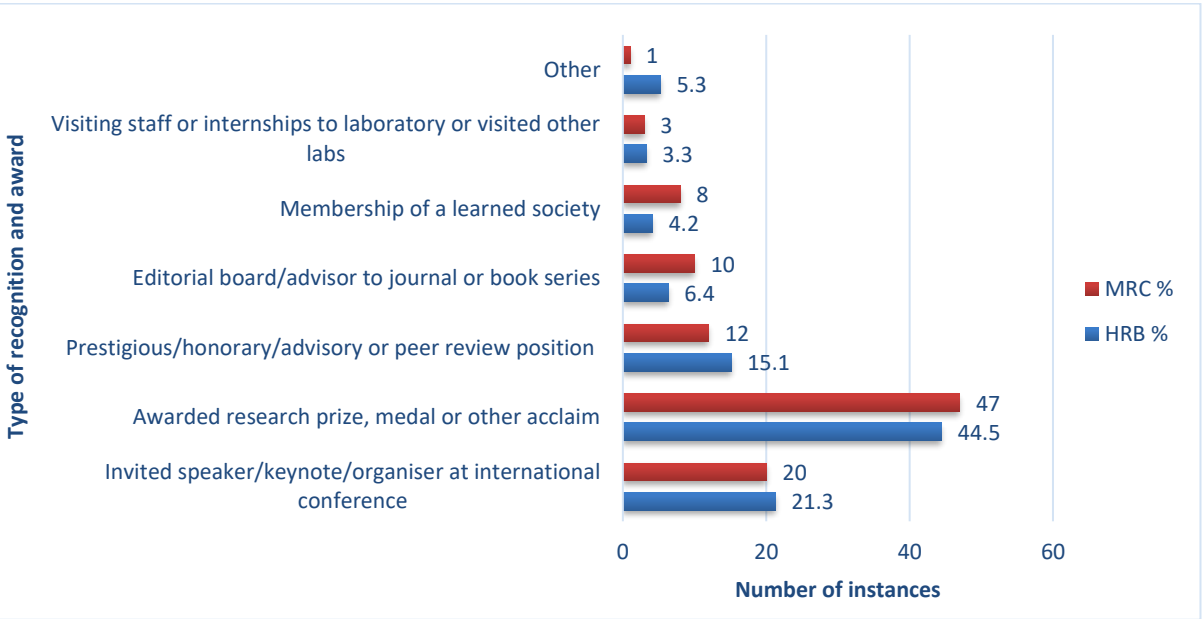
No. awards/prizes/recognition per 1 million spend	
Applied Biomedical Research	11.4
Clinical Research	9.2
Health Services Research	7.4
Population Health Sciences	8.9

5.3.2 Comparison of awards and recognition outputs of HRB and UK MRC

It is interesting to compare the types of awards and recognition being obtained by HRB-supported researchers with those of UN MRC supported researchers. While the categories used by both organisations are not completely compatible, there is enough commonality to make some comparisons in Figure 5.12.

Figure 5.12 shows that the type of awards and recognition that HRB and UK MRC researchers attract is very similar, despite the different scales and remits of these organisations. For both organisations, research prizes, medals or other acclaim are the most frequent type of recognition achieved, with invitations to present papers and keynotes at international conferences or participate in their organising committees being equally important for researchers in the HRB and MRC. Relatively speaking HRB researchers received a greater percentage of prestigious/honorary, advisory or peer review positions on external bodies that their MRC peers, while a higher proportion of MRC researchers were invited onto publication advisory boards and awarded membership to a learned society.

Figure 5.12: Comparison of HRB and MRC research awards and recognition patterns 2016/2017



5.3.3 Examples of recognition and awards outputs

Table 5.8 provides some examples of the types of research awards and recognition outputs reported by PIs whose awards completed in 2016/2017 as being linked to their award.

Table 5.8: Examples of research awards and recognition received by HRB-supported researchers 2016/2017

Scheme	Recipient	Type of Award/ Prize/ Recognition	Details
Health Professional Fellowship	Dr Eric Roche	Appointed to editorial board of journal or book series	Appointed to the editorial board of the Irish Journal of Psychological Medicine.
MRCG Co-Funded	Miss Denise Fitzgerald / Prof. Eileen Treacy	Invited authorship on International practice guidelines	Co-author and member of Study section for new European Galactosaemia guidelines.
Health Research Awards	Dr Emma Wallace	Invited authorship on International practice guidelines	Panel member for WikiRecs, which aims to create timely, trustworthy clinical practice recommendations based on the high-quality evidence.
Knowledge Exchange and Dissemination Scheme	Professor Ella Arensman	Prestigious/honorary/advisory position to an external body	President of the International Association for Suicide Prevention (IASP) in 2016, which works with WHO and has 70 country members.
Research Collaborative in Quality and Patient Safety	Professor Sean Dinneen	Visiting professor, international	James M. Flaherty Visiting Professor Award from the Ireland Canada University Foundation.
Health Professional Fellowship	Dr Donal Sexton	Awarded research prize, medal or other acclaim	Vincent Dolan Medal for best clinical research at the Irish Society of Nephrology Annual Scientific Meeting 2017 for generalisability of the SPRINT trial to Irish population.
MRCG Co-Funded	Miss Suzanne McCormack / Fergal O'Gara	Awarded research prize, medal or other acclaim	Winner of 2015 'You in Youtube' Science Communication Competition, School of Microbiology, UCC, Cork.
ICE Award	Professor Andrew Murphy	Awarded research prize, medal or other acclaim	Awarded 'Paper of Distinction' at North American Primary Care Research Group 2014 New York.
Cochrane Training Fellowship	Dr Kate Frazer	Granted membership of a learned society	Invited to join Science Media Centre, Wellcome Trust, London, Public Health Experts.
Clinician Scientist Award	Professor Orla Hardiman	Granted membership of a learned society	Elected to membership of Royal Irish Academy.
Knowledge Exchange and Dissemination Scheme	Professor Ella Arensman	Invited speaker or keynote at major international conference	Invited to present a keynote lecture at the 16th European Symposium on Suicide and Suicidal Behaviour, Oviedo, Spain.
MRCG Co-funded Award	Pamela Gallagher	Invited to sit on scientific advisory or peer review committee	Prof Pamela Gallagher was invited onto the Irish Cancer Society Research Advisory Committee.

6. Collaborations and leveraged funding

The development of collaborations and partnerships with national and international researchers, charities, policy makers and health bodies are an important indicator of the quality and potential future impact of HRB-funded research. The development of collaborations is also vital to enable leveraging of research funding.

Summary of 2016/2017 research collaboration and partnership outputs, compared to 2012/2013, 2010/2011 and 2008/2009 reporting periods

Research collaborations and leveraged funding	2016/2017 (N=187 awards)	2014/2015 (N=198 awards)	2012/2013 (N=134 awards)	2010/2011 (N=196 awards)	2008/2009 (N = 204 awards)
Research collaborations and partnerships					
Total no. collaborations	399	413	278	415	384
% of collaborations with health bodies	15.8%	18.6%	14%	10%	NA
Further funding leveraged					
No. additional research awards	199	180	149	113	117
Total value of leveraged funding	€57 M	€41.8 M	€39.5 M	€34.8 M	NA*
Amount leveraged per Euro of HRB investment	€1.20	€0.76	€0.89	€0.64	NA

Key Finding

Collaborations and partnerships

- 74.3% of HRB award-holders reported participation in collaborations/partnerships during the lifetime of their award, and almost three quarters of all collaborations involved an academic researcher, either in Ireland or based overseas.
- There were a significant number of collaborations established with health organisations who were either policy-focused or service delivery-focused, health charities or voluntary and community groups.
- The most popular reason for collaborating with academic or other partners was to conduct joint research, form networks, or share data and results. Gaining access to infrastructure, equipment, materials, methodology support, cohorts and datasets were also important reasons to collaborate.

Leveraged funding

- Almost half of awardees were successful in securing additional funding on the back of their HRB award. This figure is very similar to UK MRC researchers.
- A total of 199 additional awards were reported by 84 awardees, with a total value to HRB awardees of €57.6 million. Almost €31.7 million came from Irish exchequer sources, while €24.4 million came from non-exchequer sources in Ireland and oversees.
- The amount of funding leveraged per euro of HRB investment was €1.2, making this the first reporting period in which the amount of leveraged funding exceeded the original HRB investment.
- Project and Programme Awards accounted for 74% of all leveraged awards, and 74% of the total amount leveraged, representing a return on investment of €1.45 million for every €1 million spend. Almost half of all leveraged funding was associated with Applied Biomedical Research awards and a further 33% was associated with Clinical Research awards.

6.1 Development of research collaborations

From the 189 completed awards analysed in 2016/2017, 139 award-holders (74.3% of total) reported participation in a total of 399 collaborations during the lifetime of their HRB award. Of these, 267 were newly established collaborations or partnerships while 132 were existing collaborations or partnerships. The average number of collaborations per award that established at least one collaboration was 3.0.

6.1.1 Bibliometric indicators of collaboration

The Bibliometric Analysis of HRB publications 2013-2016 (of which the publications in this report form a subset) indicated that for both HRB and its benchmark units, the largest share of publication output resulted from international collaboration, at around 50% to 60%. For HRB funded internationally co-authored papers, there has been a steady upward trend over time and such papers have risen from 33.8% (2000-04) and 43.8% (2008-12) to 48% of all HRB publications in the 2013-16 publication period.

The proportion of publications resulting from national collaboration or from no collaboration outside of the authors' institution differs per benchmark unit. For the HRB, both publication types had an equal share (around 25%). This was also the case for UK MRC (though the share is lower, around 20%). There was strong collaboration between Irish institutions and university hospitals, and with institutions worldwide, that have resulted in co-authored publications.

6.1.2 Distribution by types of collaborations

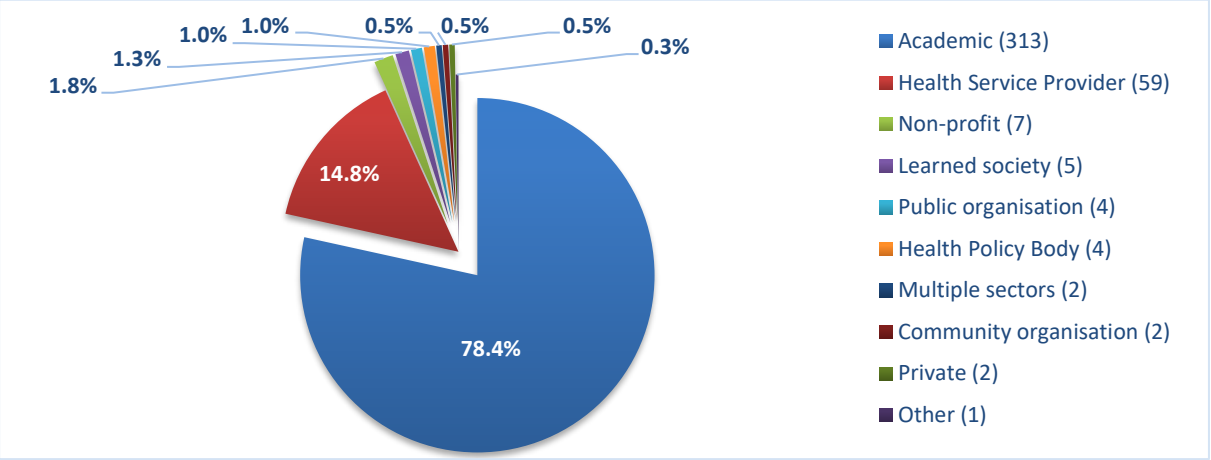
A breakdown of the 399 collaborations reported on, by type of collaboration, is provided in Figure 6.1. As can be seen, over three quarters (77.3%) of all collaborations reported were those involving an academic researcher, either in Ireland or based overseas.

Many researchers reported collaborations with health service providers, either hospital-based clinicians or allied health professionals in Ireland and overseas, some researchers also sought to collaborate in some way with industry partners, either national or international (N=8). It should be noted that 'international' in terms of company description refers to the type of company, for example a multinational company based either in Ireland or elsewhere, while 'national' in this sense refers to Irish-owned companies.

The number of industry collaborations, as a proportion of all collaborations established was less than the figure reported from awards ending in 2012/2013, from 31% to 12%. This reduction brings it more in line with the 2010/2011 reporting period when 8% of new collaborations were with industry, suggesting the high proportion of industry collaborations in 2012/2013 was an anomaly rather than an emerging trend. In that reporting period, a few Translational Research Awards completed, which contributed to this high number.

Given that the HRB seeks to impact on policy and practice, it was good to note that there were a significant number of collaborations established with health bodies who were either policy-focused or service delivery-focused, health charities and voluntary and community groups. The proportion of collaborations established with health bodies increased from 10% of total collaborations in 2010/2011 to 15.8% of total collaborations in 2016/2017.

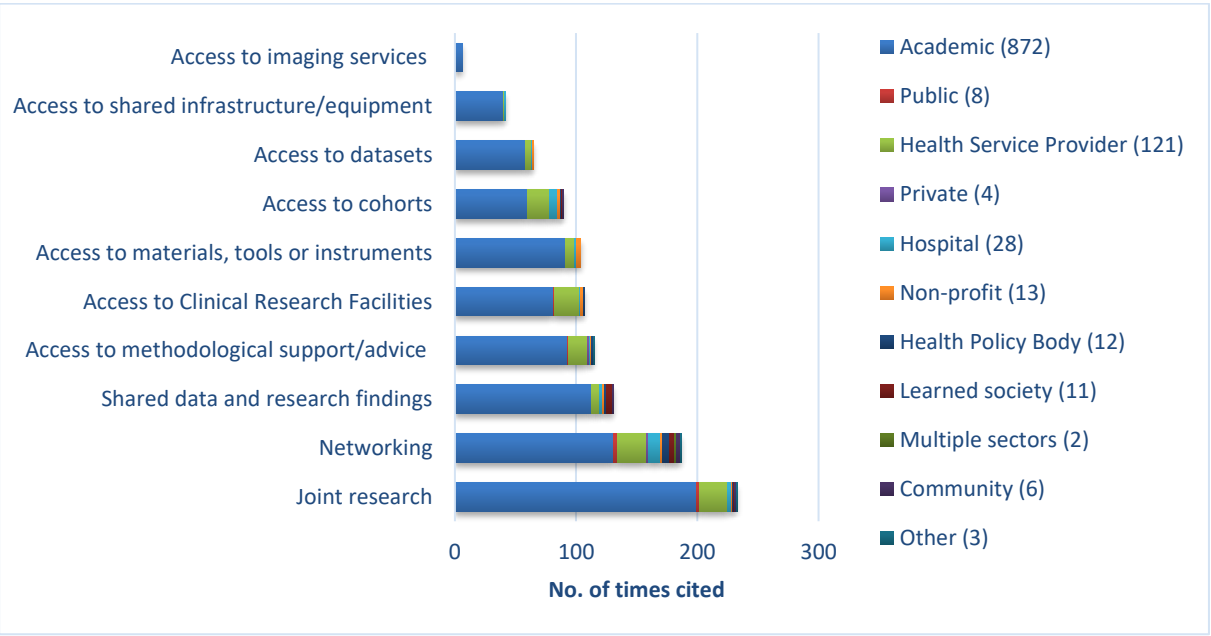
Figure 6.1: Breakdown of collaborations formed by HRB-funded researchers by type



6.1.3 Purpose of collaborations

Researchers were asked about the aim of their collaboration with another group or organisation. Figure 6.2 sets out the reasons cited (there could be more than one reason selected). Of the aims reported, the most popular reason for collaborating was Joint research (21.6%) with other academics but also with health bodies, charities, community groups and in three cases, the public advocacy groups. Other important reasons for collaboration included opportunities to network (17.3%) and share data and research findings (12.1%). Researchers also collaborated with others both within and outside of academic to gain access to a variety of supports, services and research tools. These included infrastructure, equipment, research materials, methodological supports, cohorts and datasets, which collectively accounted for 49% of the total response.

Figure 6.2: Cited reasons for participating in a collaboration by collaborating partner



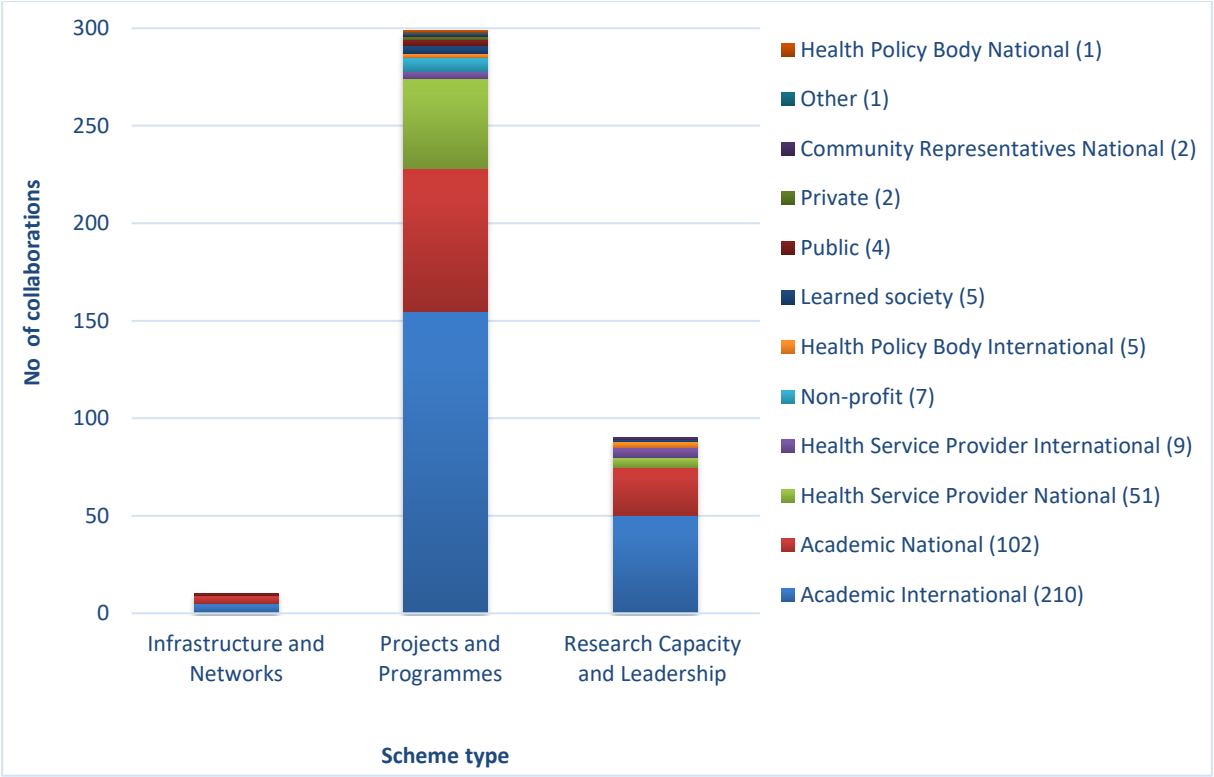
6.1.4 Distribution of collaborations by award type

The Bibliometric Analysis of HRB publications 2013-2016 (of which the publications in this report form a subset) found that the award type 'Capacity-building and Leadership' had the largest share of publications resulting from international collaboration. International co-authored publications arising from 'Co-funded Awards' (which includes MRCG Co-funded awards had citation scores of over twice the world average (2.22). For 'Infrastructures & Networks' non-collaborative publications yielded the highest citation impact (2.23), well over twice the world average, while internationally co-authored publications had an MNCS that was lower than the HRB aggregate, and just slightly above world average.

Analysis of collaboration activity by award type for the 187 awards that completed in 2016/2017 is presented in Figure 6.3. Overall, there was an average of 2.1 collaborations established per award. This relates to an overall average productivity of 8.5 collaborations per €1 million spend. However, the number and cost of collaborations varied widely depending on the award type.

As has been found in previous reporting periods, Project and Programme awards accounted for 75% of all collaborations reported in 2016/2017 and were very productive, with 10.1 collaborations established per €1 million spend. Research Capacity and Leadership awards accounted for 22.5% of the total number of collaborations and 5.6 collaborations per €1 million spend. Infrastructure and Network awards accounted for 0.02% of total collaborations but were very similar to Research Capacity and Leadership awards in terms of productivity, producing 6.3 collaborations per €1 million spend.

