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Outputs and outcomes of HRB awards completed in 2012 and 2013

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Executive Summary

Introduction

The HRB systematically and routinely collects output and outcomes data on all of the research that it funds. This evaluation activity is vital to ensuring that we understand how our programmes are working and helps to highlight where changes may be needed or opportunities arise. The information we collect also enables us to better communicate the value of health research to others, be they policy and practice stakeholders, the research community, patient groups, the enterprise sector or the public.

This report presents an analysis of 134 HRB grants (combined spend of €44 million) that completed in 2012 and 2013. It provides an overview of the initial outputs and some outcomes arising from these grants across a range of metrics and indicators. The purpose of the report is to: provide the HRB Management and Board with strategically useful information on the potential impacts of HRB-funded research; provide the staff of the Research Strategy and Funding Directorate with information that can inform improvement in scheme documentation and set-up, peer review processes, reporting, finalisation of metrics and so on. The report spans a very interesting time in the HRB funding portfolio when we were coming to the end of a period of peak investment in 2006/2007 and had only begun to deliver the changes set out in our current strategy through awards made in 2010/2011.

An important *proviso* in considering this report is that the analysis presented is not a complete picture of the outputs and outcomes from HRB-funded research, but rather a snapshot at the point of end-of-grant (EOG). Further outputs, outcomes and impacts would be expected to occur in the years following the completion of a grant. In addition, it should be noted that the data presented in this report relates to grants that were awarded predominantly in the 2007-2010 period, prior to and just at the beginning of the HRB's *Strategic Business Plan 2010-2014*. Hence, the data presented can provide only limited indications of the impact of the strategic shifts driven by that strategy.

Indicator framework

HRB evaluation data collection is guided by the Buxton-Hanney Payback Framework for Health Research (see Appendix 1 for the full framework). This framework groups metrics into five impact categories which span short to medium-term outputs, such as knowledge production, research capacity-building, informing policy and the public. The framework also spans longer-term outcomes, for example, policy changes, health sector innovations and economic and commercial activity. For the purposes of this report data was collected on a sub-set of quantitative metrics across all impact categories. Evaluation data to populate the framework was collected for the first time in 2013 via a bespoke online survey instrument (Outcomes Tracker.) Data for grants that completed in 2012 was a blend of End-of-Grant Management Reports collected via SurveyMonkey, combined with data on HRB outputs and outcomes collected from grants awarded between 2000 and 2009 as part of a wider portfolio analysis published in 2014.[1]

[1] Curran B and Barrett R (2014) Outputs, outcomes and impacts of arising from the HRB's 2000-2009 grants portfolio. HRB Publication. http://www.hrb.ie/publications/hrb-publication/publications//634/

Main findings

The analysis displayed in this report demonstrates a wide variety of outputs produced by HRB-funded research in terms of scientific output, capacity-building outputs, health sector and economic benefits and outcomes. When compared to analysis of grants completed in 2010/2011 and 2008/2009, the data shows that HRB-funded research completing in 2012/2013 led to more peer reviewed publications, policy and clinical practice outputs and influences, healthcare innovations (as a proportion of total number of grants) and economic and commercial outputs and outcomes. It produced less scientific presentations and new academic collaborations, but led to a significantly more industry collaborations.

Key output statistics for grants ending in 2012/2013 compared to previous years

IMPACT CATEGORY	2012/2013 (N=134 grants)	2010/2011 (N=196 grants)	2008/2009 (N = 204 grants)
Value of investment	**€44 million**	**€54.5 million**	**€45 million**
1. Knowledge production outputs			
No. peer-reviewed journal publications	584	470	526
% papers in high impact journals	N/A	28 %	31 %
No. scientific presentations reported	940	1427	1118
2. Research capacity-building outputs			
No. of research-related posts created	422	280	296
No. health professionals trained	136	82	70
No. PhDs registered	135	72	88
No. new research collaborations formed	287	415	384
No. new research materials/methods developed	112	85 (2011)	NA
3. Informing policy, practice and public			
% grants reporting policy/practice outputs	38 %	24 %	20 %
No. policy/practice outputs and activities	127	100	84
% grants that disseminated to public	50 %	35 %	21 %
4. Health sector innovations			
% grants reporting healthcare innovations	24.6 %	21 %	15 %
No. healthcare innovations in development	43	48	32
5. Economic and commercial activity			
No. research grants leveraged	149	113	117
Value of leveraged funding	€39.5 million	€34.8 million	NA
Amount leveraged per Euro of HRB investment	€0.89	€0.64	NA
No. patents filed or pending	16	11	12
No. technologies licenced	5	3	3
No. start-up companies incorporated or pending	2	2	2
No. industrial collaborations established	88	25	10