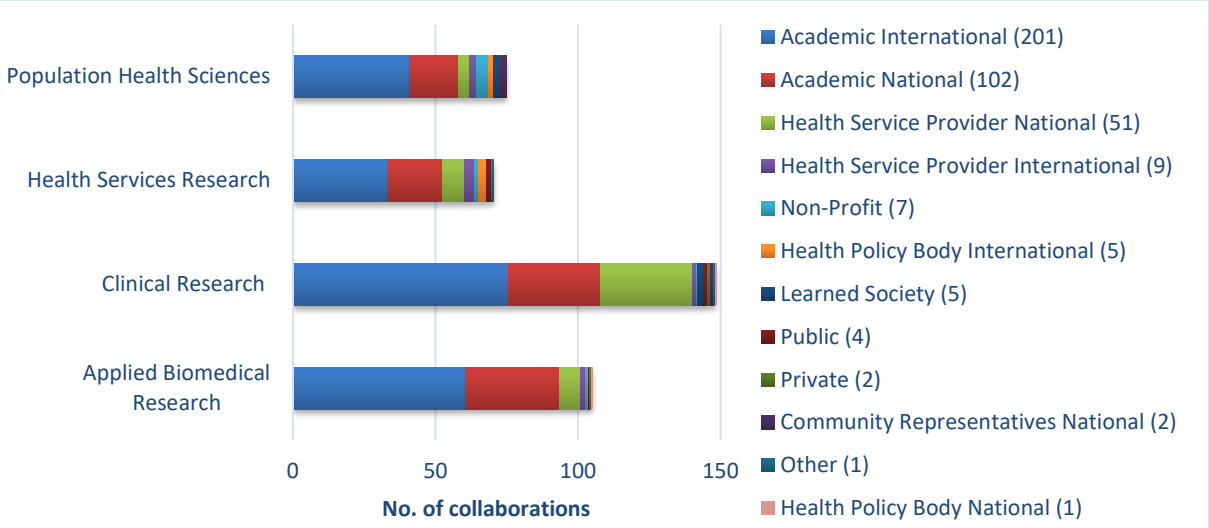
Figure 6.3: Type of collaboration established by award type



6.1.5 Distribution of collaboration by broad research area

Figure 6.4 looks at type of collaboration established by broad research area. From this it is evident that awards in all broad research areas established collaborations with academic partners, both internationally and nationally. Likewise, awards in all broad research areas had collaborations with both national and international health service providers, although unsurprisingly, this was more common for Clinical Research awards. Health Service Research and Population Health Science awards had also established significant collaborations with international health service providers and health policy bodies.

Figure 6.4: Type of collaboration established by broad research area



6.2 Further funding leveraged

From the HRB awards that completed in 2016/2017 a total of 84 awardees reported obtaining 199 additional awards on the back of research findings derived in whole or part from the original HRB award. The total value to HRB awardees of these leveraged awards was €57.6 million, which is significant increase on previous reporting periods (2014/2015 -€41.8 million; 2012/2013 -€39.5 million; 2012/2013 – €34.8 million).

The amount funding leveraged per euro of HRB investment in awards completing in 2016/2017 was €1.2, making this the first reporting period in which the amount of leveraged funding exceeded the original HRB investment. Almost €31.7 million came from Irish exchequer sources, while €24.4 million came from non-exchequer sources in Ireland and oversees.

Table 6.2 shows the number and value of these 199 leveraged awards according to their funding source, nationally and internationally, while Table 6.3 compares leveraged funding sources across reporting periods. In terms of EU and other collaborative awards, funding may have been awarded based on participation (rather than primary leadership) of the PI within a wider research consortium and the amounts shown in these cases reflect the allocation to the PI, as opposed to the total value of the award.

Overall, almost half (45%) of PIs were successful in securing additional funding by the end of grant on the back of their HRB award, an increase on previous reporting periods. The 2016/2017 figure compares well with the equivalent metric for UK MRC researchers, who reported instances of further funding in 47% of awards at the point of completion.

Leveraged exchequer funding, which accounted for €40.9 million (71% of total leveraged funding) came primarily from SFI, HRB, the Irish Research Councils and Enterprise Ireland. The category 'Other: National' captures awards that were reported as exchequer funding by an Irish agency, but the agency name was not specified, or the funding source was a university.

Non-exchequer funding, which accounted for €16.6 million (28.8% of total leveraged funding) came primarily from EU Framework programmes (58% of total non-exchequer) and given that the HRB has invested considerable resources in promoting, encouraging and helping Irish health researchers to participate in European funding programmes, this proportion is not surprising. However, national and international charities, philanthropy and national and international industry were also important sources of non-exchequer funding.

Table 6.2: Number and value of awards leveraged by HRB-supported researchers

Source of funding	No of Awards	% of total leveraged	Value of leveraged funding
Exchequer			
HRB	45	22.61%	€15,084,255
SFI	28	14.07%	€17,394,215
Other: National	18	9.05%	€6,338,682
IRC	11	5.53%	€1,779,790
Enterprise Ireland	4	2.01%	€140,523
Government Department	2	1.01%	€257,000
Non-Exchequer			
EU Other Programmes	17	8.54%	€7,089,013
Charity: National	16	8.04%	€2,306,352
Other: National	14	7.04%	€507,851
Industry: International	12	6.03%	€2,230,931
Industry: National	8	4.02%	€542,610
EU Framework Programme	8	4.02%	€2,576,300
Other: International	8	4.02%	€573,000
Philanthropic	4	2.01%	€561,684
Charity: International	4	2.01%	€201,262
Grand Total	**199**	**100.00%**	**€57,583,467**

Table 6.3: Funding leveraged by awards completed in 2016/2017, 2014/2015, 2012/2013 and 2010/2011

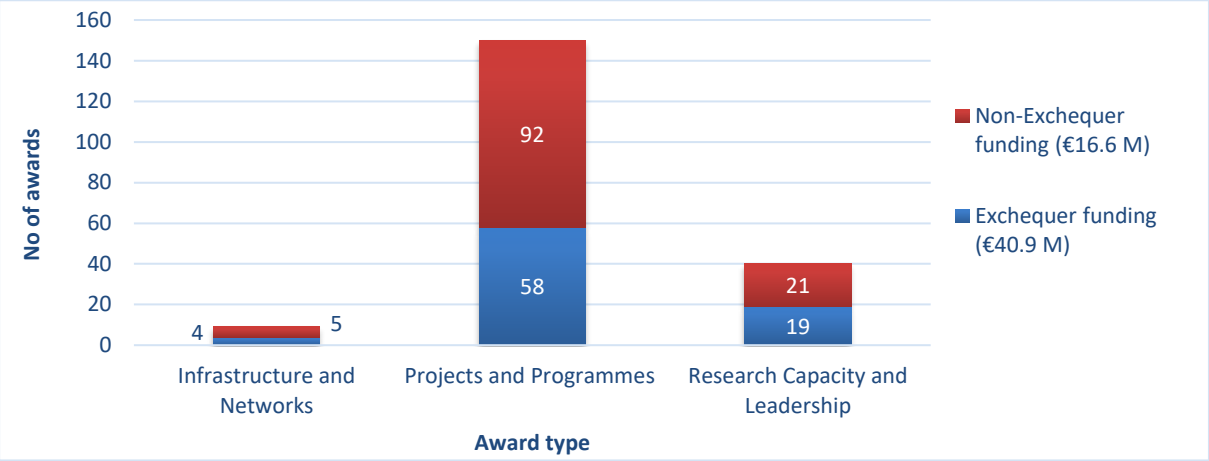
Source of funding	2016/2017	2014/2015	2012/2013	2010/2011
Exchequer				
HRB	€15,084,255	€11,570,015	€10,804,174	€6,448,756
Science Foundation Ireland	€17,394,215	€11,154,158	€5,603,990	€12,669,935
IRCSET/IRC	€1,779,790	€541,149	€626,127	€540,108
Enterprise Ireland	€140,523	€1,348,515	€671,927	€515,326
Other National (includes Government departments)	€6,479,205	-	€178,000	-
Non-Exchequer				
EU Framework Programmes	€2,576,300	€4,474,408	€13,916,028	-
EU Other	€7,089,013	€3,667,851	-	€6,681,534
Charity: National	€2,306,352	€3,400,661	€954,711	€3,703,952
Charity: International	€201,262	€1,106,247	€1,319,366	€716,271
Other: National	€507,851	€2,542,994	€2,677,343	€443,411
Other: International	€573,000	€1,093,348	€1,155,509	€1,772,659
Industry: National	€542,610	€54,800	€587,579	€791,823
Industry: International	€2,230,931	€479,800	€55,180	€184,000
Philanthropic	€561,684	€325,000.00	€130,000.00	€0.00
Total	**€57,583,467**	**€41,758,946**	**€38,679,934**	**€34,467,775**

6.2.1 Distribution of leveraged funding by award type

The number of leveraged funding awards, distributed by awards type is shown in Figure 6.5, while the value of awards leveraged as a percentage of the total additional funding secured and per €1 million spend are shown in Figure 6.6. These figures should be interpreted with caution as some award-holders may not yet have submitted applications for further funding by the end-of-award stage.

Of the 84 awardees that leveraged additional funding, 70 awardees reported between one and three additional awards, seven reported between four and six additional awards, while seven reported between seven and thirteen additional awards. Overall, the value of individual leveraged awards varied greatly, from €100 to support a one-day symposium, to €7.98 million from SFI to establish the Future Neuro Research Centre.

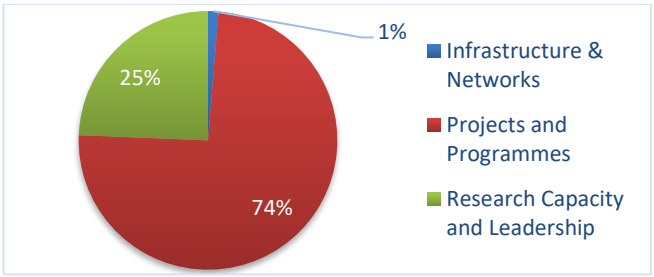
Figure 6.5: Number of leveraged awards (Exchequer and non-exchequer) by award type



Project and Programme Awards accounted for 74% of all leveraged awards, and 74% of the total amount leveraged. This represented a return on investment of €1.45 million for every €1 million spend on this award type. Research Capacity and Leadership awards accounted for 20% of the total number of leveraged awards and represented 24.4% of the total value of leveraged awards. This represented a return on investment of €0.87 million per €1 million spent. The size of these awards varied from €15K for a UCD Seed Funding Award to €2.5 million for an HRB Research Centre.

Infrastructure and Network awards accounted for 0.05% of leveraged awards and made up 5% of the total value of leveraged funding. This represented a return on investment of €0.48 million per €1 million spend.

Figure 6.6: Leveraged awards broken down by award type and amount leveraged per €1 million spend



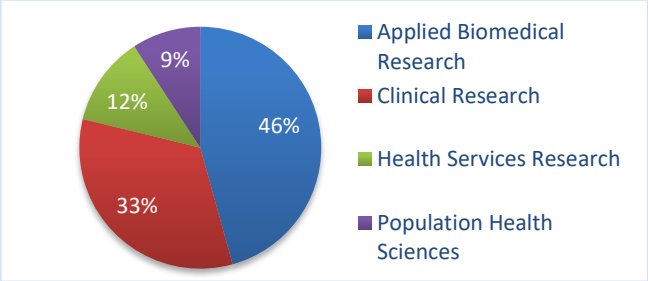
Value (€) of leveraged awards secured per €1 million spend	
Infrastructure and Network Awards	€480,127
Projects and Programme Awards	€1,450,925
Research Capacity and Leadership Awards	€871,266

6.2.2 Distribution of leveraged funding by broad research area

Figure 6.7 looks at the amount of leveraged funding obtained by broad research area and its value per €1 million spend, while Figure 6.8 looks at the distribution of funding sources across the broad research areas. These figures should be interpreted with caution as some award-holders may not yet have submitted applications for further funding by the end-of-award stage.

Figure 6.7 shows that almost half (46%) of all leveraged funding was associated with awards classified as Applied Biomedical Research and a further 33% was associated with Clinical Research awards. Awards in these broad research areas also accounted for the highest return on investment in terms of leveraged funding, with Applied Biomedical Research and Clinical research yielding €1.7 million and €1.1 million of leveraged funding per €1 million spend, respectively. Awards classified as Health Services Research and Population Health Sciences, although they only accounted for 12% and 9%, respectively, of the total amount of leveraged funding, were, nonetheless only slightly less productive in terms of the amount of funding leveraged per €1 million spend on these broad research areas.

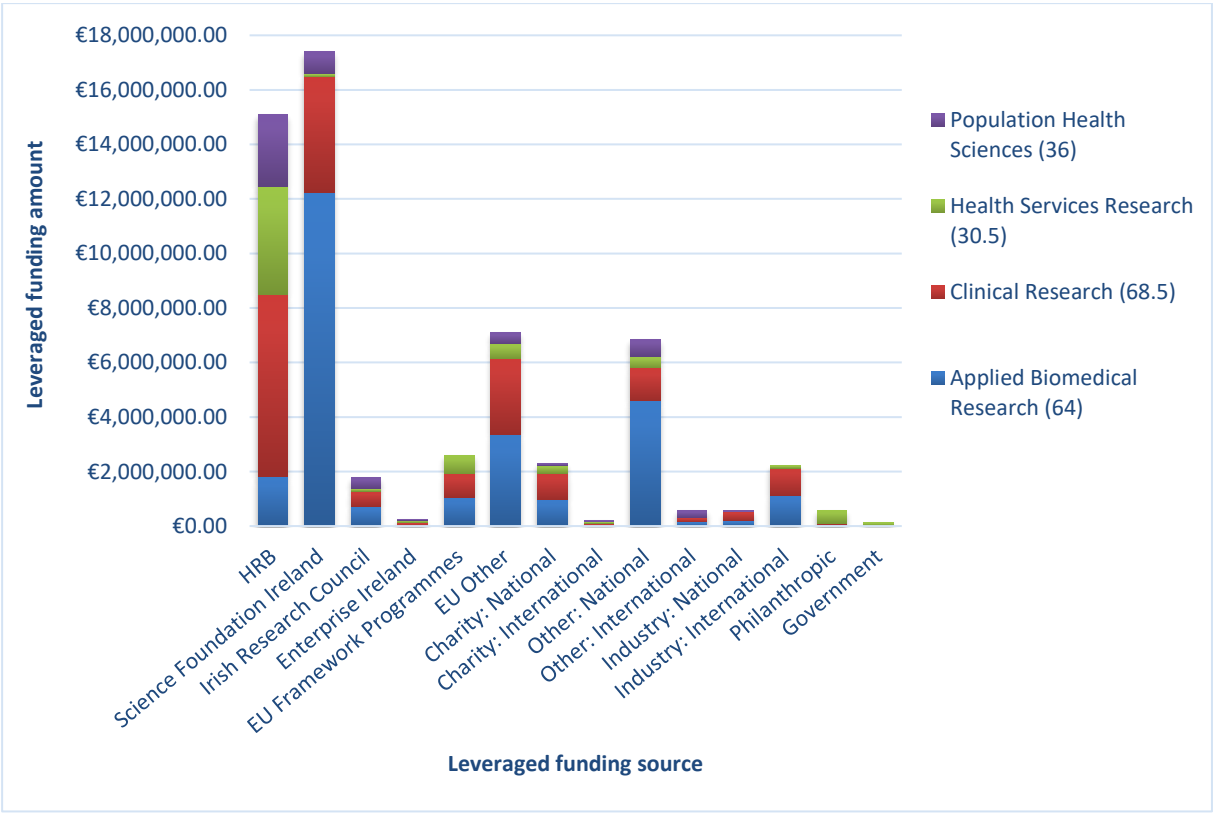
Figure 6.7: Leveraged awards broken down by broad research area and amount leveraged per €1 million spend



Value (€) of leveraged awards secured per €1 million spend	
Applied Biomedical Research	€1,697,611
Clinical Research	€1,085,672
Health Services Research	€878,482
Population Health Sciences	€848,149

Figure 6.8 shows that HRB funding was leveraged across all broad research areas, while SFI leveraged funding was primarily confined to Applied Biomedical and Clinical Research. In fact, Applied Biomedical and Clinical Research awards did well in leveraging funding across all exchequer and non-exchequer sources nationally and internationally. Funding leveraged by awards classified as Population Health Sciences came from a variety of sources, especially Irish funding agencies, charities and other EU and international sources, which awards classified as Health Services Research obtained additional funding from the HRB, EU Framework and other programmes, national and international charities and other sources, and philanthropic sources.

Figure 6.8: Source of funding broken down by broad research area for awards completing in 2016/2017



6.2.3 Examples of leveraged funding

Table 6.4 provides examples of the type of leveraged funding secured by awards that completed in 2016/2017.

Table 6.4: Examples of leveraged awards

Award	Details of additional awards leveraged
MRCG Co-fund award	1. HRB €349,319; The SEA-CHANGE study: a pilot randomised controlled trial of the SElf-management After Cancer of the Head and Neck Group intervention. 2. Other National €1,996,922; Exploration of therapeutic strategies for ocular disorders
Health Professional Fellowship	1. HRB €240,835; Concealed Pregnancy in 21st Century Ireland. 2. EU Other €156,062; Big Data Against Childhood Obesity. 3. Industry International €90.401; Pharmacokinetics and Pharmacodynamics of Sofosbuvir-based DAA therapy in the UK Expanded Access Programme (EAP).
Interdisciplinary Capacity Enhancement Award	1. HRB €2,499,650; HRB Primary Care Clinical Trial Network Ireland. 2. Charity International €90,000; Defining and Addressing the Complex Needs of ALS Caregivers. 3. EU Other €1,781,622; Meanings and Mechanisms of Psychotic Experiences in Young People.
Clinician Scientist Award	1. Enterprise Ireland €182,000; Enterprise and Innovation Partnership award. 2. Industry International €125,000; Seed funding a collaboration between RCSI and Aerogen. 3. Charity National €296,000; Investigating miRNA and NOCTURNIN regulation in early rapid growth and childhood obesity. 4. SFI €1,500,000; Co-applicant SFI Infrastructure award to establish an Early Life Lab in Cork University Hospital. 5. IRC €96,000; IRC-PhD a 4-year scholarship for Ms Sophie Casey to complete a PhD in neuroscience examining the role of miRNA markers in the pathogensis of HIE, using in vitro and small animal models of HIE.
Health Research Award	1. HRB €1,376,095; Individual and Area Level Determinants of Self-Harm and Suicide in Ireland: Enhancing Prediction, Risk Assessment and Management of Self-Harm by Health Services. 2. SFI €7,982,727; Future Neuro Research Centre. 3. IRC €400,000; Does Immune senescence contribute to AMD. 4. Enterprise Ireland €75,000; Stath-Guard: A novel securement technology to prevent catheter related infections. 5. EU Framework Programme €900,000; H2020 Marie Skłodowska-Curie Innovation Training Network "Training in Extracellular vesicles for benefit in Health and Disease". 6. Charity National €252,000; Improving and personalising chemotherapy treatment options for paediatric brain tumour patients. 7. Industry International €1,350,000; Prospective comparison of ARni with ArB in patients with natriuretic peptide eLEvation (PARABLE). 8. Philanthropic €58,000; Development of a (non-live) innovative digitally-based prototype application (App) to enhance the engagement of young adults with type 1 diabetes with health services.
Knowledge Exchange and Dissemination Award	1. HRB €679,255; Improving outcomes for young adults with type 1 diabetes in Ireland: The D1 Now feasibility and cluster randomised pilot study. 2. SFI €500,000; Investigating the molecular mechanisms underlying IL-1 family regulation of vascular integrity in the eye to identify next generation therapeutics for AMD. 3. EU Framework Programme €278,300; Drug Discovery and Delivery NEtwork for ONcology and Eye Therapeutics.

7. Informing policy and practice

Translating research into improved policies and practices is a strategic driver for the HRB. This translation occurs in many ways, but engagement – communicating and exchanging information and expertise – between researchers, the public and policymakers is crucial. Indicators that HRB supported researchers are working to achieve outputs and outcomes in this realm include efforts to place research evidence such that it can contribute to the development of policy development and improvements in clinical practice and contributing evidence to, or being actively involved in, the development of clinical guidelines, curriculum development, regulation etc.

Summary of 2016/2017 policy and practice outputs, compared to 2012/2013, 2010/2011 and 2008/2009 reporting periods

Health policy and clinical practice outputs/influences	2016/2017 (N=187 awards)	2014/2015 (N=198 awards)	2012/2013 (N=134 awards)	2010/2011 (N=196 awards)	2008/2009 (N = 204 awards)
Total no. policy and practice outputs	187	105	127	99	84
% awards reporting policy and practice outputs	44.9%	26.8%	38%	24%	20%
Average no. policy/practice outputs per €1 million spend	3.8	1.9	2.9	1.8	0.9

Key Finding

- Overall, the number of awards reporting policy and practice outputs continues to increase year on year with 187 policy and practice outputs reported in 2016/2017. This is higher than the 25% of UK MRC award holders who reported policy influences in 2016.
- The most common approach to placing research results in the policy and clinical practice spheres was to present finding to relevant stakeholders (policy makers, health managers etc.) through seminars, workshops and face-to-face meetings.
- The likelihood of a PI seeking to influence policy or clinical practice was strongly associated with the type of research being undertaken, with Health Services Research, Population Health Sciences and to a lesser extent Clinical Research being the most productive in terms of outputs per €1 million spend.
- Researchers employed a range of influencing strategies to achieve specific impacts. The most common impacts researchers hoped to have were to inform clinical care pathways and/or policy and practice guidelines, influence the development of policy or to provide the evidence to underpin improved health and wellbeing.

7.1 Health policy and practice outputs and influences

One of the HRB's core objectives is to encourage the uptake of evidence generated through HRB research investment in the development of policy and the improvement of clinical and public health practice. Therefore, a key metric in terms of assessing the potential impact of HRB-funded research relates to outputs and activities that have the potential to influence health policy, clinical practice and patient care. Researchers can ensure that the evidence generated by their HRB-funded research can influence policy and practice in many ways, including by:

- publication of reports, guidelines, policy briefs, handbooks and so on that are targeted at health policy-makers or practitioners
- interactions with research beneficiaries/users in health policy or clinical practice sectors (e.g. meetings, seminars hosted)
- advisory roles or expert group memberships (e.g. guideline committee, policy development group) instances of their HRB-funded research being cited in key clinical or health policy documents
- research findings being used to inform the education or training of health professionals or policy-makers

HRB awards holders would appear to be increasingly active in this regard. In total, PIs whose awards completed in 2016/2017 reported 187 policy and practice outputs from 81 awards (44.9%). This is higher the 25% of UK MRC award holders who reported policy influences in 2016.

7.1.1. Distribution of policy and practice outputs by type

Table 7.1 shows the breakdown of the reported policy/practice outputs and influences by sub-type in 2016/2017. A common approach by researchers to placing their research results in the policy and clinical practice spheres was to present their finding to relevant stakeholders (policy makers, health managers etc.) through seminars, workshops and face-to-face meetings and so on. This approach accounted for 40.1% of all outputs reported. Various forms of dissemination via specialist publications, policy reports and briefings, Cochrane reviews, newsletters, professional body websites or as submissions to consultation processes were also reported (21.9% of reports).

Table 7.1: Breakdown of policy/practice outputs and influences by type in 2016/2017

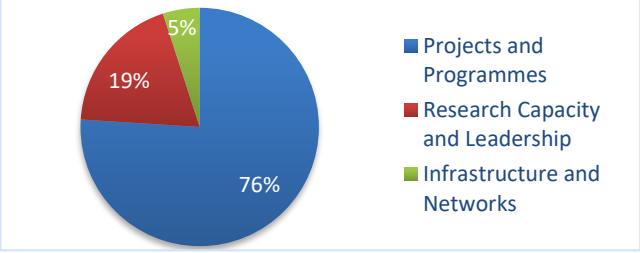
Output/influences sub-categories	% awards
Meetings with policy-makers, health managers or other key users to present/discuss findings	23.5%
Hosted or presented research findings at a stakeholder seminar or workshop	16.6%
Influenced training or education of health professionals and/or policy makers	13.4%
Advisory role, or member of policy committee	10.7%
Published a policy report/brief or booklet	7.5%
Research featured in newsletter, or on website, of professional body	6.4%
Coverage in specialised medical or health publications (e.g. Irish Medical Times)	4.8%
Submitted research evidence to a national consultation process	4.3%
Published practice or treatment guidelines or standards	3.2%
Citation in clinical guidelines	2.1%
Submitted evidence to or was a member of a guideline committee	2.1%
Citation in other policy documents	2.1%
Citation in systematic review	1.6%
Other	1.1%
Submitted evidence to a government review group	0.5%

The results emerging from HRB-funded awards were cited in influential policy and clinical practice documents such as Clinical Guidelines, clinical reviews, policy documents, government reports (5.9%), or influenced the training or education of health professionals and/or policy makers (13.4%).

7.1.2 Distribution of policy and practice influences by award type and scheme

In terms of the distribution of policy and practice outputs across award type, Figure 7.1 shows that Project and Programme awards accounted for 76% of all reported policy and clinical practice outputs and were productive in terms of the number of outputs per €1 million spend (4.7). Research Capacity and Leadership awards accounted for 19% of outputs reported and resulted in 2.2 outputs per €1 million spend. Unsurprisingly, given that they were exclusively in the clinical and health services research space, the Infrastructure and Network Awards report the highest productivity for this metric, and while they only accounting for 5% of the total reported policy and practice output, they resulted in 5.7 outputs per €1 million spent.

Figure 7.1: Policy and practice outputs, broken down by award type and number per €1 million spend



No. of reported policy/practice influences per €1 million spend	
Projects and Programmes	4.7
Research Capacity and Leadership	2.2
Infrastructure and Networks	5.7

Distribution of policy and practice influences by scheme

When the data is analysed at the level of individual schemes, Table 7.2 captures the number of policy and practice outputs reported by schemes and examines the total number of outputs as a proportion of the total number of awards reporting in 2016/2017.

Table 7.2: Distribution of policy and practice outputs by schemes, and as a proportion of total number of awards in each scheme completing in 2017/2017

Scheme	No. of policy & practice outputs	Total no. of awards reporting in scheme 2016/2017	Average no. outputs per award
Health Research Awards	75	73	1.0
Knowledge Exchange and Dissemination Scheme	51	44	1.2
Health Professional Fellowship	16	15	1.1
Framework for Safe Nurse Staffing and Skill Mix	8	1	8.0
Interdisciplinary Capacity Enhancement Awards	8	6	1.3
MRCG Co-fund Award	7	20	0.4
Structured Research Network	5	1	5.0
JPI Healthy Diet for a Healthy Life	4	2	2.0
Applied Research Projects in Dementia	3	1	3.0
Joint Programme in Neurodegenerative Disease	3	3	1.0
Clinician Scientist Award	2	2	1.0
Cochrane Training Fellowship	2	7	0.3
Research Collaborative in Quality and Patient Safety	2	4	0.5
Cancer Research Nursing Project	1	2	0.5
Grand Total	**187**	**181**	**1.0**

Unsurprisingly, given that the primary focus of HRB-funded research investment is the generation of opportunities for improved healthcare delivery, better health outcomes and the generation of research evidence to inform policy and improve clinical practice, Table 11.2 shows that for almost all schemes that reported on this metric, there was between 0.5 and one output per award. Schemes that produced more than one output were predictably strongly Health Services Research or Population Health Sciences focused (e.g. Framework for Safe Nurse Staffing and Skills Mix (N=8), Structured Research Network in Palliative Care (N=5), Applied Projects in Dementia (N=3) and JPI Healthy Diet for a Healthy Life (N=2)).

Schemes that completed in 2016/2017, but that did not report any policy and practice outputs (e.g. Cancer Prevention Fellowships, National SpR/SR Academic Fellowship Programme, PhD Scholars Programme and Post-Doctoral Fellowship in Translational Medicine) were all targeted at early-stage researchers, who focused on Applied Biomedical and Clinical Research.

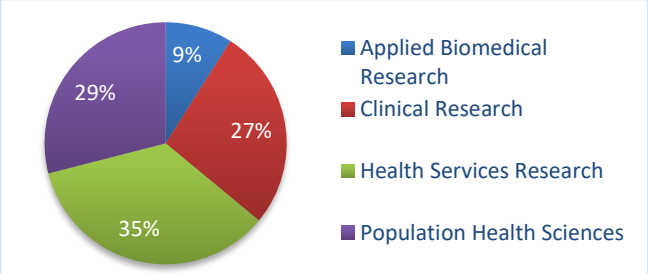
7.1.3 Distribution of policy and practice influences by broad research area

The likelihood of a PI seeking to influence policy or clinical practice will be associated to a large extent with the type of research being undertaken. Therefore, research Clinical Research, Population Health Sciences and Health Services Research areas might be expected to be more productive in terms of attempting to influence policy or clinical practice.

This is verified in Figure 7.2, where these broad research areas accounted for 91% of all policy and clinical practice influences. However, this distribution was somewhat different when the number of outputs per €1 million spend was considered. Using this metric, Population Health Sciences and Health Services Research-focused awards had the highest number of outputs (8.3 each) per €1 million spend, which is an increase on the number of outputs per €1 million reported by awards completing in 2014/2015. Surprisingly, awards classified as Clinical Research, which might be expected to produce considerable clinical practice outputs, produced only 2.9 outputs per €1 million spend.

Awards classified as Applied Biomedical Research the least productive in terms of policy and practice outputs, accounting for 1.0 outputs per €1 million spend. This is not an entirely surprising result, since these types of awards would be more focused on outputs in the categories of knowledge production and capacity building, rather than in influencing policy and clinical practice.

Figure 7.2: Policy and practice outputs, broken down by broad research area and number per €1 million spend



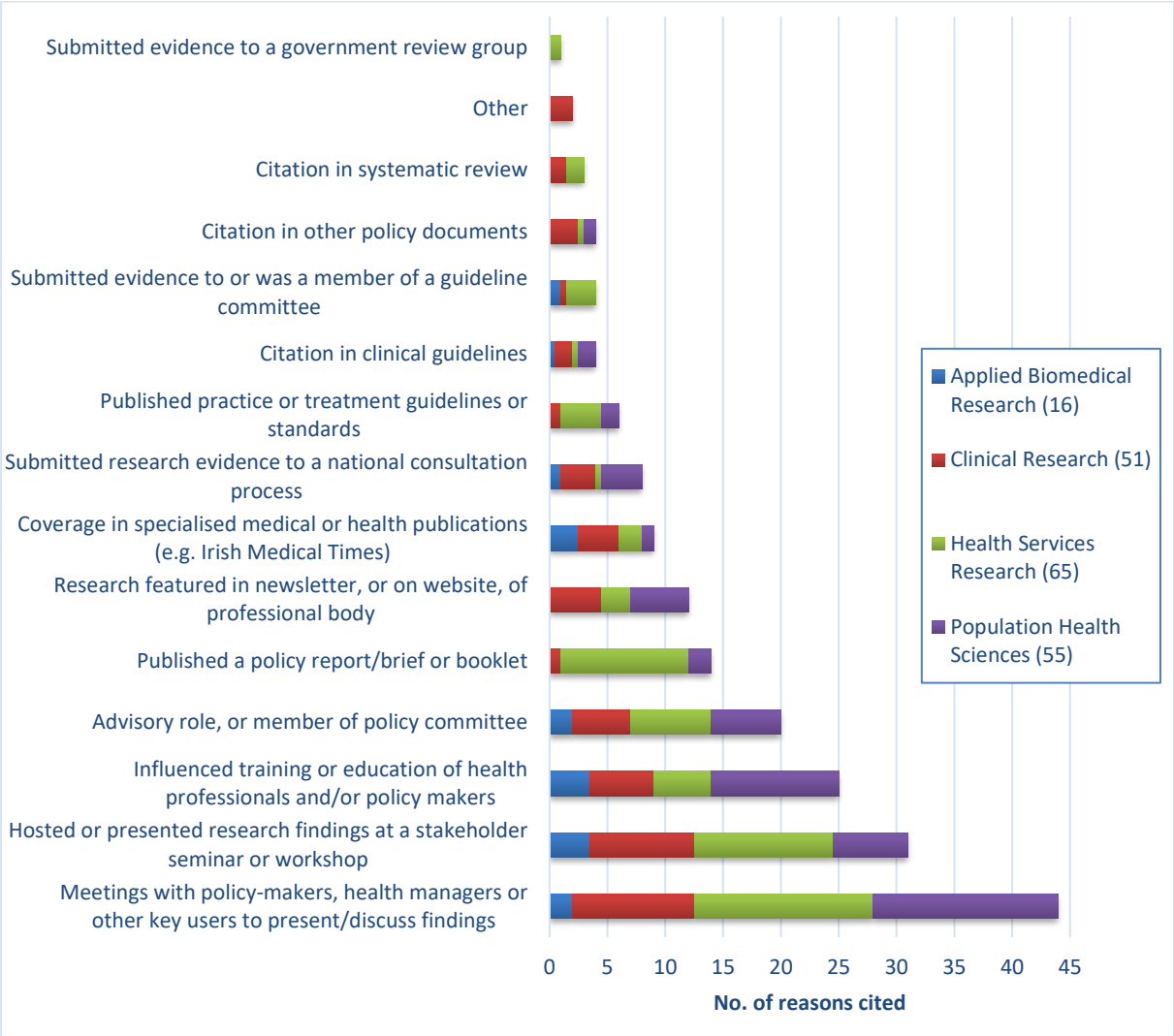
No. of reported policy/practice influences per €1 million spend	
Applied Biomedical Research	1.0
Clinical Research	2.9
Health Services Research	8.3
Population Health Sciences	8.3

Figure 7.3 looks at distribution of policy and practice influence by type across the broad research areas. This compares levels of output (as a proportion of the total funding awarded) as opposed to numbers of outputs, to normalise comparison across different broad research areas.

Figure 7.3 shows that researchers on awards classified as Health Services Research used all mechanisms available to them, and in particular; hosting stakeholder workshops and seminars or presenting their research finding at such events, and meeting with policy-makers, health managers and other key service users to discuss the implications of their research findings. This latter mechanism was also the most popular mechanism used to try and have an influence on developments in policy or clinical practice by researchers in Clinical Research

and Population Health Sciences, although Researchers in these broad areas also used a range of mechanisms to a lesser extent. Researchers in Clinical Research also used publication of policy briefs and presentation of results to stakeholders influence policy and clinical practice, while researchers in Population Health Science reported many instances of influencing training and education of healthcare professionals and/or policy makers.

Figure 7.3: Policy and practice outputs per broad research area broken down by output type



7.1.4 Potential impacts on policy and practice

Researchers were not only asked about how they attempted to inform policy or clinical practice through various dissemination strategies but also about how they hoped that these activities might inform or underpin policy and/or practice.

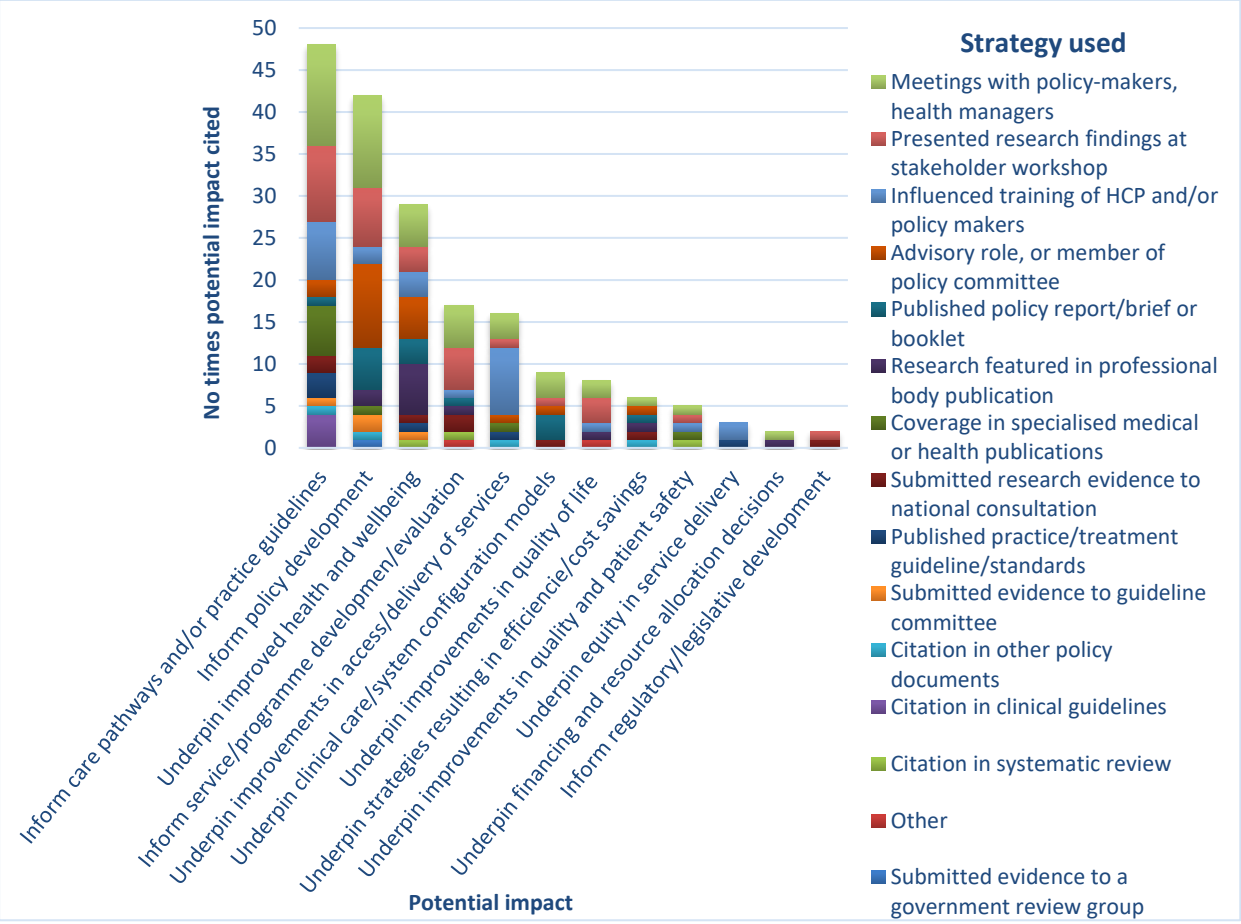
Table 7.3 shows the type of potential impacts on policy and practice selected by researchers. This shows that the most common impacts researchers hoped to have though their activities were to inform clinical care pathways and/or policy and practice guidelines (25.7%), influence the development of policy (22.5%), provide the evidence to underpin improved health and wellbeing (15.5%), provide research evidence to underpin product, service or programme development and evaluation (9.9%) or provide research evidence to underpin improvements in the quality of life of patients, family and caregivers (8.6%).

Figure 7.4 looks at the influencing/dissemination strategies used by researchers to achieve an impact. This shows that researchers employed a range of strategies to attempt to achieve specific impacts.

Table 7.3: Potential impacts identified by researchers for their policy and practice outputs

Potential impact of policy and/or practice influence	No. of potential policy and practice impacts
Inform clinical care pathways and/or clinical practice guidelines	48
Inform policy development	42
Underpin improved health and wellbeing	29
Inform product/service/programme development and evaluation	17
Underpin improvements in access to and delivery of services	16
Underpin clinical care/health system configuration models	9
Underpin improvements in quality of life of patients, family and caregivers	8
Underpin strategies resulting in efficiencies and cost savings	6
Underpin improvements in quality and patient safety	5
Underpin equity in service delivery	3
Underpin financing and resource allocation decisions	2
Inform regulatory/legislative development	2
Grand Total	**187**

Figure 7.4: Influencing strategy used by researchers compared to anticipated potential impact



7.1.5 Examples of policy and practice influences

Table 7.4 provides some examples of the type of policy and practice outputs reported for this metric by PIs whose awards completed in 2016/2017.