A more detailed summary of key outputs, broken down by scheme type is provided in Appendix 2.

Type of research funded

- Grants in basic and applied biomedical research that ended in 2012/2013 accounted for the largest proportion of spend, at 57 % (applied biomedical research accounted for 50.3 % of spend and basic biomedical research for 6.6 % of spend). This statistic is identical to the corresponding statistic for grants that ended in 2010/2011 and is down slightly on the statistic for grants that completed in 2008/2009, when 64 % of spend went on biomedical research.
- The percentage spend on clinical research-focused grants increased from 21 % of grants competed in 2010/2011 to almost 25 % of grants that completed in 2012/2013.
- The proportion of spend on grants in health services research was the same (15 %) for grants that competed in 2010/2011 and 2012/2013. However, the proportion of spend on grants in population health sciences decreased from 7 % to 3 % of total funding in 2010/2011 and 2012/2013, respectively.

Achievement of grant objectives

- The number of grants reporting that they had achieved all of their original objectives was 58 % (up on the corresponding 2010/2011 figure of 51 %).
- The most common reasons cited for non-fulfilment of all of the original grant objectives were 'insufficient time, or aspects of the research took longer than originally anticipated' (36 %); 'early findings led to a shift in research focus' (23 %); or one or more 'objectives changed due to developments in the field' (13 %). Grant holders also cited 'technical problems or lack of access to essential equipment or infrastructure' (12 %) as a contribution to not achieving all original objectives.
- In 2009 the HRB completed the process of moving to purely international peer review panels and increased the information required in grant applications regarding objectives, timelines, deliverables, personnel etc. This has resulted in much greater scrutiny of the feasibility of grant proposals, to the extent that proposals can be turned down on the basis of feasibility/over-ambition alone.
- There is evidence in the report that the HRB's increased emphasis on clarity in the application process, robust peer review and on-going grant monitoring is having a real impact in terms of PIs achieving their originally stated objectives.

Personnel employed

- There were a total of 422 research-related posts supported by the 134 HRB grants analysed, which represented a significant increase on previous reporting periods.
- Grants categorised as biomedical research accounted for 58 % of total posts, of which 8 % were in basic biomedicine and 50 % were in applied biomedicine. Grants focused on clinical research accounted for 22 % of posts created, while population health sciences and health services research, when combined, accounted for the remaining 20 % of posts created.
- Biomedical research grants employed 55.9 % of all post-doctoral researchers and 52 % of all PhD students. The number of post-graduate and post-doctoral researchers employed in population health sciences (5.5 %) was disproportionately low.
- Researchers with a health professional background (e.g. medicine, nursing, allied health professions) accounted for 32.2 % (N=136) of the 422 personnel employed across all grants, which was a slight increase of 3.2 % on the equivalent 2010/2011 statistic.
- The most common next destination of HRB-funded personnel was a post-doctoral research post in a higher education setting (37.7 % of all personnel). 91 personnel (21.5 % of total) were employed in the health sector, either as a medical clinician, clinical nurse or an allied health professional, which was a significant increase on the previous reporting period.

Peer-reviewed publications

- The 134 grants that ended in 2012/2013 produced 584 peer-reviewed publications, giving an average of 4.4 papers per grant. This is an increase on both the 2010/11 and 2008/2009 statistic of 470 and 526 publications, respectively, or an average of 2.4 and 2.6 papers per grant, respectively. This may be accounted for by two PhD Scholars programmes (both categorised as applied biomedical research) that completed in 2012/2013, where peer-reviewed publications were a primary output.
- Five-year programmatic grants, on average, produced slightly fewer papers per €1 million spend than other scheme types while the MRCG Co-fund scheme produced more papers per €1 million spend (20.8) that any other scheme type.
- ePublications accounted for 17.1 % of total publications in 2012/2013 (in 2010/2011 the equivalent statistic was 16.3 %.) In most cases this indicated that the electronic version of the paper was available ahead of printing, although not necessarily in an open access format. However, the number of papers published in the open access on-line journal PLoS increased from 5 in 2010/2011 to 15 in 2012/2013, indicating that this approach to publication is improving.

Dissemination and collaborations

- Grant-holders reported 940 scientific dissemination events (oral and poster presentations at scientific conferences), or 7.0 per grant. This is less than the 2010/2011 statistic of 1427 (7.2 per grant) but in terms of presentations per grant, is a slight increase on the 2008/2009 statistic of 5.5 presentations per grant (N = 1,118 presentations)
- 51 % of grant holders disseminated their research findings to patient groups or the public – this is a significant increase on the corresponding statistics of 35 % and 21 % for grants that ended in 2010/2011 and 2008/2009, respectively.
- Relative to other scheme types the number of keynote addresses per €1 million spend at both national and international scientific conferences was almost two times higher for MRCG Co-fund Awards.
- Grant holders reported the establishment of 278 new research collaborations or partnerships during the lifetime of the HRB grant. This represents an average of 2.1 per grant which is identical to the statistic for 2010/2011, and an increase on the 2008/2009 statistic of 1.9 new collaborations per grant.
- The proportion of collaborations established with health bodies increased from 10 % of total new collaborations in 2010/2011 to 14 % in 2012/2013.
- The number of industry collaborations, as a proportion of all collaborations established, increased dramatically from the 2010/2011 reporting period, from 8 % of new collaborations in 2010/2011 to 31 % in 2012/2013.
- For the first time in 2013, one PI reported the use of social media to disseminate the results of their research to a wider audience.

Policy and practice-oriented outputs

- 52 grant-holders (38 % of total) reported a total of 127 policy or clinical practice outputs and influences. This is an increase on the corresponding statistics for 2010/2011 and 2008/2009 when 48 and 41 grant-holders, respectively, reported 100 and 84 policy and practice outputs and influences, respectively.
- Per €1 million spend, grants in health services research produced more health sector outputs and influences than either population health sciences, clinical research or applied biomedical research. Surprisingly, basic research grants reported almost as many policy and practice outputs as health

service research awards per €1 million spend but these tended to be presentations to stakeholder groups and publication or citation in systematic reviews or specialist publications.

- Project Grants accounted for almost 60 % of reported policy and practice outputs, and 4.4 outputs per €1 million spend, as compared to Programme Grants and Fellowship Awards which produced 2.6 and 2.2 outputs per €1 million spend, respectively.
- MRCG Co-fund awards had the highest productively of all scheme types for this metric, with 6.9 policy and practice outputs reported per €1 million spend.

Health sector innovations

- A total of 33 grant-holders (24.6 % of total) reported 43 healthcare innovations. This is similar to the corresponding statistic for 2010/2011 (48 innovations) but higher than 2008/2009 (32 innovations).
- The most common type of healthcare innovation reported was development of a new, or refinement of an existing, care model of service.
- Per €1 million spend, grants in population health and health services research produced more health sector innovations than other scheme types (2.2 and 2.0, respectively.) Surprisingly, basic research grants (primarily the MRCG Co-fund scheme) reported almost as many healthcare innovations (1.0 per €1 million spend) as clinical research (1.1 outputs per €1 million spend), and more than applied biomedical grants (0.5 per €1 million spenda.)
- The vast majority of the 43 innovations were in the early stages of development or were still being tested and refined, with only 2 % reported as having achieved large scale adoption in the health sector, although a further 14 % had been adopted on a small scale within the health sector.