Table 7.4: Examples of policy and practice influences arising from HRB-funded awards

Award Type	Type of policy and practice outputs	Details of policy/practice output
Cochrane Training Fellowship	Published practice or treatment guidelines or standards	The 1st review was reported by NIHR for updating guidance on smoking bans
Applied Research Project in Dementia	Meetings with policy-makers, health managers or other key users to present/discuss findings	Meetings with National Dementia Office regarding the outcome of the research and discussion on the potential to include cognitive communication assessment and intervention within care pathways.
Joint Programme Healthy Diet for a Health Life	Submitted evidence to a Government review group	Written submission to Oireachtas Committee on School Food to inform policy development and implementation in this area.
Health Professional Fellowship	Meetings with policy-makers, health managers or other key users to present/discuss findings	Work related to the W28GO intervention was delivered and discussed at a lunch-time Dáil session in 2013.
Health Research Award	Citation in clinical guidelines	Incorporation of the St Vincent's Screening TO Prevent Heart Failure Programme into the American College of Cardiology/American Heart Association Guidelines on Heart Failure (2017).
HRB-MRCG Joint Funding Award	Research featured in newsletter, or on website, of professional body	Research results described in the Epilepsy Ireland newsletter for members.
Health Research Award	Published a policy report/brief or booklet	Policy Brief on Interdisciplinary Team Working in Ireland: A New Direction 16 years on.
Structured Research Network	Hosted or presented research findings at a stakeholder seminar or workshop	Quality of life & palliative care needs of patients with advanced heart failure & their caregivers project held a workshop in November 2016 with policy makers, researchers, clinicians and members of the public.
Health Professional Fellowship	Citation in clinical guidelines	Cited in ESC Guidelines for the Diagnosis and Management of Syncope
Research Collaboration in Quality and Patient Safety	Meetings with policy-makers, health managers or other key users to present/discuss findings	Meetings were held prior to the publication of the results with key stakeholders including the HSE, RCPI, HIQA, RCQPS to inform them of the main results of the study.

8. Engagement activities

Engaging with audiences outside of academia is an important part of the research process. Wider dissemination of research findings to non-scientific audiences is vital for improving the public understanding of complex research topics, for recruiting patients to clinical trials and engaging the public in the design and conduct of research, and for communicating the benefits and value of health research to non-scientific stakeholders. Such activities include:

Summary of policy and practice outputs, compared to 2012/2013, 2010/2011 and 2008/2009 reporting periods

Activity type	2016/2017 (N=187 awards)	2014/2015 (N=198 awards)	2012/2013 (N=134 awards)	2010/2011 (N=196 awards)	2008/2009 (N = 204 awards)
Non-academic engagement					
Total no. non-academic engagement activities	531	258	188	122	NA*
% PIs reporting non-academic engagement activity	70.1	47.5%	50%	35%	NA
Average no. non-academic engagement outputs per €1 million spend	11.2	4.69	4.6	2.2	NA
Public and patient involvement					
% projects reporting PPI outputs	21.9%	-	-	-	-
No. of PPI outputs reported	69	-	-	-	-

** Questions on engagement outputs were not included in the 2008/2009 survey*

Key Finding

- 70.1% of award holders reported 531 non-academic engagement outputs which is a significant increase on this type of activity from previous reporting periods and is also considerably higher that the equivalent metric reported by UK MRC researchers of 59%.
- Additionally, 41 awardees (21.9% of total) reported 69 public and patient involvement (PPI) outputs during the period of their research project.
- Presentation of research findings to public and patient groups was the most popular medium, followed by dissemination in the print media, and there was a significant increase in PIs reporting the use of social media and blogs to disseminate their research findings.
- Project and Programme awards were by far the productive in terms of engagement outputs per €1 million spend (15.2), and Health Services Research and Population Health Sciences awards were the most productive in terms of engagement outputs, with 13.3 and 26.2 outputs per €1 million spend, respectively.

8.1 Non-academic engagement outputs

When asked if they had engaged in wider dissemination of their research to non-academic audiences through various fora, 131 (70.5%) of award holders reported 531 outputs in this area. This is a significant increase in both the number of awards reporting this output and the number of outputs on the 2014/2015 reporting

period. This figure is also considerably higher that the equivalent metric reported by UK MRC researchers of 59% in the 2016 reporting period. 84 award holders reported 1-3 engagement outputs, 26 reported 4-6 engagement outputs, 12 award holders reported 7-10 engagement outputs and four award holders reported 11-14 engagement outputs. There were also a small number of award holders (N=4) who reported between 15 and 35 engagement outputs, all of these being Health Research Awards in Population Health Sciences or Health Services Research.

8.1.1 Distribution of engagement outputs by type

Table 8.1 shows a breakdown of public/patient engagement outputs by type. This shows that presentation to various non-academic stakeholder groups including school children and participation in non-academic workshops and open days were popular forms of communication, accounting for 40.4% of non-peer dissemination outputs reported by researchers. Disseminating research findings in the print media, popular magazines, via social media and blogs, or preparation of plain English material for a public audience accounted for 38.3% of engagement activity. Conducting an interview or issuing a press release were also popular forms of communications, accounting for a combined 21.3% of dissemination outputs reported by researchers.

Table 8.1: Breakdown of public and patient engagement activity by type

Type of activity	No. of outputs
Talk or Presentation to a non-academic audience	127
Coverage in local, regional or national general press	94
Participation in activity, workshop or similar	65
Radio or TV interview in Ireland	59
Press release, press conference or response to a media query	53
Social media coverage (Facebook, Twitter etc)	44
Plain English material (e.g. information booklet)	27
Online publication or blog (non-academic)	20
Participation in open day	13
School talk on subject of HRB-funded research	10
Coverage in international general press	10
Popular magazine feature or other popular media	8
Radio or TV interview in other country	1
Total	**531**

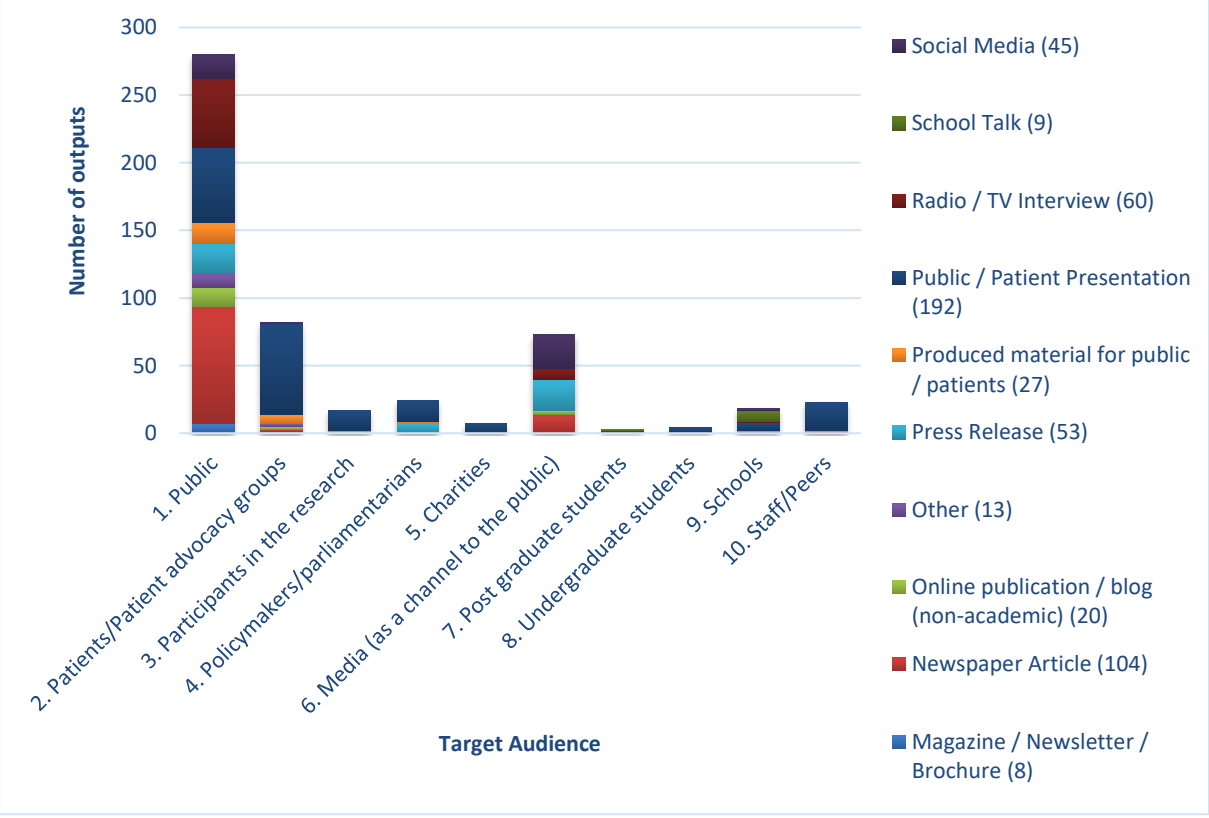
Table 8.2 shows that the use of presentations to or interactions with patients, charities, students and advocacy groups has remained popular over all reporting periods. A notable trend is that there is a swing away from coverage in the local and international press to the use of social media and blogs, and radio and TV interviews in Ireland to get the message out about research findings.

Table 8.2: Non-academic engagement activity - comparing 2014/2015, 2012/2013 and 2010/2011

Type of activity	2016/2017	2014/2015	2012/2013	2010/2011
Presentation to / interactions with patients, charities, students, advocacy groups or public	36.2%	27.9%	36.7%	34.1%
Coverage in local, regional or national general press	17.5%	20.9%	16.5%	34.1%
Radio or TV interview in Ireland	11.1%	8.5%	6.4%	7.3%
Press release, press conference or response to a media query	10.0%	11.6%	8.5%	2.4%
Social media coverage (Facebook, Twitter etc)	8.3%	6.2%	0.5%	0.0%
Plain English material (e.g. information booklet)	5.1%	9.3%	13.3%	0.0%
Online publication or blog (non-academic)	3.8%	0.0%	0.0%	0.0%
Interacted with school students	2.5%	3.1%	3.2%	0.0%
School talk on subject of HRB-funded research	1.9%	3.9%	1.1%	0.0%
Coverage in international general press	1.9%	0.8%	6.4%	22.0%
Popular magazine feature or other popular media	1.5%	5.8%	5.9%	0.0%
Radio or TV interview in other country	0.2%	1.9%	1.6%	0.0%

Figure 8.1 shows the target audience for distribution of dissemination events reported by HRB award holders according to the media type. This shows that the public was by far the most common target audience, with all media types being utilised to reach this audience, as was using the media as a channel to the public. Patient advocacy groups were also an important target audience.

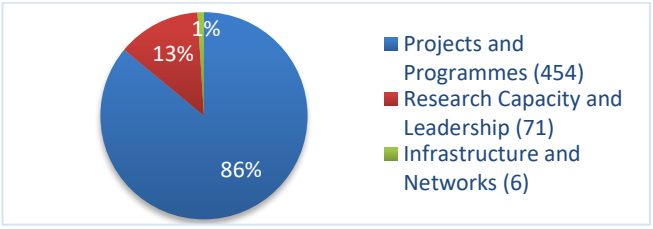
Figure 8.1: Target audience for engagement output by media type 2016/2017



8.1.2 Distribution of non-academic engagement outputs by award type

The distribution of engagement outputs broken down by award type and outputs per €1 million spend is shown in Figure 8.2. Project and Programme awards, which accounted for 86% of engagement outputs, were by far the productive in terms of public engagement outputs per €1 million spend (15.2). Research Capacity and Leadership awards and Infrastructure and Network awards collectively accounted for 14% of engagement outputs, but per €1 million spend were considerably less productive than Project and Programme awards (4.4 and 3.8 outputs per €1 million spend, respectively.) This difference might be accounted for by the type of research being conducted across award types, which will have different objectives and focus.

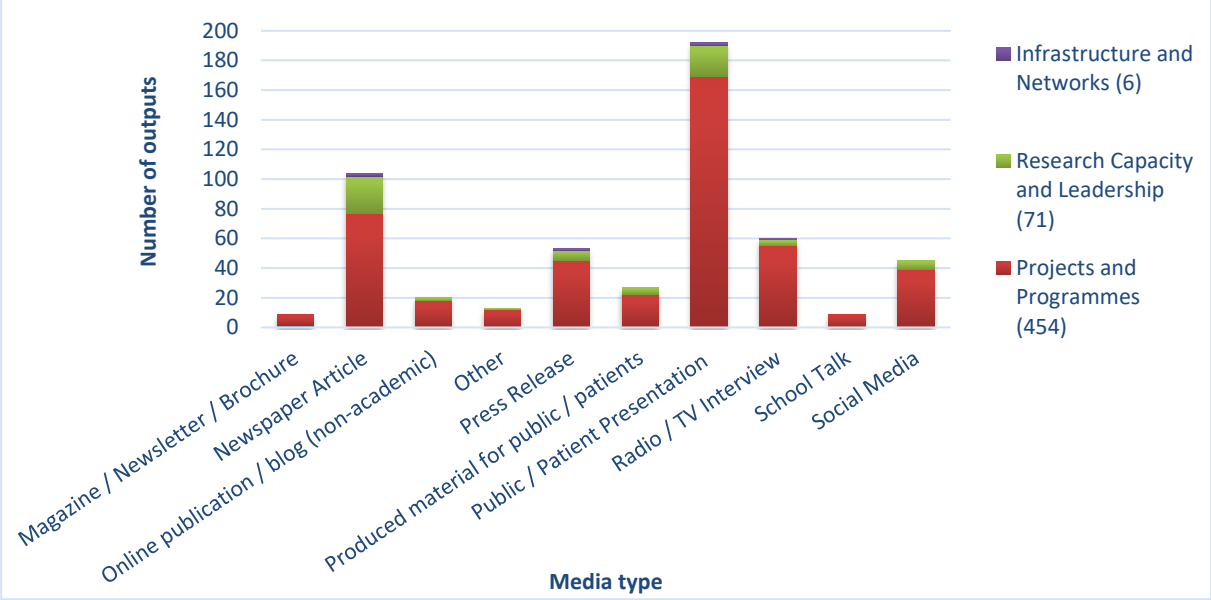
Figure 8.2: Non-academic engagement outputs, broken down by award type and number per €1 million spend



No. of reported public/patient engagement outputs per €1 million spend	
Projects and Programmes	15.2
Research Capacity and Leadership	4.4
Infrastructure and Networks	3.8

The distribution of engagement outputs broken down by media type and by award type is shown in Figure 8.3. Project and Programme awards employed all media types to disseminate research findings to non-academic audiences. For Research Capacity and Leadership and Infrastructure and Network awards, public and patient presentations, newspaper articles and press-releases, production of patient materials, radio and TV interviews were the most prevalent tools used to disseminate to a non-academic audience.

Figure 8.3: Non-academic engagement outputs broken down by media and award type

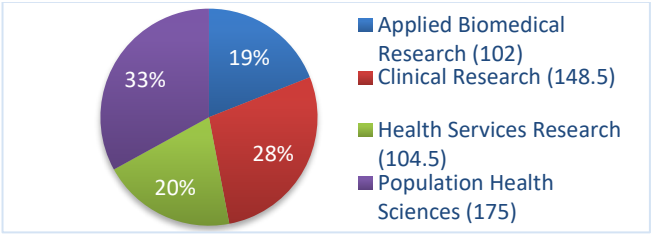


8.1.3 Distribution of non-academic engagement outputs by broad research area

The percentage distribution of non-academic engagement outputs and spend per €1 million investment across the broad research areas is shown in Figure 8.4, while the distribution of dissemination outputs broken down by media type and by broad research area is shown in Figure 8.5.

Figure 8.4 shows that while there were a similar number of engagement outputs for awards classified as Applied Biomedical Research (19% of outputs) and Health Services Research (20% of outputs) the productivity per award on engagement outputs was very different and was 6.6 outputs and 13.3 outputs per €1 million spend, respectively. Likewise, the number of engagement outputs reported for awards classified as Clinical Research (28% outputs) and Population Health Sciences (33% of outputs) were similar, but their productivity per award on engagement outputs was very different and was 8.5 and 26.2 outputs per €1 million spend, respectively. These differences in productivity of engagement outputs reflect the differing objectives and focus of Applied Biomedical and Clinical Research awards, where the focus is at the level of the laboratory or clinic, compared to awards classified as Health Services Research and Population Health Sciences, where the focus of the research is towards the healthcare system, policy, and public health and health promotion.

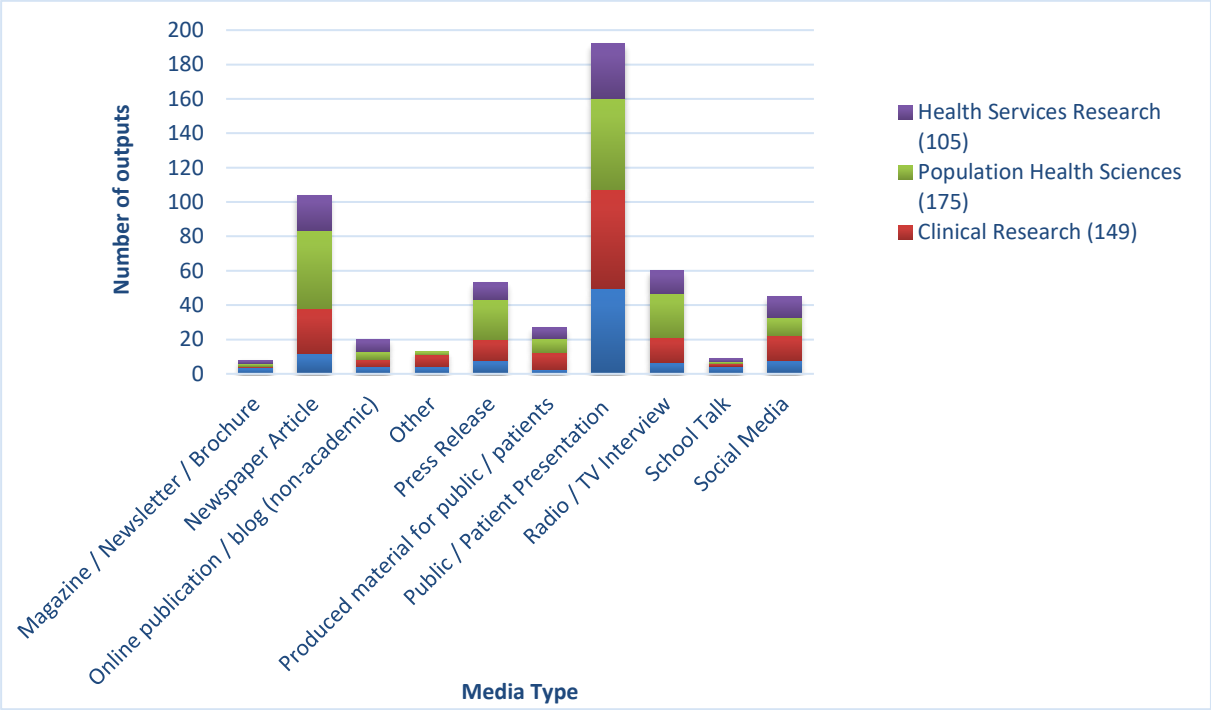
Figure 8.4: Non-academic engagement outputs, broken down by broad research area and per €1 million spend



No. of reported public/patient engagement outputs per €1 million spend	
Applied Biomedical Research	6.6
Clinical Research	8.5
Health Services Research	13.3
Population Health Sciences	26.2

In terms of the type of dissemination outputs used by researchers, Figure 8.5 shows that presentation of research findings to public and patient groups was the most popular medium, followed by dissemination in the print media. Production of materials for lay readers and publication in popular media outlets (print, broadcast and social media) were also used by researchers across all broad research areas.

Figure 8.5: Non-academic engagement outputs broken down by media type and broad research area



8.1.4 Examples of non-academic engagement activities

Table 8.3 provides some examples of the type of public and patient engagement activity in which HRB funded PIs and their teams engaged in order to communicate the results of their research beyond the scientific community.