Follow-on funding leveraged

- 149 follow-on grants were leveraged by PIs whose grants completed in 2012/2013. This is an increase on the 2010/2011 and 2008/2009 statistics of 113 and 117 follow-on grants, respectively.
- Of the approximately €39.5 million that these 149 grants were collectively worth, 54.7 % came from non-exchequer sources such as industry, charities, and international bodies. This was the first time since this data began to be collected on this metric that leveraged non-exchequer funding exceeded exchequer funding.
- The return on HRB investment of leveraged funding, euro for euro, was almost parity (€0.89), in comparison to the 2010/11 reporting period, when it was €0.65 of leveraged funding for every €1.00 of HRB funding invested.
- Nine grant-holders had secured follow-on technology development or commercialisation grants from Enterprise Ireland, which is a significant increase on the corresponding 2010/2011 statistic of two awards.

Intellectual property and commercial activities

- Grants that ended in 2012/2013 produced 16 patents, five licensed technologies, contributed to the establishment of two start-up companies, and led to 88 academic-industry collaborations.
- In total, HRB grant-holders reported 48 commercial outputs - this is similar to the 2010/2011 statistic of 54 outputs, and a slight increase on the 2008/2009 statistic of 42 commercial outputs.
- Unsurprisingly, grants in the biomedical sciences produced more commercial opportunities than clinical research, health services research and population health sciences grants.
- Project Grants produced 1.2 commercial/enterprise outputs per €1 million spend. Other scheme types produced between 0.2 and 0.7 outputs per €1 million spend.

Conclusions

A number of observations can be made from the data presented in this report:

- Grants in the biomedical and clinical sciences produced the most scientific publications and commercial opportunities such as patents and industrial collaborations;
- Grants in health services research, population health sciences and clinical research produced the most health policy and practice outputs and provided the most research training opportunities for health professionals;
- The MRCG Co-fund scheme was very productive in terms of number of outputs per €1 million spend across a wide range of metrics.

The implication of a shift away from basic biomedical and applied biomedical research that is not specifically patient-oriented, towards greater investment in patient oriented research, population health sciences and health services research, is that over the coming years we may see a slight decrease in scientific 'productivity' (e.g. number of peer-reviewed publications per €1 million spend) and commercial impact (e.g. patents, industry collaborations), since these outputs tend to arise predominantly from the former types of research activity. However, there is no reason to believe that a decrease will occur in indicators of scientific quality (e.g. field-normalised citation impact).

The new HRB funding initiatives in Clinical Research, Population Health Sciences and Health services research, based on the multi-disciplinary collaborative funding model, along with the emphasis placed by international peer review panels on methodological rigour, ensures that only high-quality research is funded with the potential for both scientific and health impact. Therefore, possible decreases in productivity metrics will be more than offset by a concomitant increase in health sector outcomes such as development of healthcare innovations (e.g. interventions, therapies) and influences on policy and practice (e.g. clinical guidelines, policy briefs, advisory roles) which tend to be associated with these broad research areas.

Section 1: Introduction and overview of awards

1.1 Introduction

The HRB seeks to improve people's health by funding cutting edge research relevant to health and social gain. To that end, the HRB manages a variety of funding schemes that: support high-quality health research; build capacity for health research by supporting researchers' career development; and facilitate the conduct of world-class health research by providing vital research infrastructure and national networks of researchers. It is imperative that the HRB measure the extent to which this portfolio of funding is achieving its' mission and delivering the intended benefits.

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. In addition, the HRB is keen to use its limited funds as efficiently and effectively as possible and to ensure that the schemes it operates are meeting the objectives for which they were established in the most cost-effective way. There is also the need to inform HRB funding strategy and decisions relating to new or existing funding initiatives with relevant evaluation evidence.

All of these requirements can be fulfilled through systematic and formalised evaluation that allows the HRB to demonstrate value for research investment, and to ascertain the following:

- The efficacy and effectiveness of funding policies and the variety of funding instruments used by the HRB;
- The scientific, societal and economic impact of the HRB's investment in health research and ultimately its impact on people's health.