Table 8.3: Examples of non-academic engagement outputs arising from HRB-funded awards

Award Type	Type of engagement	Description of engagement activity
HRB-MRCG Joint Funding Scheme	Talk or presentation to a non-academic audience	Lets' talk about epilepsy- presentation at national Epilepsy Ireland conference to public in Sligo.
Knowledge Exchange and Dissemination Scheme	Popular magazine feature or other popular media	Articles published in 'Senior Times' to coincide with exhibit at the Senior Times' Active Over-50's event in Cork.
Health Research Award	Social media coverage	Several of the published manuscripts have been discussed on Twitter.
Health Professional Fellowship	Online publication or blog (non-academic)	BMJ Podcast accompanying the publication Managing multimorbidity in primary care.
Interdisciplinary Capacity Enhancement Award	Plain English material (e.g. information booklet)	Video co-created by children and parents living with Chronic Pain.
Research Collaborative in Quality and Patient Safety	Talk or Presentation to a non-academic audience	Results disseminated to all participating hospitals and key stakeholders (RCSI, RCPI, HRB, HSE, DoH, HIQA, SCA/CIS, INAES Advisory Group) through presentations of the results and/or email of the publication.
Health Research Award	School talk	Transition Year students had a chance to be in our lab. learning about this exosomes/NmU research and its implications.
Health Research Award	Participation in activity, workshop or similar	Participation in outreaching activities / workshops in the Ploughing Championships facilitated by Science Foundation Ireland.
Health Professional Fellowship	Press release	A press release and research brief entitled 'Potentially inappropriate prescribing and adverse health outcomes in older people in primary care' was published.
National SpR/SR Academic Fellowship Programme	Coverage in local, regional or national general press	https://www.irishtimes.com/news/health/nui-galway-researchers-make-key-finding-in-spread-of-blood-cancer-cells-1.1891829
Knowledge Exchange and Dissemination Award	Online publication or blog (non-academic)	Online dissemination of materials on an accessible IDS-TILDA website and TCD YouTube channel.
MRCG Co-fund Award	Plain English material (e.g. information booklet)	Each year, the PI is directly involved in compilation of the Alpha-1 Foundation Handbook for increasing awareness and knowledge of Alpha-1 Antitrypsin Deficiency (AATD).
Cancer Prevention Fellowship Programme	Coverage in international general press	Parkrun: Where your fellow runners cheer you on but still try to beat you. Washington Post. December 22nd, 2015.
Knowledge Exchange and Dissemination Award	Participation in activity, workshop or similar	Workshop with representatives of AIIHPC Voices4Care user and carer forum to discuss preliminary results from KINDLE project.
Health Research Awards	Radio or TV interview in Ireland	RTE Radio One Drivetime live interview, May 2018, on foot of Release of our Report: Retaining our Doctors. Medical Workforce Evidence, 2013-18.

8.2 Public and Patient Involvement

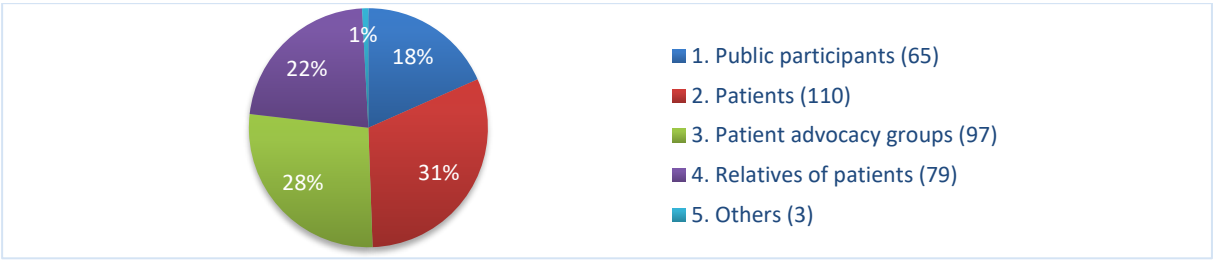
Recipients of awards that completed in 2016/2017 were asked whether they had engaged in specific Public and Patient Involvement (PPI) activities, which were defined in the survey as 'activities undertaken with, as distinct to on, for or about patients or the public', the latter activities being captured under Non-academic engagement (Section 8.1).

41 awardees (21.9% of total) reported 69 PPI outputs during the period of their research project. However, the responses demonstrated that researchers still do not fully understand the difference between non-academic engagement activities, as captured in Section 8.1, and true PPI activities and they reported on these different activities interchangeably. It is hoped that over time, and through the efforts of HRB Public Review of grant applications, PPI coordinators in the university sector, and awareness raising among the research community, this distinction will become clearer to researchers. That said, the results of this first attempt to look at PPI activity were interesting, in that they mark a change in the way in which researchers engage with patients, advocacy groups and the public around the design, conduct and dissemination of their research.

8.2.1 Target audience for PPI activity

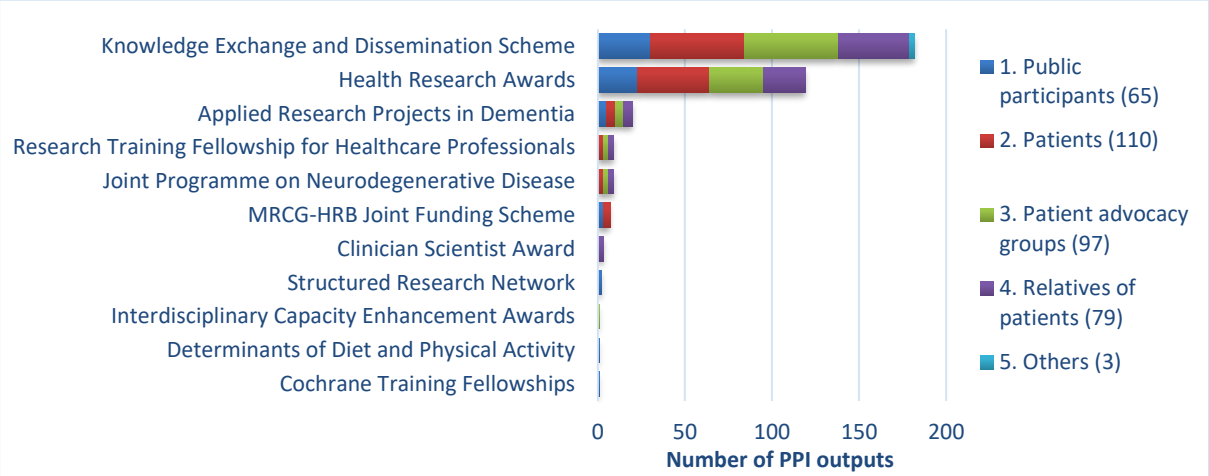
Figure 8.6 examines the relative distribution of PPI activities across target audiences. Researchers could choose more than one target audience type. This shows that almost 60% of reported PPI outputs targeted at patients and patient advocacy groups. Activities that involved the relatives of patients were also important, accounting for 22% of reported outputs, with activities that involved public participants being less important (18% of total.)

Figure 8.6: Distribution of PPI outputs across target audiences



Awards made in 11 of the 19 Schemes reporting in the 2016/2017 period described PPI outputs. Figure 8.7 shows that Knowledge Exchange and Dissemination awards, and Health Research Awards accounted for 85% of all PPI outputs reported and included all types of target audiences.

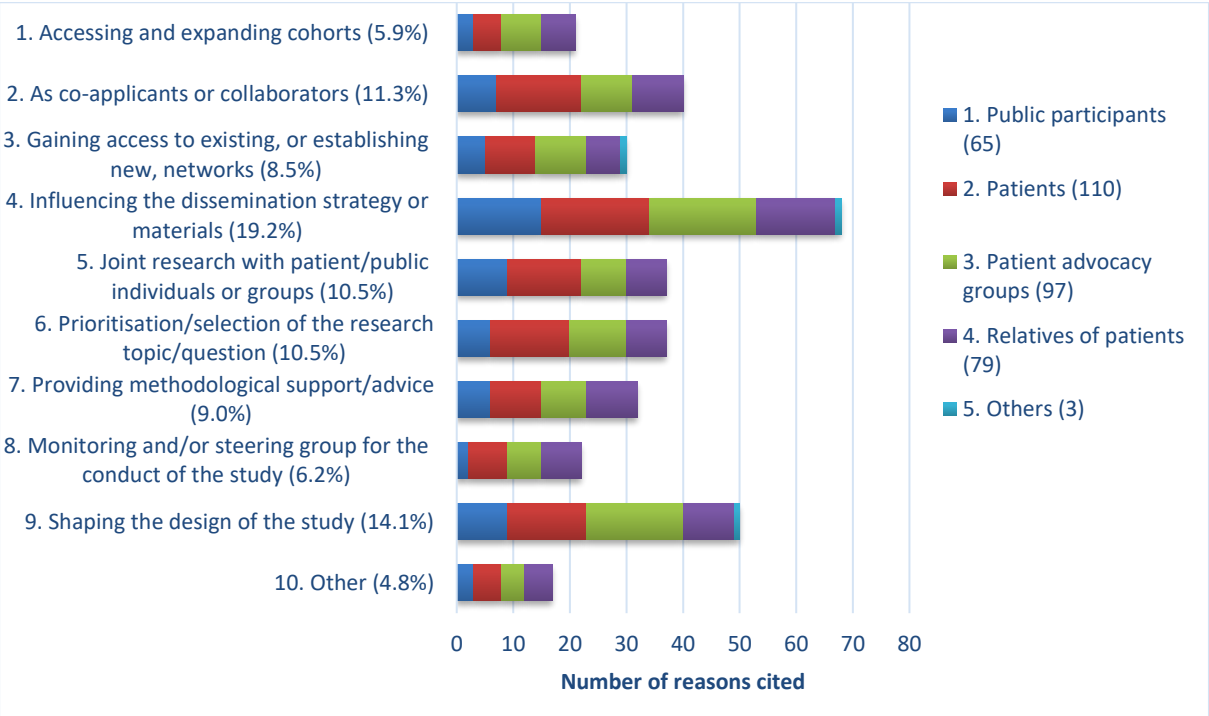
Figure 8.7: Distribution of target audiences across HRB schemes



8.2.2 Purpose of PPI activities

Researchers were asked to indicate the objective of their reported PPI engagements and could choose more than one objective. Figure 8.8 shows that the most common reasons cited for PPI activities was to shape the design of a study or providing methodological support/advice (23.1%), involve patients or the public as co-applicants, collaborators or in joint research (21.8%), shape the dissemination strategy or materials for the research findings (19.2%), gain access to cohorts and networks (14.4%), identify and select priorities/topics for research in a particular area (10.5%), or assist in monitoring or steering the study (6.2%).

Figure 8.8: Objective of PPI activity (as % of total outputs), by type of target audiences



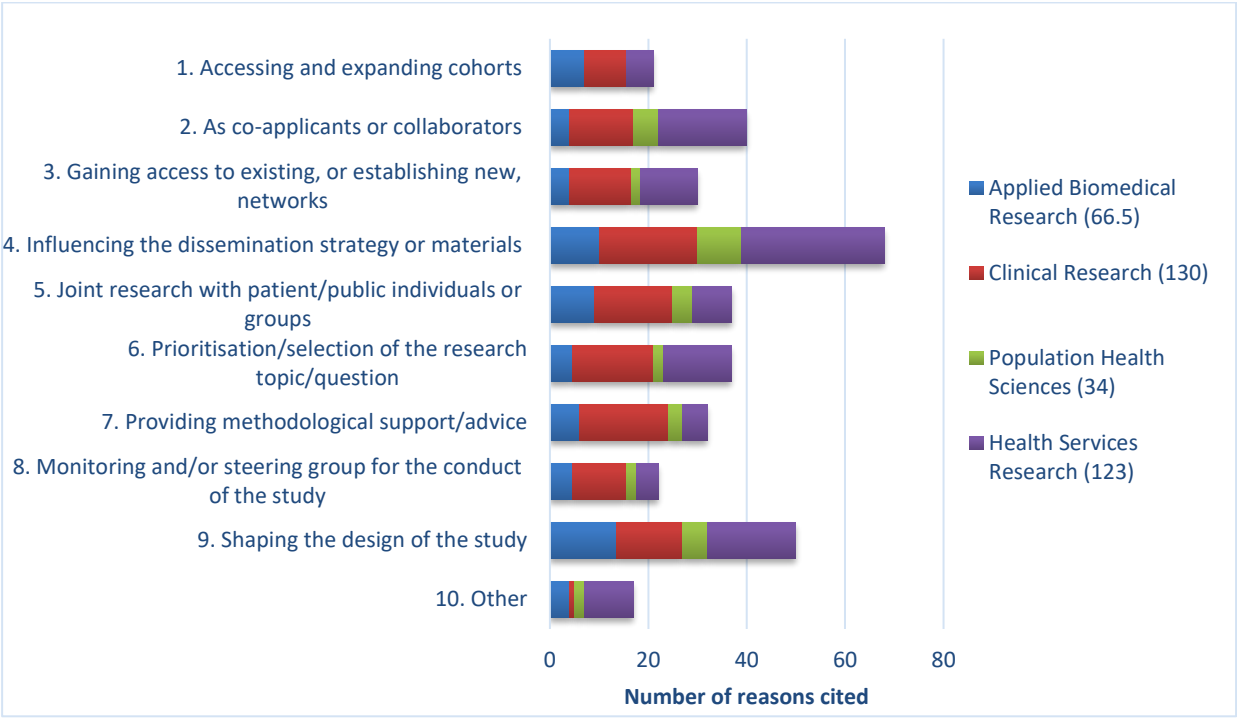
8.2.3 Distribution of PPI outputs by broad research area

Distribution of the objectives of PPI activity across the broad research area of Applied Biomedical Research, Clinical Research, Population Health Sciences and Health Services Research are shown in Figure 8.9.

This shows that awards classified as Clinical Research and Health Services Research yielded the most PPI outputs (36.7% and 34.9%, respectively) and that the objectives for these outputs spanned the whole range. That said, PPI objectives of most importance to Clinical Research were to shape the dissemination strategy or materials for the research findings, undertake joint research, identify and select priorities/topics for research in an area and obtain methodological support/advice. For Health Services Research the most important objectives of undertaking PPI were to shape the dissemination strategy or materials for the research findings, involve patients or the public as co-applicants, collaborators, shape the design of a study or identify and select priorities/topics for research in an area.

Fewer PPI outputs were reported for awards classified as Applied Biomedical Research (18.8%) and Population Health Sciences (9.5%). It was interesting that the most important objective for PPI activity cited by awards classified as Applied Biomedical research was to shape the design of a study, which speaks to researchers attempting to make the outcomes of their research more relevant and robust. Other important objectives cited included influencing the dissemination strategy or materials and to undertake joint research with patient/public individuals or groups. For awards classified as Population Health Sciences, the primary reason cited for engaging in PPI activities was to shape the dissemination strategy or materials for the research findings.

Figure 8.9: Distribution of objectives of PPI activity by broad research area



8.2.4 Examples of PPI outputs

Table 8.3 provides some examples of PPI outputs reported by researchers whose awards completed in 2016/2017.

Table 8.4: Examples of PPI outputs arising from HRB-funded awards 2016/2017

Scheme	Objective	Audience	Description
Knowledge Exchange and Dissemination Award	Accessing and expanding cohorts	Patient advocacy groups	Focus groups were held with carers groups to gain an understanding of their needs regarding animations and video, and to draw attention to the online resource.
Applied Research Project in Dementia	As co-applicants or collaborators	Public participants	People with dementia were part of the focus groups that helped inform the delivery and content of the P-CAD. Spouses, family members were also involved in the research and steering committee.
Health Research Award	Influencing the dissemination strategy or materials	Patients	Developed a core outcome set (COS) for young adults living with Type 1 Diabetes in conjunction with them and other key stakeholders.
JPI Healthy Diet for a Healthy Life	Joint research with patient/public individuals or groups	Patients	People with dementia involved in the Delphi Process undertaken to gain consensus on the best-practice recommendations from the Actifcare project.
Health Professional Fellowship	Prioritisation/selection of the research topic/question	Patients and relatives	At patient and family event, patients and family members submitted their preferences and questions for future research.
Clinician Scientist Award	Providing methodological support/advice	Patients and relatives	To inform futured studies parents of children who participated in neurodevelopmental outcome were asked to elucidate the positive and negative experiences of participating in neonatal trials.

9. Research tools, materials and methods

The development or application of novel research tools, materials, methodologies and/or technologies is an indicator of the extent to which HRB award holders are advancing research within their field both nationally and internationally. They may include new biological models, biobanks and datasets, new techniques and so on. Although they are usually generated to advance the objectives of a specific project, they may be used more widely by other researchers and can facilitate new lines of enquiry or accelerate research in related fields.

Summary of research tools, materials and methods outputs, compared to 2014/2015, 2012/2013, 2010-2011 and 2008/2009

Development of research tools, materials and methods	2016/17 (N=187 awards)	2014/15 (N=198 awards)	2012/13 (N=134 awards)	2010/11 (N=196 awards)	2008/09 (N=204 awards)
Total no. new material/methods developed	113	96	112	85 (2011 only)	NA
Average no. outputs per €1 million spend	2.4	1.8	2.9	1.6	0.6

Key Finding

- 40.6% of award holders reported the development of one or more novel research materials or methods wholly or partly as a result of their HRB award. Of these, 25 reported more than one (up to 4) new research materials or methods.
- The most common type of research material developed was of educational and training material, followed by the development of a novel experimental assay or method.
- Project and Programme Awards produced 77% of novel materials or methods.
- Applied Biomedical Research and Clinical Research accounted for well over half of all novel materials or methods. The most commonly reported outputs were development of novel experimental assay, reagent or methods and development of animal models of disease, while for Health Services Research and Population Health Sciences the development of educational and training materials was the most common output.

9.1 Development of novel research materials or methods

Of the 187 awards analysed in 2016/2017, 76 (40.6%) award holders reported the development of one or more novel research materials or methods wholly or partly as a result of their HRB award. Of these, 25 reported more than one (up to 4) new research materials or methods.

As shown in Table 9.1, the most common type of research material developed was the development of educational and training material (n=26), followed by the development of a novel experimental assay or method (n=23). Database or dataset creation (N=15), novel physiological assessment or clinical outcomes measured (N=9) and mammalian models of disease (N=9) were also highly cited.

Table 9.1: Number of novel research materials/methods developed by type

Type of material/method developed	No. developed (HRB)
Educational/Training materials	26
Experimental Assay, Reagent or Method	23
Database/dataset	15
Physiological assessment or clinical outcome measure	9
Model of mechanisms or symptoms – mammalian in vivo	9
Research software	7
Data analysis technique	6
Biological samples/biobank	5
Cell Line	4
Computer model/algorithm	3
Model of mechanisms or symptoms – in vitro	3
New or expanded cohort	2
Improved research infrastructure	1
Total number of new research materials/methods	**113**

Table 9.2 maps the types of research materials and methods developed by HRB researchers from 2010 to 2017. This shows some similarities across reporting periods, for example the percentage of reported novel experimental assays or methods, databases/datasets, animal models of disease and data analysis techniques. There were also some notable differences, including a reduction in the number of new biological samples/biobanks, new or expanded cohorts, research infrastructure and development of computer models. There has been an increase over time in reports of physiological assessment or clinical outcome measures, research software, and structured educational programmes.

Table 9.2: Number of novel research material/methods developed by type – comparing 2016/2017, 2014/2015, 2012/2013 and 2008/2009

Type of material/method developed	2016/2017	2014/2015	2012/2013	2010/2011
Biological samples/Biobank	4.4%	26%	16.1%	8.2%
Experimental assay or method	18.6%	18.8%	15.2%	11.8%
Database/ dataset	13.3%	13.5%	19.6%	17.6%
New or expanded cohort	1.8%	11.5%	0	0
Animal model of disease	7.1%	7.3%	6.3%	9.4%
Other	1.8%	7.3%	0	0
New or improved research infrastructure	0.9%	6.3%	8%	8.2%
Data analysis technique	5.3%	4.2%	13.4%	11.8%
Physiological assessment or clinical outcome measure	14.2%	3.1%	8%	11.8%
New research software	6.2%	2.1%	1.8%	8.2%
Training protocol, computer-delivered	6.2%	0	5.4%	0
Structured education manual	12.4%	0	3.6%	0
Computational model	2.7%	0	0	7.1%
Cell Line	3.5%	0	0	5.9%

**NC = not comparable across reporting periods*

Comparison with UK MRC outputs 2016

In the 2016/2017 reporting period classification of research materials and methods was revised to align it more closely with the UK MRC classification, thus allowing some comparison. Table 9.3 shows this comparison and reflects the differing focus of HRB and MRC research portfolios.

Table 9.3: Comparison of research materials/methods developed by HRB and MRC researchers

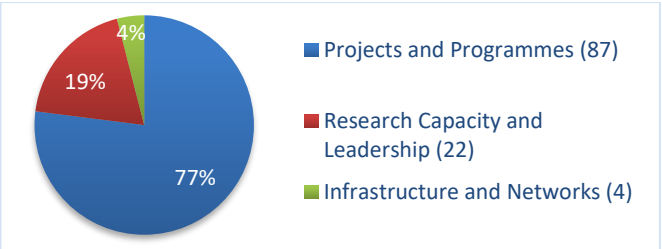
Type of material/method developed	HRB (% of total outputs)	UK MRC (% of total outputs)
Experimental Assay, Reagent or Method	18.58%	16%
Database/dataset	13.27%	4%
Physiological assessment or clinical outcome measure	14.16%	4%
Model of mechanisms or symptoms – mammalian in vivo	7.08%	43%
Research software	6.19%	16%
Data analysis technique	5.31%	3%
Biological samples/biobank	4.42%	7%
Cell Line	3.54%	4%
Computer model/algorithm	2.65%	3%
Model of mechanisms or symptoms – in vitro	1.77%	2%
Improved research infrastructure (including cohorts)	2.65%	10%

9.1.1 Distribution of materials/methods by award type

Figure 9.1 shows how the development of novel materials/methods was distributed across award types and the number of novel materials/methods developed per €1 million spend overall per award type. Project and Programme Awards produced the highest number of novel materials or methods (77% of reports), followed by Research Capacity and Leaderships awards (19%) and Infrastructure and Network awards (4%).

In terms of the number of novel materials or methods developed per €1 million spend, similar productivity was found for Projects and Programmes and Infrastructure and Networks, which produced 2.9 and 2.5 outputs per €1 million spend, respectively. As expected, the number of materials/methods outputs produced from Infrastructure and Network awards were considerably lower, at 1.3 outputs per €1 million spend.

Figure 9.1: Novel material/methods broken down by award type and number per €1 million spend



No. novel materials/methods per €1 million spend	
Projects and Programmes	2.9
Research Capacity and Leadership	1.3
Infrastructure and Networks	2.5

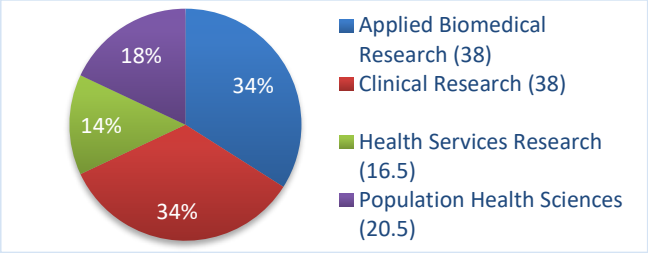
9.1.2 Distribution of materials and methods by broad research area

Figure 9.2 shows how the development of novel materials/methods were distributed across broad research areas and the number of novel materials/methods developed per €1 million spend overall per broad research area.

Awards classified as Applied Biomedical Research and Clinical Research accounted for over half (68%) of all reported developments of novel materials or methods. In keeping with the focus of such awards, the most commonly reported outputs were development of novel experimental assay, reagent or methods (N=18) and in development of animal models of disease (N=9). For Clinical Research Awards development of physiological assessment or clinical outcome measures (N=7) and collection of biological samples/biobanks (N=7) were also particularly important. In terms of productivity for this metric, awards classified as Clinical Research were almost twice as productive as awards classified as Applied Biomedical Research, with 2.2 and 1.4 outputs per €1 million spend, respectively.

For awards classified as Health Services Research and Population Health Sciences the development of educational and training materials was the most common outputs (N=21). Unsurprisingly, for awards classified as Population Health Science the development of databases/data sets was also important (N=7). In terms of productivity for this metric, awards classified as Population Health Sciences were considerably more productive than awards classified as Health Services Research, with 3.1 and 2.1 outputs per €1 million spend, respectively.

Figure 9.2: Novel material/methods broken down by broad research area and number per €1 million spend



No. novel materials/methods per €1 million spend	
Applied Biomedical Research	1.4
Clinical Research	2.2
Health Services Research	2.1
Population Health Sciences	3.1

9.1.3 Examples of materials and methods developed

Table 9.3 provides some examples of the types of materials and methods developed or refined by HRB funded researchers whose awards completed in 2014/2015.

Table 9.3: Examples of the types of materials and methods developed from HRB-funded awards

Award Type	Type of novel material/method	Description
Health Research Award	Physiological assessment or clinical outcome measure	Using Doppler ultrasound as a criterion standard, we demonstrated that venous occlusion plethysmography can accurately assess dynamic responses of leg blood flow (leg blood flow kinetics) during calf plantar-flexion exercise at intensities between 30 and 70% maximum voluntary contraction.
Clinician Scientist Award	Educational/Training materials	Interpretation of output from INCA device to provide feedback on inhaler use to patients.
Health Research Award	Computer model/algorithm	Developed a novel record linkage algorithm for linking health data sets without a unique identifier.
Post-Doctoral Research Fellowship	Model of mechanisms or symptoms – in vitro	State of the art in vitro model of IH. Previous cell culture models of IH have been limited by requiring prolonged soak times, reduced cycle numbers and inadequate control treatment. This new model uses a state-of-the-art custom-built system to overcome these limitations.
Interdisciplinary Capacity Enhancement Award	Physiological assessment or clinical outcome measure	Established the effectiveness of speed of heart rate recovery to standing as a marker of cardiovascular fitness and mortality.

Award Type	Type of novel material/method	Description
Health Research Award	Experimental Assay, Reagent or Method	Methods for scaling up the manufacturing process for inhalable drug-loaded particles.
PhD Scholars Programme	Educational/Training materials	The training structure put in place for this PhD programme continues to be used in the School of Biochemistry and Cell Biology in PhD training and in a new MSc programme in Molecular Cell Biology with Bioinnovation and a MRes programme.
JPI Healthy Diet for a Healthy Life	Dataset or Database	Development of a compendium of 150 European datasets relevant to diet, physical activity and sedentary behaviour and their determinants.
Health Research Award	Research Software	Three computerised tests of cognition - Letter and Shape Drawing Test (LSD), Digitalised Months Backwards Test (MBT) and Lighthouse Test.
HRB-MRCG Joint Funding Scheme	Biological samples/biobank	A biobank of sputum samples has been generated in BIOMERIT with sputum and saliva from a cohort of paediatric patients with CF from CUH, Cork.
Framework for Safe Nurse Staffing and Skill Mix	Experimental Assay, Reagent or Method	The design for this research is unique in that it includes a before and after and longitudinal study designs and the addition of an economic evaluation. The uniqueness of the design is that it includes the unit of analysis at ward rather than hospital level, repeated measures and, the collection of staffing levels for each shift rather than nurse self-reports. Although the above has previously been recommended in studies, this is the first research where this has been put in place.
Health Research Award	Model of mechanisms or symptoms – mammalian in vivo	State of the art in vitro model of IH | Previous cell culture models of IH have been limited by requiring prolonged soak times, reduced cycle numbers and inadequate control treatment. I have developed a state-of the art model using a custom-built system (Coy Laboratories, Grass Lake, MI, USA) overcoming these limitations which is now located at the Conway Institute at UCD.

10. Health sector innovations

Health research is the basis for many products and innovations in the commercial life sciences, MedTech and biotech sectors as well as treatment and service innovations in the healthcare sector. Such products and innovations can emerge through ideas or new intellectual property, or the application or enhancement of existing ideas or intellectual property.

Summary of health sector innovations, compared to 2012/2013, 2010/2011 and 2008/2009 reporting periods

Health sector innovations	2014/2015 (N=198 awards)	2012/2013 (N=134 awards)	2010/2011 (N=196 awards)	2008/2009 (N = 204 awards)
Total no. health sector innovations	57	43	48	32
% awards reporting health sector innovations	20.7%	24.6%	21%	15%
Average no. health sector innovations per €1 million spend	1.0	1.0	0.9	0.7

Key Finding

- 46 awards reported that their HRB-funded research had either directly led to or contributed to the development of a total of 57 healthcare innovations, of which 22 had already attracted further funding (two from industry). This number continues an upward trend in this metric since 2008 and is over twice the percentage reported by UK MRC awards.
- The most common healthcare innovations were the development of therapeutic drug-based interventions and non-imaging diagnostic tools, which were also the most common types of innovations reported by MRC researchers in 2016.
- Compared to previous reporting periods, there was a large increase in development of care models or services and the development of behavioural/psychological therapeutic interventions outputs, which are also considerably higher than MRC output figures for 2016.
- 25% of interventions were in early stage development, while a further 44% were in the late stages of development or were being tested, trialled or refined as part of the award. 24% of innovations had been adopted on a small scale while 9% had been adopted on a large scale.
- 61% of healthcare innovations were developed by Applied Biomedical or Clinical Research awards, while Health Services Research awards accounted for 33% of reported healthcare innovations.

10.1 Health sector innovations

Award-holders were asked whether their HRB-funded research led to, or significantly contributed to, the development or application of any health-related innovations. Such innovations were defined broadly to include products (e.g. diagnostics, drugs, devices), non-drug interventions, health IT systems, clinical decision support tools, disease management strategies, clinical care models and so on. Award-holders were also asked about the stage of development of the innovation along the discovery-development continuum and were asked to provide a description of the innovation.

In total, 46 awards (24.6% of total awards) that completed in 2016/2017 reported that their HRB-funded research had either directly led to or contributed to the development of a total of 57 innovations. This shows a continuing upward trend in this metric since 2008.

The number of HRB awards completing in 2016/2017 that reported the development of one or more health sector innovations is also higher than the equivalent figure reported by UK MRC researchers (11% of total awards) for 2016. However, the average number of health sector innovation outputs per MRC award was higher than per HRB awards (2.2 as opposed to 1.4 outputs.)

Table 10.1 shows the breakdown of the 57 innovations by type. The development of a wide range of healthcare interventions were reported including diagnostic, prognostic, preventative and therapeutic interventions. The most common types of health sector innovation reported were the development of therapeutic drug-based interventions (N=10) and non-imaging diagnostic tools (N=10). These were also the most common types of innovations reported by MRC researchers in 2016. HRB researchers also reported the development of care models or services (N=9) and the development of psychological or behavioural interventions (N=9) more commonly that other types of innovations.

Table 10.1: Number of HRB-funded healthcare innovations in development by type

Type of healthcare innovation	Number developed
Therapeutic intervention – New drug or indication	10
Diagnostic Tool – Non imaging	10
Care model or service	9
Therapeutic intervention – Psychological/Behavioural	9
New ICT-based technology (ICT system, software, webtool/application or eBusiness platform)	6
Clinical Decision Support Tool	5
Preventative Intervention – Behavioural Risk Modification	3
Prognostic Tool (Imaging, Algorithm or other)	3
Preventative Intervention – Physical/biological risk modification	1
Film/video/animation	1

Figure 10.1 plots the stages of development of reported interventions. 25% of interventions were in early stage development, while a further 44% of interventions were in the late stages of development or were being tested, trialled and refined as part of the award. In terms of uptake of innovations, PIs reported that 24% (N=14) of their innovations had been adopted on a small scale or had completed a proof of concept phase, while 9% reported that there was large scale adoption of their innovation in the health system.

Figure 10.1: Stages of development of HRB-funded health innovations

Table 10.2 compares reported health sector innovation outputs across HRB reporting periods from 2010 to 2017, and includes figures from the UK MRC 2016 Outputs report, where available. For the most part, the number of reported outputs in each category of health sector innovations has remained relatively steady over

time. However, in the 2016/2017 reporting period there was a large increase in reported development of care models or services and the development of behavioural/psychological therapeutic interventions, which are also considerably higher than MRC output figures for 2016. The increased development of care models of services highlights the HRB's drive to facilitate the creation of knowledge which can quickly be adapted to a clinical setting.

Table 10.2: Breakdown of health sector innovations - comparing 2014/2015, 2012/2013 and 2010/2011

Type of healthcare innovation	2016/ 2017	2014/ 2015	2012/ 2013	2010/ 2011	UK MRC 2016
Therapeutic intervention: New drug or Indication	17.5%	22.2%	11.6%	18.8%	32%
Diagnostic Tool: Non-Imaging	17.5%	7.4%	16.3%	16.7%	15%
Care model or service	15.8%	7.4%	25.6%	4.2%	1%
Therapeutic Intervention: Psychological/Behavioural	15.8%	0	14%	10.4%	6%
New ICT- based technology	10.5%	11.1%	0	10.4%	-
Clinical Decision Support Tool	8.8%	7.4%	7%	2.1%	5%
Prognostic tool	5.3%	3.7%	2.3%	6.3%	-
Preventative Intervention: Behavioural Risk Modification	5.3%	3.7%	7%	12.5%	4%
Preventative Intervention: Physical/Biological Risk Modification	1.8%	3.7%	4.7%	0	1%
Other*	1.8%	1.9%	0	2.1%	3%
Strategy to manage disease or condition	-	13%	2.3%	4.2%	6 %
Therapeutic intervention: Cell or Gene Therapy	-	9.3%	2.3%	8.3%	5%
Therapeutic Intervention: Vaccine or Immunotherapy	-	3.7%	2.3%	0	4%
Diagnostic Tool: Imaging	-	1.9%	0	2.1%	6 %
Preventative Intervention: Nutritional or Chemoprevention		1.9%	2.3%	0	1%
Therapeutic Intervention: Surgery	-	1.9%	0	0	2%
Therapeutic Intervention: Medical Device	-	0	2.3%	2.1%	3%

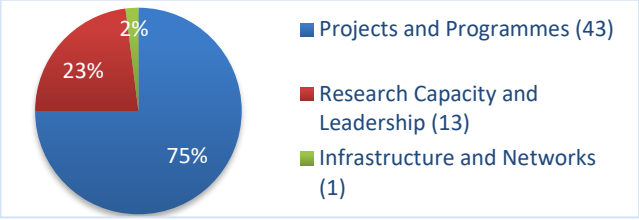
** 'Other' includes Therapeutic intervention – physical, Therapeutic intervention – radiotherapy, Products with applications outside of medicine, Therapeutic intervention – complimentary and File/Video/Animation.*

10.1.1 Distribution of health sector innovation by award type and scheme

Figure 10.2 shows the number of health sector innovations by award type and number of outputs per €1 million spend while Figure 10.3 shows the distribution of healthcare innovations across award types.

Project and Programme Awards accounted for 75% of all reported health sector innovation outputs and were distributed across all types of innovations reported. In terms of productivity, there were 1.4 innovations reported per €1 million spend on Project and Programme Awards, as was also the case in the 2014/2015 reporting period.

Figure 10.2: Healthcare innovation outputs broken down by award type and number per €1 million spend

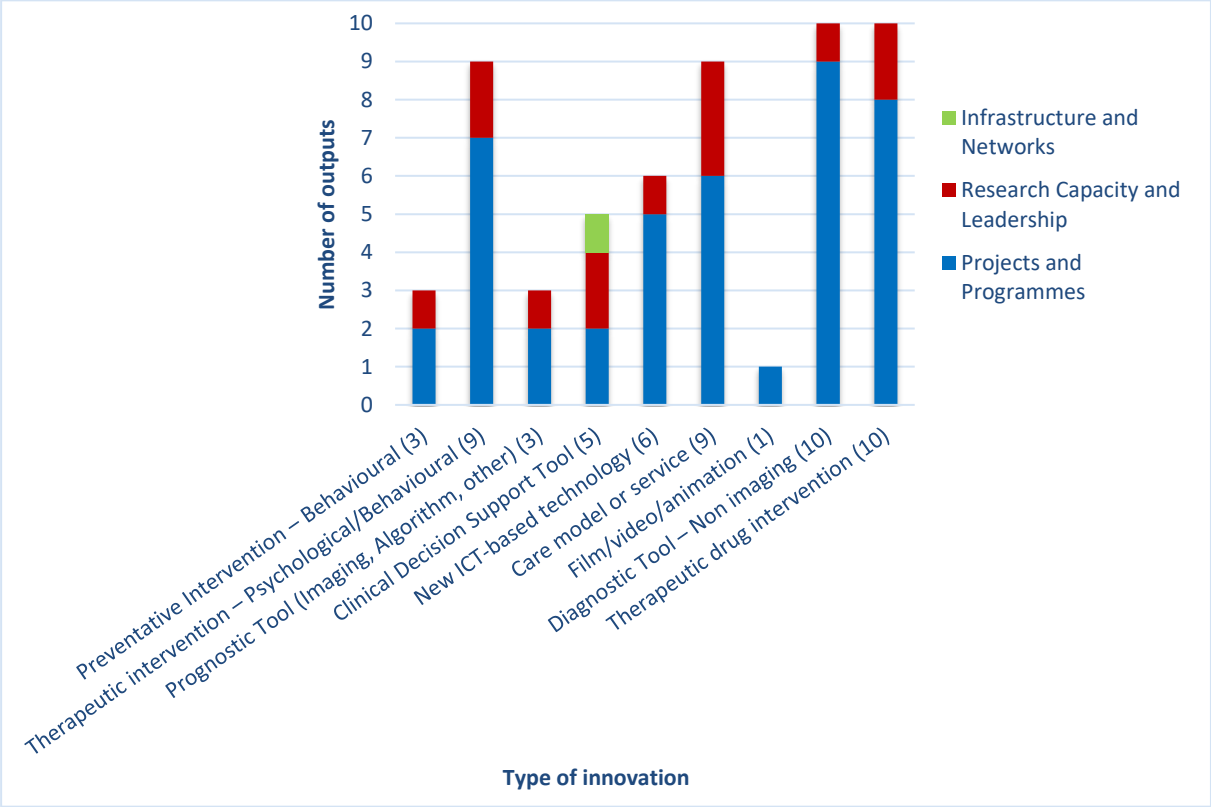


No. of healthcare innovation outputs per €1 million	
Projects and Programmes	1.4
Research Capacity and Leadership	0.8
Infrastructure & Networks	0.6

Research Capacity and Leadership Awards accounted for 23% of reported healthcare innovations but had productivity levels of below 1 per €1 million spend, of 0.8. These outputs were distributed across almost all types of healthcare innovation.

Infrastructure and Network Awards accounted for 2% of reported healthcare innovations and, like Research Capacity and Leadership Awards, had productivity levels of below 1 per €1 million spend, of 0.6. These outputs were confined to clinical decision support tools.

Figure 10.3: Healthcare innovation outputs broken down by innovation and award type



Distribution of healthcare innovation outputs by scheme

When the data is analysed at the level of individual schemes, Table 10.3 captures the number of health sector innovation outputs reported by scheme and examines the total number of outputs as a proportion of the total number of awards reporting in 2016/2017.

Table 10.3 shows that for almost all schemes that reported on this metric, there was less than one output per award, and only four schemes had one output (Clinician Scientist Awards, Applied Research Projects in Dementia, Framework for Safe Nurse Staffing and Skill Mix, Structured Research Network in Palliative Care) and

all of these awards were either Clinical Research or Health Services Research, or a mixture of these broad areas. Schemes that completed in 2016/2017, but that did not report health sector innovation outputs (e.g. Cancer Prevention Fellowships, Cochrane Training Fellowship, PhD Scholars Programme, Post-doctoral Fellowship in Translational Medicine and JPI Healthy Diet for a Healthy Life) were either targeted at early-stage researchers, or in the case of JPI HDHL, a network generating an international dataset.