Evaluation in this sense is a separate although related activity to monitoring of individual awards, which the HRB carries out through annual grant reports, as well as conducting peer-assisted interim reviews for larger awards. The end-of-grant (EOG) report is used to systematically collate information on outputs and outcomes arising from HRB-funded research at the point of completion of the grant.

It should be noted that, 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 economy. Therefore, evaluation data collected at the point of end-of-grant can only provide a snapshot in time. Further outputs, outcomes and impacts would be expected to occur in the years following the completion of a grant.

1.2 The Payback Framework

HRB evaluation data collection is guided by the Buxton-Hanney Payback Framework for Health Research (Buxton and Hanney, 1994[2], 1996[3]), originally developed to examine the 'impact' or 'payback' of health services research. This framework groups metrics into five impact categories which span short to medium-term outcomes, such as knowledge production, research capacity-building, informing policy and the public. The framework also spans longer-term impacts, for example, policy changes, health sector innovations and economic and commercial activity. The full framework is presented in Appendix 1.

For the purposes of this report data on a substantial subset of quantitative metrics set out in this framework were collected using a bespoke online survey instrument. Other metrics in the framework are more qualitative

[2] Buxton, Martin and Stephen Hanney (1994) Assessing Payback from Department of Health Research and Development: Preliminary Report. Volume 1: The Main Report. HERG Research Report, No. 19. Uxbridge: HERG, Brunel University.

[3] Buxton, Martin and Stephen Hanney 1996. How can payback from health services research be assessed? Journal of Health Service Research and Policy, **1**(1), 35–43.

in nature and are not amenable to collection via a survey. However, the metrics collected allow the HRB to get a comprehensive overview of how its funding instruments are performing against their original objectives.

Table 1: Example of the multi-dimensional categorisation of paybacks of the Payback Framework Category Definition*

Impact Category	Key HRB metrics
Knowledge production	• Total no. peer-reviewed publications produced • Average no. of publications per grant • No. papers per €1 million spend by scheme type and broad research area • No. and type of scientific presentations by scheme type
Research capacity-building	• No. and type of personnel funded • No. personnel with health professional background • No. PhDs and post-docs by scheme type and broad research area • Next destination of funded personnel • No. and type of new research collaborations • No. and type of new research materials and methodologies • No. and type of research awards and recognition
Informing policy, practice and public	• % grants reporting policy/practice influences and outputs • No. and types of outputs and influences reported (e.g. meetings with end users, reports, guidelines, submissions produced) • No. influences by scheme type and strategic broad research area • No. influences per € million spend by scheme type and broad research area • No. and type of public/patient dissemination events
Health sector innovations	• % grants reporting development of health innovations • No. and types of health innovations developed (e.g. new drugs, interventions, diagnostics, ICT systems, care models) • Stage of development of innovations • No. innovations by main scheme type and broad research area • No. innovations per € million spend by scheme type and broad research area
Economic and commercial activity	• No., source and value of leveraged grants obtained • No. invention disclosures filed • No. patents filed • No. technologies licenced • No. spin-out companies incorporated • No. industrial collaborations established • No. commercialisation grants secured

* Adapted from Buxton and Hanney (1994, 1996, 1997[4]) and Wooding *et al* (2004[5])

[4] Buxton, Martin and Stephen Hanney 1997. Assessing Payback from Department of Health Research and Development: Second Report. Volume 1: The Main Report. HERG Research Report, No. 24. Uxbridge: HERG, Brunel University.

[5] Wooding, Steve, Steve Hanney, Martin Buxton and Jonathan Grant 2004. The Returns from Arthritis Research Volume 1: Approach, Analysis and Recommendations. Cambridge: RAND Europe. <http://www.rand.org/pubs/monographs/2004/RAND_MG251.pdf>, last accessed 15 July 2011.

1.3 Number, type and value of grants completed

In total, 134 grants that completed in 2012 and 2013 are analysed in this report. These grants had a combined value of €44 million. The equivalent statistics for grants that completed in 2010/2011 and 2008/2009 are 196 grants (€54.5 million value) and 204 grants (€45 million value), respectively. The report does not contain complete information on all grants that finished in 2012/2013, since one PhD Scholars Programme that completed in 2013 provided information in only some categories, the means whereby the information was collected changed from 2012 to 2013, and a number of grant holders did not provide evaluation data. However, this report covers over 75 % of grants across all schemes.

The year of award of these grants is plotted in Figure 1. This figure shows that the vast majority of the analysed grants were awarded between 2007 and 2010. In other words, the report spans a very interesting time in the HRB funding portfolio when we were coming to the end of a period of peak investment in 2006/2007 and had only begun to deliver the changes set out in our current strategy through awards made in 2010/2011. Table 2 shows that most of the awards were standard project grants and fellowships of 2-3 year duration. Grants that were awarded prior to 2006 were more likely to be 5-year programme grants.

Figure 1: Breakdown of grants by year of award

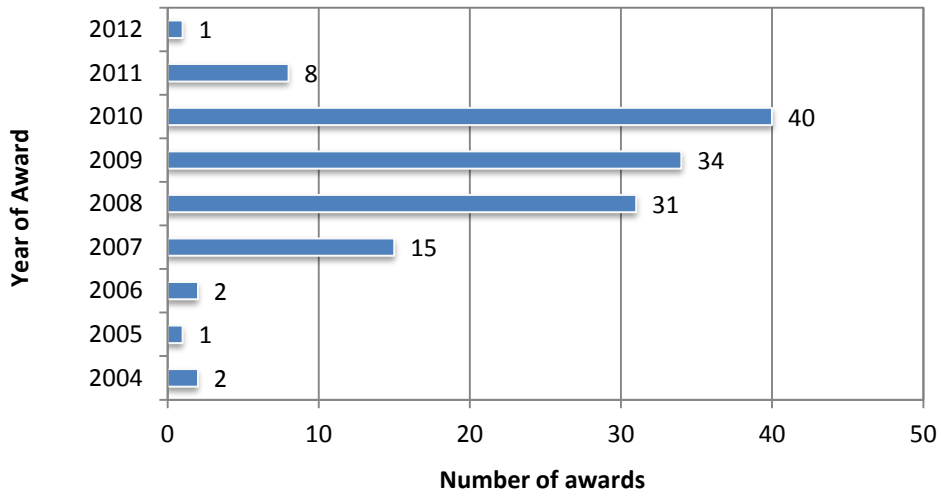


Table 2: Breakdown of grants by scheme and year of award

Scheme	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Clinical Research Training Fellowship					1					**1**
Clinician Scientist Award				1						**1**
Clinical Therapies Professional Fellowship					2					**2**
Cochrane Training Fellowship						2	9			**11**
Global Health Award				1	1					**2**
Health Economics Fellowship					1	2				**3**

Scheme	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Health Professionals Fellowship						7	8	1		**16**
Health Research Award						19	19	5	1	**44**
Health Services Research Fellowship					1					**1**
Joint Research Project Grant in Cancer					1					**1**
Marie Curie / HRB Post-doctoral Fellowship						2	4			**6**
MRCG Co-Fund Award				2	6			1		**9**
Nursing & Midwifery Research Priorities Study				1						**1**
Nursing and Midwifery Research Fellowship					2					**2**
PhD Scholars Programme	2									**2**
Post-doctoral Fellowship				1	1	2				**4**
Post-doctoral Fellowship in Translational Medicine								1		**1**
Research Project Grant			1	7	15					**23**
Strategic Health Services R&D Award		1								**1**
Translational Research Award			1	2						**3**
Grand Total	**2**	**1**	2	**15**	**31**	**34**	**40**	**8**	**1**	**134**

Distribution of spend by scheme type

Figure 2 shows the breakdown of the 134 grants by scheme type and overall funding received. Project Grants[6] accounted for the largest number of awards and received the largest proportion of the total funding, at an average cost of €239K per award, Fellowship Awards[7] accounted for almost 25 % of all awards that completed in 2012/2013, and the second largest spend, at an average cost of €213K per award – this category comprised of a diverse range of fellowship schemes, which have since been consolidated into a small number of schemes.