Table 10.3: Distribution of health sector innovation outputs by schemes, and as a proportion of total awards in each scheme completing in 2017/2017

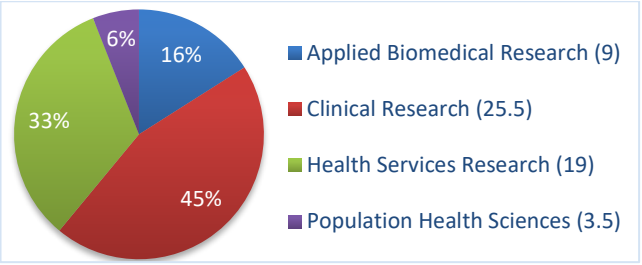
Scheme	No. of innovation outputs	Total no. of awards reporting in scheme 2016/2017	Average no. outputs per award
Health Research Awards	22	73	0.3
Knowledge Exchange and Dissemination Scheme	11	44	0.3
Health Professional Fellowship	6	15	0.4
MRCG Co-fund Award	6	20	0.3
Clinician Scientist Award	2	2	1.0
ICE Award	2	6	0.3
Applied Research Projects in Dementia	1	1	1.0
Cancer Research Nursing Project	1	2	0.5
Framework for Safe Nurse Staffing and Skill Mix	1	1	1.0
Interdisciplinary Capacity Enhancement Awards	1	6	0.2
Joint Programme in Neurodegenerative Disease	1	3	0.3
National SpR Academic Fellowship Programme	1	3	0.3
Research Collaborative in Quality and Patient Safety	1	4	0.3
Structured Research Network	1	1	1.0
Grand Total	**57**	**181**	**0.3**

10.1.2 Distribution of healthcare innovations by broad research area

Figure 10.4 shows the distribution of innovations by broad research area and per € million spend.

Of the 57 healthcare innovations reported, 34.5 (61%) were developed by awards categorised as Applied Biomedical or Clinical Research. Of these, 10 had already attracted further funding to develop their innovations (two from industry). These innovations were spread across several innovation types and award types (Health Research Awards, HRB-MRCG Joint Funding Award, a Clinician Scientist Award and a KEDS Award.) In terms of productivity, Applied Biomedical or Clinical Research produced 0.6 and 1.5 outputs per €1 million spend, respectively.

Figure 10.4: Healthcare innovation outputs broken down by broad research area and number per €1 million spend

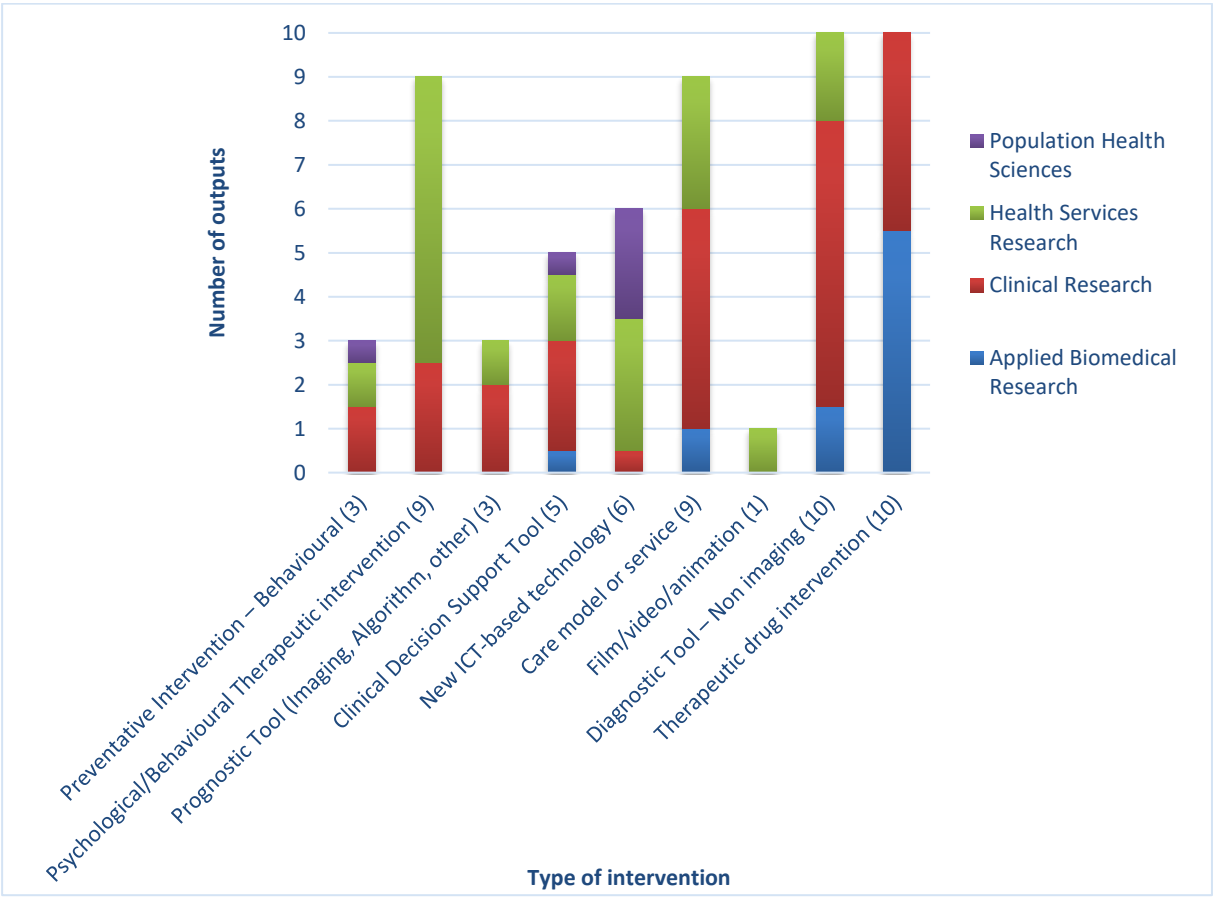


No. of healthcare innovation outputs per €1 million	
Applied Biomedical Research	0.6
Clinical Research	1.5
Health Services Research	2.4
Population Health Sciences	0.5

Awards categorised as Health Services Research accounted for 33% of reported healthcare innovations (N=19). These were spread across almost all innovation types and several award types (Health Professional Fellowships, Clinician Scientist Awards, Health Research Awards, ICE Awards, HRB-MRCG Joint Funding Awards, KEDS Awards, and Applied Projects in Dementia). 11 PIs reported having attracted further funding from funding agencies, charities and health bodies to continue the development of their work.

Awards categorised as Population Health Science accounted for 6% of reported healthcare innovations (N=3.5), which was also reflected in their low productivity of 0.5 outputs per €1 million spend. The main type of outputs from this award type was a new ICT-based technology (ICT system, software, webtool/application or eBusiness platform), and to a lesser extent Clinical Decision Support Tools and Behavioural Preventative Interventions.

Figure 10.5: Healthcare innovation outputs broken down by broad research area and innovation type



10.1.3 Examples of health sector innovations

Table 10.4 presents some examples of the types of healthcare innovations developed or refined by PIs whose awards completed in 2016/2017.

Table 10.4: Examples of health sector innovations in development arising from HRB-funded awards

Award Type	Type of innovation	Description
Health Research Award	Preventative Intervention – Behavioural Risk Modification	The complex intervention developed as part of the project is to enhance alcohol screening and brief intervention in primary care more generally.
Clinician Scientist Award	Prognostic Tool (Imaging, Algorithm or other)	Using the extensive database of clinical parameters and metabolite data we have used machine learning techniques to develop a predictive algorithm which will predict the development of HIE.
HRB-MRCG Joint Funding Scheme	Therapeutic intervention: Psychological/Behavioural	SEA-CHANGE: SElf-management After Cancer of the Head And Neck Group intervention.
Interdisciplinary Capacity Enhancement Awards	Clinical Decision Support Tool	A web-based care matrix for ALS has been developed as a clinical support/management tool for the non-specialist seeing MND patients and is in the final stages of optimisation and testing.
Health Professional Fellowship	New ICT-based technology (ICT system, software, webtool/application or eBusiness platform)	The Reactivate intervention and evaluation study has provided an opportunity to evaluate the real-life application of a connected-health tool in the clinical setting.
Health Research Award	Care model or service	A clinical intervention to enhance access to hepatitis C treatment in primary care and which incorporates the PINTA intervention to address problem alcohol use has been developed and tested as part of a feasibility study in three sites - Dublin, Seville, London.
Health Research Award	Therapeutic intervention – New drug or indication	Phase Ib/II Trial of coPANlisib in Combination with Trastuzumab in HER2-positive Breast Cancer. (Panther Study) (Panther).
HRB-MRCG Joint Funding Scheme	Preventative Intervention: Physical/biological risk modification	The research has led to convincing data that supports targeting bile acid aspiration in young paediatric patients with Cystic Fibrosis to prevent the establishment of chronic infections and chronic inflammation. This work is approaching proof of concept stage.
Knowledge Exchange and Dissemination Award	Film/video/animation	Animated films providing easy-to-understand practical advice to carers to improve their quality of life and reduce stress. FreeDem Films are animations about memory loss, dementia and brain health.
Health Research Joint Programme in Neurodegenerative Disease	Diagnostic Tool – Non imaging	CSF Biomarker testing to support the diagnosis of Alzheimer's disease is now available in Ireland at the Immunology Lab, St. James's Hospital because of BiomarkAPD which allows us to establish cut-offs and normative values for an Irish population.
National SpR Academic Fellowship Programme	Therapeutic intervention: New drug or indication	Patent application submitted around inhibition of sialylation in multiple myeloma - New therapy arising from this work completed in animal studies.

11. Commercialisation and economic benefit

The primary focus of HRB-funded research investment is the generation of opportunities for improved healthcare delivery, better health outcomes and the generation of research evidence to inform policy and improve clinical practice. The successful commercial exploitation, or "commercialisation", of intellectual property arising from health research can result in economic benefits through job creating and the development of products and services, by converting scientific and technological advances into marketable products or industrial processes.

Summary of economic/commercial activity, compared to 2014/2015,2012/2013, 2010/2011 and 2008/2009 reporting periods

Commercial and enterprise activity	2016/2017 (N=187 awards)	2014/2015 (N=198 awards)	2012/2013 (N=134 awards)	2010/2011 (N=196 awards)	2008/2009 (N = 204 awards)
No. patents/copyrights/trademarks filed	10	24	16	11	12
No. licenced technologies developed	5	2	5	3	3
No. start-ups/spin-outs established	2	4	2	2	2
No. industry collaborations established	59	58	88	25	10

Key Finding

- HRB researchers were very active in this space, which 103 unique commercialisation and enterprise outputs reported by 46 award holders (24.6% of total awards.) This is significantly higher than the 9% of UK MRC award holders who had reported similar outputs after five years in 2016.
- 25 awardees had discussed the commercial potential of their work with a university Technology Transfer Office or potential industry partner and 10 researchers had filed patents, copyrights or trademarks
- Five awards had negotiated licencing agreements (four Exclusive Royally Free, one option to licence), and there were two start-ups reported
- Project and Programme Awards reported the highest number of outputs (N=37), representing 1.2 outputs in this category per €1 million spend.
- Applied Biomedical Research and Clinical Research were the most likely to produce commercialisation outputs of all types and accounted for almost 84% of all commercialisation outputs, productivity of 1.3 and 1.0 outputs per €1 million spend, respectively.
- 59 unique instances of new or strengthened academic – industry collaborations were identified by 34 award holders (18% of total awards).
- Collaboration for the purpose of conducting joint-research projects, with both Irish and international industry partners, accounted for 46.6% of all cited reasons. Gaining access to cohorts or datasets and sharing data, research findings and expertise were also important reasons cited by HRB researchers.

11.1 Commercialisation and enterprise activity

An increasingly important indicator of the impact of publicly-funded research in Ireland is the proportion of research awards producing outputs that can be commercialised and the level of collaboration between the academic and industrial sectors. HRB-funded researchers were asked if their research findings had commercial

potential and if so, to what extent they had pursued this opportunity in terms of intellectual property protection and various commercialisation routes. Award-holders were also asked if they had established industry collaborations.

11.1.1 Distribution of commercialisation and enterprise outputs by type

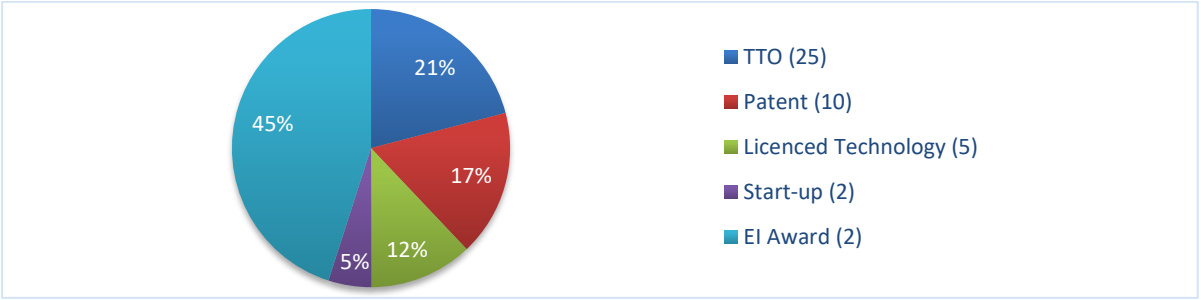
A summary of the reported outputs for 2016/2017 and a comparison with outputs for the 2014/2015, 2012/2013, 2010/2011 and 2008/2009 reporting periods is presented in Table 11.1. HRB researchers were very active in this space, which 103 unique commercialisation and enterprise outputs reported by 46 award holders (24.6% of total awards.) This is significantly higher than the 9% of UK MRC award holders who had reported similar outputs after five years in 2016.

Table 11.1: Number of commercial outputs by type – comparison of reporting periods

Output type	2016/2017 (N=187 awards)	2014/2015 (N=198 awards)	2012/2013 (N=134 awards)	2010/2011 (N=196 awards)	2008/2009 (N = 204 awards)
Filed invention disclosure or in discussions with TTO	25	5	20	9	9
Patents filed (includes trademarks or copyright, pending, active or lapsed)	10	24	16	11	12
Licenced technologies	5	2	5	3	3
Start-ups established or in train	2	4	2	2	2
Academic-industry collaborations established	59	58	88	25	10
Commercialisation awards secured from EI	2	9	5	4	6
Total	**103**	**102**	**136**	**54**	**42**

Figure 11.1 shows the distribution of commercialisation outputs by type. 25 awardees reported that they had discussed the commercial potential of their work with a university Technology Transfer Office or potential industry partner. 10 researchers had filed patents, copyrights or trademarks for their research outputs. In terms of the jurisdiction of filing, three were files with the Irish Patent Office, one was a UK patent, three were filed with the EU Patents Office, two were filed with the US Patents Office, and one patent were filed under the Patent Cooperation Treaty (PCT). [5]

Figure 11.1: Distribution of commercialisation outputs by type



[5] By filing one international patent application under the PCT, applicants can simultaneously seek protection for an invention in 148 countries throughout the world.

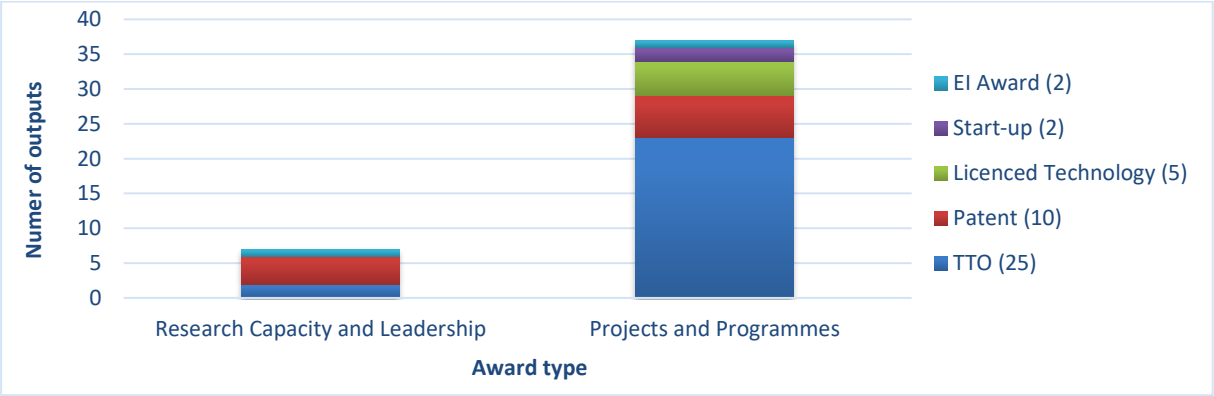
Five (12%) of awards had negotiated licencing agreements (four Exclusive Royally Free, one option to licence), and there were two start-ups reported from awards that completed in 2016/2017, with one employee reported. One start-up was established specifically to bring a product to clinical trial while the other was established to commercialise a technology developed in the laboratory.

11.1.2 Distribution of commercialisation outputs by award type and scheme

Figure 11.2 shows the distribution of commercialisation outputs (IDFs, patents, licenced technologies, start-ups, Enterprise Ireland commercialisation awards), reported for awards that completed in 2016/2017, broken down by award type. This shows that the largest number of commercialisation outputs of all types arose from Project and Programme Awards (N=37), representing 1.2 outputs in this category per €1 million spend. Research Capacity and Leadership Awards produced seven commercial outputs, resulting in an overall productivity of 0.4 outputs per €1 million spend for Programme Awards.

As was the case in the 2014/2015 reporting period, there were no commercial outputs reported for the Infrastructure and Network Awards.

Figure 11.2: Distribution of commercialisation outputs by award type



Distribution of commercialisation outputs by scheme

When the data is analysed at the level of individual schemes, Table 11.2 captures the number of commercialisation outputs reported by schemes and examines the total number of outputs as a proportion of the total number of awards per scheme reporting in 2016/2017.

Unsurprisingly, given that the primary focus of HRB-funded research investment is the generation of opportunities for improved healthcare delivery, better health outcomes and the generation of research evidence to inform policy and improve clinical practice, Table 11.2 shows that in general, there was less than one commercialisation output per award in schemes that reported on this metric. The exceptions were the Clinician Scientist Scheme, which produced 4.5 commercialisation outputs per award, and the Joint Programme in Neurodegenerative Diseases, which produced 1.7 commercialisation outputs per award.

Schemes that completed in 2016/2017, but which did not report any commercialisation outputs (e.g. Applied Projects in Dementia, Cancer Prevention Fellowships, Cochrane Training Fellowships, ICE Awards and Research Collaboration in Quality and Patient Safety) were almost exclusively categorised as Population Health Sciences or Health Services Research. This result is to be expected, since the focus of this type of activity is health improvements targeted at the population level and in health services delivery and organisation.

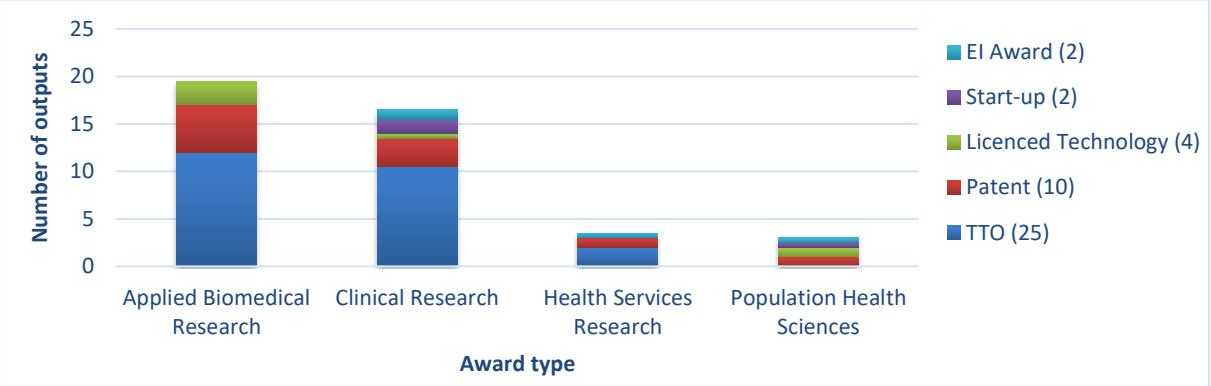
Table 11.2: Distribution of commercialisation outputs across schemes, and as a proportion of total awards in each scheme completing in 2017/2017

Scheme	Industry Collab.	TTO/ Industry IDF	IP	Licence	Spin-out	Total no. outputs	Total no. of awards reporting in scheme 2016/2017	Average no. outputs per award
Clinician Scientist Award	5	1	3			**9**	2	4.5
Health Professional Fellowship	2	1				**3**	11	0.3
Health Research Awards	38	16	4	4		**62**	73	0.8
Joint Programme in Neurodegenerative Disease	3	2				**5**	3	1.7
Knowledge Exchange and Dissemination Scheme	4		1		1	**6**	44	0.1
MRCG Co-fund Award	4	5	2	1	1	**13**	20	0.7
National SPR Academic Fellowship	1					**1**	3	0.3
PhD Scholars Programme	1					**1**	1	1.0
Postdoc in Translational Medicine	1					**1**	1	1.0
Total	**59**	**25**	**10**	**5**	**2**	**101**	**143**	**0.7**

11.1.3 Distribution of commercialisation outputs by broad research area

The distribution of broad research areas in which awards with commercialisation outputs were categorised is show in Figure 11.3. As would be expected given their focus, awards categorised as Applied Biomedical Research and Clinical Research were the most likely to produce commercialisation outputs of all type in the 2016/2017 reporting period. These broad research areas accounted for almost 84% of all commercialisation outputs, and reached 1.3 and 1.0 outputs per €1 million spend, respectively.

Figure 11.3: Distribution of commercialisation outputs by broad research area



Awards categorised as Population Health Sciences and Health Services Research accounted for only 16.3% of commercialisation outputs and had productivity of 0.5 commercialisation outputs per €1 million spend. This

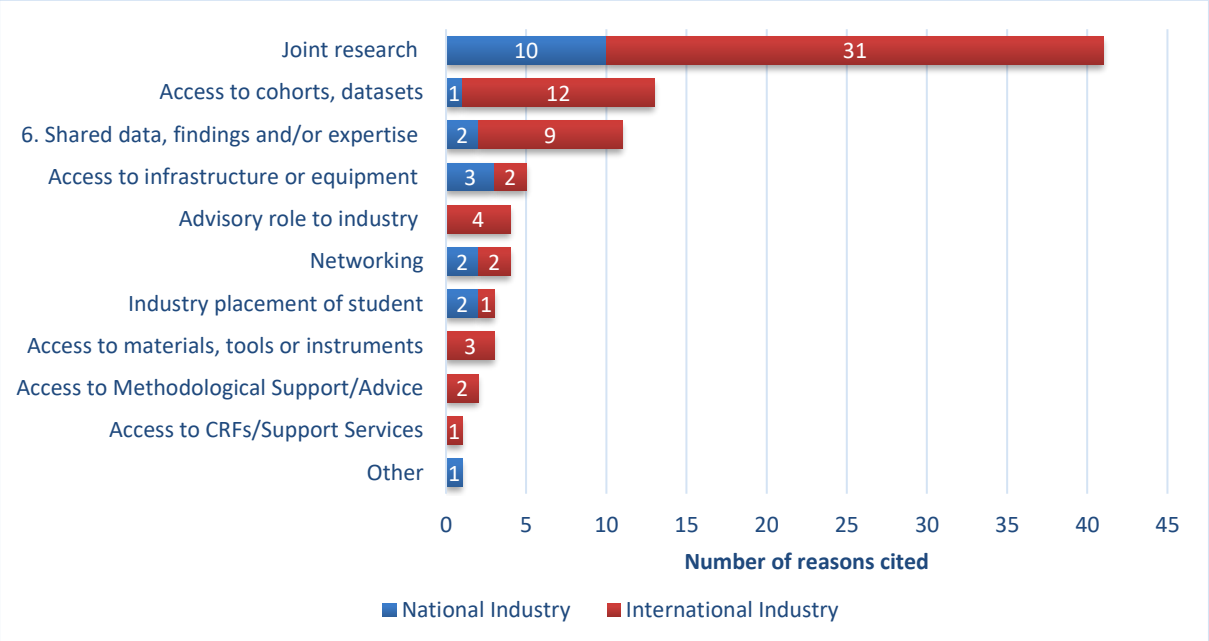
result aligns with the observations in Table 11.2, that these broad research areas are far less likely to produce commercialisation and enterprise outputs.

11.2 Establishment of collaborations with industry

PIs whose awards ended in 2016/2017 were asked to cite the reasons for collaborating with industry (and could chose more than one reason.) In total, 59 unique instances of new or strengthened academic – industry collaborations were identified by 34 award holders (18% of total awards).

Figure 11.4 shows the reasons cites by researchers for establishing a collaboration of some type with an industry partner, and whether this industry partner was national or international. Collaboration for the purpose of conducting joint-research projects, with both Irish and international industry partners, accounted for 46.6% of all cited reasons. Gaining access to cohorts or datasets and sharing data, research findings and expertise were also important reasons cited by HRB researchers.

Figure 11.4: Cited reasons for establishing new industry collaborations (national or international)



11.3 Examples of commercialisation and enterprise outputs

Table 11.3 provides examples of the type of commercialisation outputs reported by researchers whose awards completed in 2014/2015.

Table 11.3: Examples of commercial activities

Award type	Output Type	Purpose of activity	Details of output
Health Research Award	Industry Collaboration: National	Joint Research	The PI has regular engagement with enterprise, specifically with pharmaceutical and medical device companies, and was awarded an Industry Engagement Award.
Postdoc in Translational Medicine	Industry Collaboration: International	Access to infrastructure or equipment	Arranged research visit to US Biotech company laboratories to undertake some of the research.
Health Research Award	Invention Disclosure (IDF) to TTO	Protection of IP	Investigation for potential use of anti-fibrin agents within a catheter locking solution under investigation and Invention Disclosure Form submitted.
Clinician Scientist Award	Patent	Protection of intellectual property	System and method for monitoring use of a device: US Patent Office - US201314424964 20130829
Health Research Award	Industry Collaboration: National	Joint Research	Collaboration with Irish company specialising in drug-delivery and generation of anti-inflammatories.
HRB-MRCG Joint Funding Award	Start-up company	Commercialisation of product	This is an early stage start-up focusing on commercialization of technology developed in our lab for delivery of ophthalmic drugs by vitamin E loaded lenses for treating multiple indications including cystinosis.
HRB-MRCG Joint Funding Award	Copyright	Protection of intellectual property	How2tell website, app, videos, booklet are copyright protected
Health Research Award	Exclusive royalty-free licence agreement	Commercialisation of product	Assignment of intellectual property, to Regulus Therapeutics “In vivo analysis of miR-134 oligonucleotide inhibitors-in intra-amygdala KA model”
Health Research Award	IDF with company	Commercialisation of product	The findings of this study have led to discussions with an Investment Company surrounding the IP of developing new drugs for HIV
Joint Programme in Neurodegenerative Diseases	Industry Collaboration: International	Access to cohorts/datasets	Provided samples for research collaboration with scientific company
Health Professional Fellowship	Industry Collaboration: International	Joint Research	Based on the outputs of this project and methodologies developed to better understand mechanisms of disease at the site of Inflammation, we have established an Industry Partnership with Janssen Global USA, for the next 2 years. This is based on identifying new therapeutic targets and biomarkers of Disease. | This has already led to one joint publication, with another two manuscripts currently under review

12. Conclusion

The data described in this report demonstrates a wide variety of outputs produced by HRB-funded research in terms of knowledge production, capacity-building, policy and practice outputs, health sector innovations and enterprise outputs.

When compared to metrics collected in previous reporting periods, the data shows that HRB-funded research completing in 2016/2017 continues to be highly productive across the full range of Payback Categories, with increases in many metrics, compared to previous reporting periods. The number of awards reporting outputs/outcomes was found to be very similar to the UK MRC, although the number of outputs per MRC award tended to be higher than per HRB award, which is understandable given the difference scale of these awards.

From the trends observed in previous reporting periods, it was predicted that shifting investment away from basic and applied biomedical research since 2008 would result in a decrease in peer-reviewed publications and commercialisation outputs/opportunities. Instead, this report found that there was an increase in the number of 'scientific productivity' markers such as peer-review papers and presentations at scientific conferences, indicating that HRB researchers in all broad research areas have increasing international reach and remain highly regarded by peers internationally.

Given the HRB's strategic objective to 'generate relevant knowledge and promote its application in policy and practice' it was good to see a significant increase in reported engagement outputs with policy makers, healthcare providers and decision-makers, patient groups and the public, as well as significant collaborations with these actors.

In recent years the HRB has taken a lead nationally in promoting the incorporation of Public and Patient Involvement (PPI) in the research that it funds. The 21.9% of awards reporting PPI outputs in 2016/2017 suggests that this policy initiative is having an impact, although it was also clear that not all researchers fully understand the difference between non-academic engagement and true PPI activities. However, it is hoped that through the efforts of university PPI Ignite Coordinators/PPI Network and expansion of Public Review of HRB grant applications, PPI methodologies will become clearer to researchers and the benefits of PPI will be better understood and embraced.

For the first time ever, the amount of additional research funding leveraged by HRB researchers exceeded the original HRB investment, with €1.2 million leveraged for every €1 million invested. The bulk of this leveraged funding was reported by Applied Biomedical and Clinical Research awards, and 42.4% of all leveraged funding came from non-exchequer sources in Ireland and overseas. Increased success in winning funding from EU Framework and other programmes reflects Ireland's overall success in these programmes.

A notable trend confirmed in the 2016/2017 reporting period is the increasing productivity of awards classified as Population Health Sciences and Health Services Research. This trend was observed across almost all Payback Indicators, particularly knowledge creation and influencing policy and clinical practice, with Health Services Research reporting the highest number of health sector innovations per €1 million spend.

The number of commercialisation outputs have remained relatively steady over time, although the number of patent applications decreased in 2016/2017. As expected, Applied Biomedical and Clinical Research awards reported more commercialisation outputs, with at least one commercialisation output per €1 million spend.

Continuing HRB emphasis on a multi-disciplinary collaborative funding model, along with the importance placed by international peer review panels on methodological rigour, ensures that only high-quality research is funded with the potential for both scientific, health and economic impact. This is reflected in the observed upward trend over the past ten years in almost all Payback Framework indicators. In the next reporting period (2018/2019) outputs, outcomes and emerging impacts from awards funded through the current HRB strategy 2016-2020 will begin to emerge, and it is anticipated that the positive trends observed to date will continue.

Appendix 1: Impact Assessment ("Payback") Framework

Table A1: Payback Framework impact categories and indicators (Buxton and Hanney)

Impact Category	Indicators
Knowledge Production	○ Peer reviewed publications and citations ○ Other publications such as books, book chapters, editorials or bulletins ○ Presentations to national and international conferences ○ Research reports and 'grey literature' produced ○ Cochrane systematic reviews produced, or findings included in a review
Research capacity-building and leadership	○ Education and training of personnel such as clinicians, health professionals and scientists ○ Higher degrees, such as PhD, obtained by research personnel ○ Retention rates of research personnel in national research or health system ○ Development and use of novel research techniques ○ Establishment of new datasets, databases or research data lodged in national database ○ New national/international collaborations or strategic partnerships formed with other research teams, industrial partners or health agencies ○ Internationalisation of research: Involvement of HRB-funded researchers with EU and global health research initiatives
Informing policy, practice and product development	○ Influencing national and international research policies and strategies ○ Dissemination and knowledge-transfer events or networks established with research 'users', such as policy-makers and health professionals ○ Advisory roles of HRB-funded researchers to government or policy-makers ○ Policy briefing papers, practical handbooks and other grey material produced and disseminated to research users such as policy-makers and health professionals ○ Contribution of research to clinical treatment or best practice guidelines ○ Evidence of public outreach and dissemination through media and other fora
Health sector benefits and innovations	○ Contribution of HRB-funded research to health promotion initiatives ○ Randomised control trials completed and new interventions established as a result ○ Numbers of patients enrolled on clinical trials or engaged with studies undertaken in clinical research facilities supported by the HRB ○ Contribution of HRB-funded research to actual health benefits within Irish population ○ Savings to the health system through gains in health service efficiency, improved primary care or introduction of preventative health measures, where research and evidence generated by HRB-funded researchers contributed to this ○ Increased availability of local pool of evidence and evidence "generators" to Irish health policy-makers and health practitioner

Impact Category	Indicators
Economic, commercial and enterprise benefits	○ Improved international reputation of Ireland for health and medical research (e.g. by attracting pharma industry R&D and collaborative partnerships with HRB-funded researchers; invited keynote addresses to international conferences; involvement of HRB-funded researchers in international research programmes) ○ Patents and other IP applications and award of commercialisation support awards to develop marketable products or devices ○ Licence agreements and revenues generated as a result ○ Spin-out companies or formal collaborative partnerships between researchers and industry ○ Success of HRB-funded personnel in attaining additional research funding, for example though the EU's Framework Programmes ○ Success of HRB-funded researcher in obtaining EI funding for further development of potentially viable enterprise outputs of the research.

Appendix 2: Summary of key payback indicators from awards ending in 2016/2017 by award type

Table A.2: Summary of key payback indicators from awards ending in 2016/2017 by award type

Impact Category / Key Indicator (Total no.)	Project and Programme Awards (148 awards)	Research Capacity and Leadership Awards (37 awards)	Infrastructure and Network Award (2 awards)
Amount invested (€)	**€29.5 million**	**€16.1 million**	**€1.6 million**
1. Knowledge production			
Total no. peer-reviewed publications (N=849)	523	289	37
Mean no. peer-reviewed publications per award	3.9	7.6	18.5
Average no. publications per €1 million spend	17.4	17.9	18.4
No. scientific presentations (N=1,524)	995	499	30
No. keynote presentations internationally (N=23)	19	3	1
2. Research capacity-building and leadership			
Total no. research related posts created (N=329)	249	58	22
No. PhD degrees (N=77)	53	16	8
No. post-doctoral researchers supported (N=124)	109	10	5
No. from health professional background (N=132)	86	34	12
No. researchers remaining in national health or research system (N=268)	201	50	17
No. awards reporting indicators of peer recognition (N=456)	315	141	0
No. research collaborations established (N=399)	299	90	10
No. collaborations with health bodies or government agencies (N=67)	53	13	0
No. new research methods, materials, datasets or tools developed (N=113)	87	22	4
No. leveraged additional awards (N=199 awards)	150	40	9
Value of leveraged funding to HRB researchers (total = €57 million)	€42.8 million	€871k	€480k
Total no. involvements in EU or international research initiatives (both collaborations or funding partnerships (N=279)	207	65	7

Impact Category / Key Indicator (Total no.)	Project and Programme Awards (148 awards)	Research Capacity and Leadership Awards (37 awards)	Infrastructure and Network Award (2 awards)
3. Informing policy, practice and product development			
Total no. policy/practice outputs (N=187)	142	36	9
Average no. policy and practice outputs per €1 million spend	4.7	2.2	5.7
No. advisory roles to government or policy makers (N=20)	19	2	0
No. policy briefings, practical handbooks etc disseminated to research users (policy makers, health professionals etc.) (N=26)	18	5	3
No. contributions to clinical treatment or best practice guidelines (N=17)	11	6	0
No. policy/health system/public engagement outputs (N=531)	454	71	6
Average no. policy/health system/public engagement outputs per €1 million spend	15.2	4.4	3.8
No. Patient and Public Involvement (PPI) outputs (N=69)	63	4	2
4. Health sector benefits and innovations			
Total no. health sector innovations developed (N=57)	43	13	1
No. therapeutic interventions (drugs or psychological/behavioural) (N=19)	15	4	0
No. preventative interventions – risk modification (N=4)	3	1	0
No. prognostic or diagnostic tools (N=13)	11	2	0
No. care models, clinical decision support tools (N=14)	8	5	1
No. innovations in design/pilot/feasibility/proof of concept/trial stage (N=44)	34	10	0
No. innovations adopted in health system (small or large scale) (N=13)	9	3	1
Average no. health sector innovations per €1 million spend	1.4	0.8	0.6
5. Economic, commercial and enterprise benefits			
No. of patents/copyrights/trademarks filed or pending (N=10)	6	4	0
No. licenced technologies developed (N=5)	5	0	0
No. start-up/spin-out companies established (N=2)	2	0	0
No. industrial collaborations established (N=59)	50	9	0
No. commercialisation outputs per €1 million spend	1.2	0.4	0

Appendix 3: Summary of key payback indicators from awards ending in 2016/2017 by broad research area

Table A.3: Summary of key payback indicators from awards ending in 2016/2017 by broad research area

Impact Category / Key Indicator (No.)	Applied Biomedical (N=44.5)	Clinical Research (N=74.5)	Health Services Research (N=38)	Population Health Sciences (N=30)
Amount invested (€)	**€5.5 million**	**€17.6 million**	**€7.9 million**	**€6.2 million**
1. Knowledge production				
Total no. peer-reviewed publications (N=849)	218.5	278	149.5	203
Mean no. peer-reviewed publications per award	4.9	3.7	3.9	6.5
Average no. publications per €1 million spend	14.1	15.8	19	30.4
No. scientific presentations (N=1,524)	384	567	250.5	322.5
No. keynote presentations internationally (N=23)	4.5	6.5	3.5	8.5
2. Research capacity-building and leadership				
Total no. research related posts created (N=329)	67.5	123.5	92	46
No. PhD degrees (N=77)	21.5	25	13.5	17
No. post-doctoral researchers supported (N=124)	34.5	46	26	17.5
No. from health professional background (N=132)	9.5	51.5	50	21
No. researchers remaining in national health or research system (N=268)	48	100.5	80	39.5
No. awards reporting indicators of peer recognition (N=456)	177.5	162	58	58.5
No. research collaborations established (N=399)	105	148.5	70.5	75
No. collaborations with health bodies or government agencies (N=67)	9.5	34	14	8.5
No. new research methods, materials, datasets or tools developed (N=113)	38	38	16.5	20.5
No. leveraged additional awards (N=199 awards)	64	68.5	30.5	36
Value of leveraged funding to HRB researchers (total = €57 million)	€26.3 million	€19.2 million	€878K	€848k
Total no. involvements in EU or international research initiatives (both collaborations or funding partnerships (N=279)	79	98	49.5	52.5

Impact Category / Key Indicator (No.)	Applied Biomedical (N=44.5)	Clinical Research (N=74.5)	Health Services Research (N=38)	Population Health Sciences (N=30)
3. Informing policy and practice				
Total no. policy/practice outputs (N=187)	16	51	65	55
Average no. policy and practice outputs per €1 million spend	1.0	2.9	8.3	8.3
No. advisory roles to government or policy makers (N=20)	2	5	7	7
No. policy briefings, practical handbooks etc disseminated to research users (policy makers, health professionals etc.) (N=26)	0	5.5	13.5	7
No. contributions to clinical treatment or best practice guidelines (N=17)	1.5	5.5	8	3
No. policy/health system/public engagement outputs (N=531)	102	149	105	175
Average no. policy/health system/public engagement outputs per €1 million spend	6.6	8.5	13.3	26.3
No. Patient and Public Involvement (PPI) outputs (N=69)	8.5	19.5	27.5	13.5
4. Health sector benefits and innovations				
Total no. health sector innovations developed (N=57)	9	26.5	19	3.5
No. therapeutic interventions (drugs or psychological/behavioural) (N=19)	5.5	7	6.5	0
No. preventative interventions – risk modification (N=4)	0.5	2	1	0.5
No. prognostic or diagnostic tools (N=13)	1.5	8.5	3	0
No. care models, clinical decision support tools (N=14)	1.5	7.5	4.5	0.5
No. innovations in design/pilot/feasibility/proof of concept/trial stage (N=44)	7.5	22	13	1.5
No. innovations adopted in health system (small or large scale) (N=13)	1.5	3.5	6	2
Average no. health sector innovations per €1 million spend	0.6	1.5	2.4	0.5
5. Economic, commercial and enterprise benefits				
No. of patents/copyrights/trademarks filed or pending (N=10)	5	3	1	1
No. licenced technologies developed (N=5)	3	1	0	1
No. start-up/spin-out companies established (N=2)	0	2	0	0
No. industrial collaborations established (N=59)	34.5	19	5	0.5
No. commercialisation outputs per €1 million spend	1.3	1.0	0.5	0.5

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