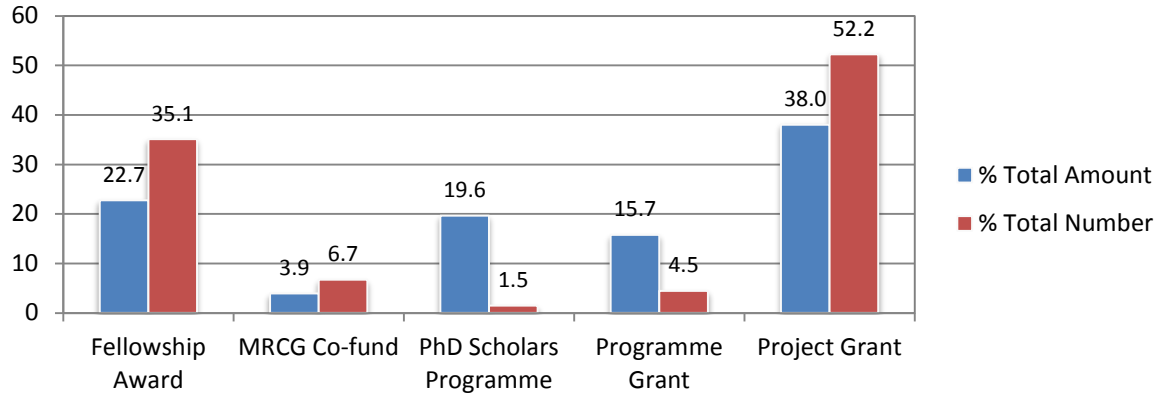
Two PhD Scholars Programmes completed in 2013 and accounted for 20 % of total funding awarded, at an average cost of €4.3 million per award, while five Programme Grants (including three Translational Awards, a Nursing and Midwifery Research Priorities Study, and a Strategic Health Services R&D Award) and a Clinician Scientist Award completed in the period 2012/2013, and accounted for 16 % of the remaining spend, at an average cost of €1.2 million per award.

The MRCG Co-fund award accounted for 6.7 % of total awards, and 3.9 % of total funding, at an average cost of €192k per award.

[6] The Project Grants category includes: Research Project Grants (N=23), Health Research Awards (N=44). Global Health Research Awards (N=2) and one Joint Project Grant in Cancer.

[7] The Fellowship Awards category includes: Clinical Research Training Fellowship (N=1), Clinical Therapies Professional Fellowship (N=2), Cochrane Training Fellowship (N=11), Health Economics Fellowship (N=3), Health Professional Fellowship (16), Health Services Research Fellowship (N=1), Nursing and Midwifery Research Fellowship (N=2),

Figure 2: Number and value of awards by scheme type

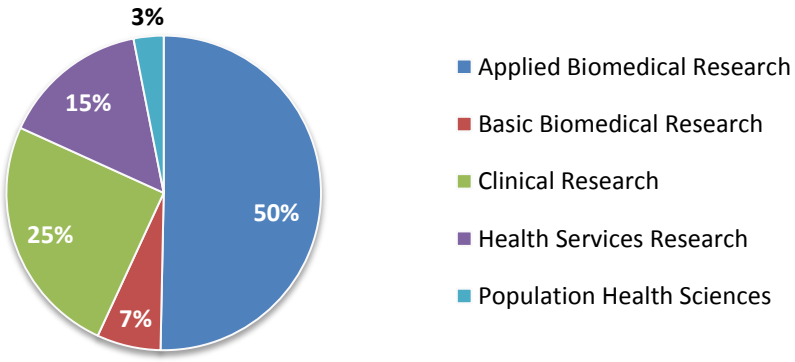


Distribution of spend by broad research area

Distribution of the €44 million investment across the five broad research areas is shown in Figure 3. For ease of analysis, each grant was allocated a single classification to represent the predominant focus of the award. A proportion of grants span more than one area of health research (e.g. clinical/HSR) and in in these cases the amount awarded was split equally between the two broad research areas.

Basic biomedical research accounted for 7 % of total spend on awards completing in 2012/2013, down from 12 % for grants that completed in 2010/2011. All of these awards were made prior to the revised HRB Strategy. Applied biomedical research accounted for the largest proportion of funding (50 %). Clinical research accounted for 25 % of the total spend. Population health sciences and health services research, when combined, accounted for 18 % of total spend. However, it should be remembered that many of these grants would have been awarded prior to the HRB's shift in emphasis to building these broad research pillars towards a significant proportion of the HRB funding portfolio.

Figure 3: Distribution of spend across broad research areas



It is also interesting to compare the broad research areas that are the focus of grants that completed over the six years from 2008 to 2013 (Figure 4).

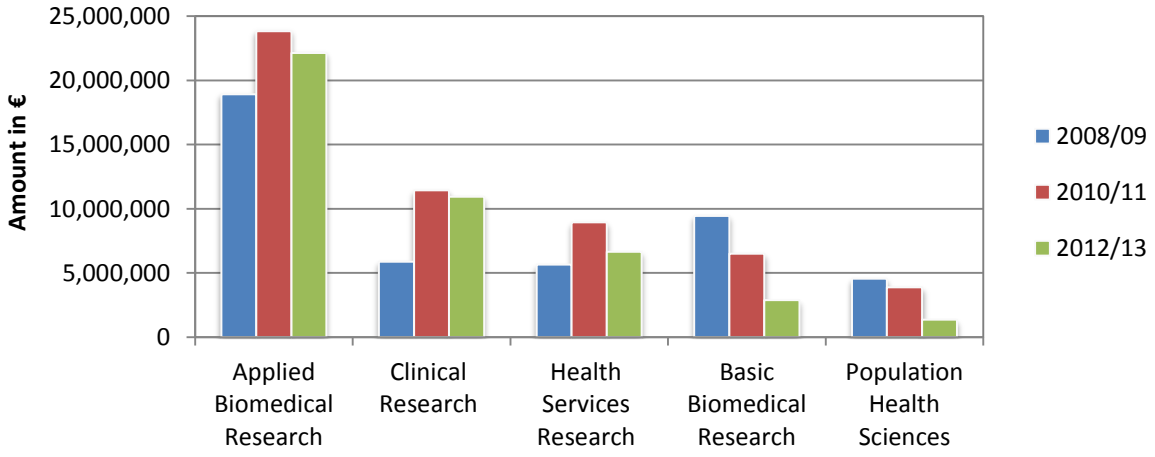
The relative distribution of spend on these grants remains relatively constant for applied biomedical research. In particular, in 2013 three large Programme Grants and two PhD Scholars Programmes categorised as applied biomedical research came to an end, which would account for the proportion of funding in this category on awards that completed in this year (36 %).

Funding of grants categorised as basic biomedical research that completed between 2008 and 2013 was in steady decline and accounted for only 7 % of the total funding for completed grants in 2012/2013, a decrease from 12 % in 2010/2011 and 21 % in 2008/2009. Grants categorised as basic biomedical research that completed in 2012/2013 were primarily MRCG Co-fund awards, which have tended to be in this space.

The spend on grants categorised as clinical research more than doubled from 2008 to 2013. HRB spend in this area would be expected to remain at its current levels in the next few years. However, with a number of Clinician Scientist Awards due to complete in 2017, as well as completion of the CRF awards in 2017 (they all stretched their original funding beyond their original completion dates, based on generated income), there is an anticipated spike for clinical research funding in the outputs report that year.

Spending on grants categorised as health services research that completed between 2008 and 2013 peaked in 2010/2011 with the completion of two large Health Services Research programme grants made in the mid 2000's (Strategic R&D Award, Nursing & Midwifery Research Priorities Study). These awards arose from the impetus of *Making Knowledge Work for Health* (Department of Health and Children 2001)[8] and the establishment of a Health Services R&D Unit within the HRB to develop new initiatives in this area.

Figure 4: Comparison of spend across broad research areas for grants ending in 2008/2009, 2010/2011 and 2012/2013



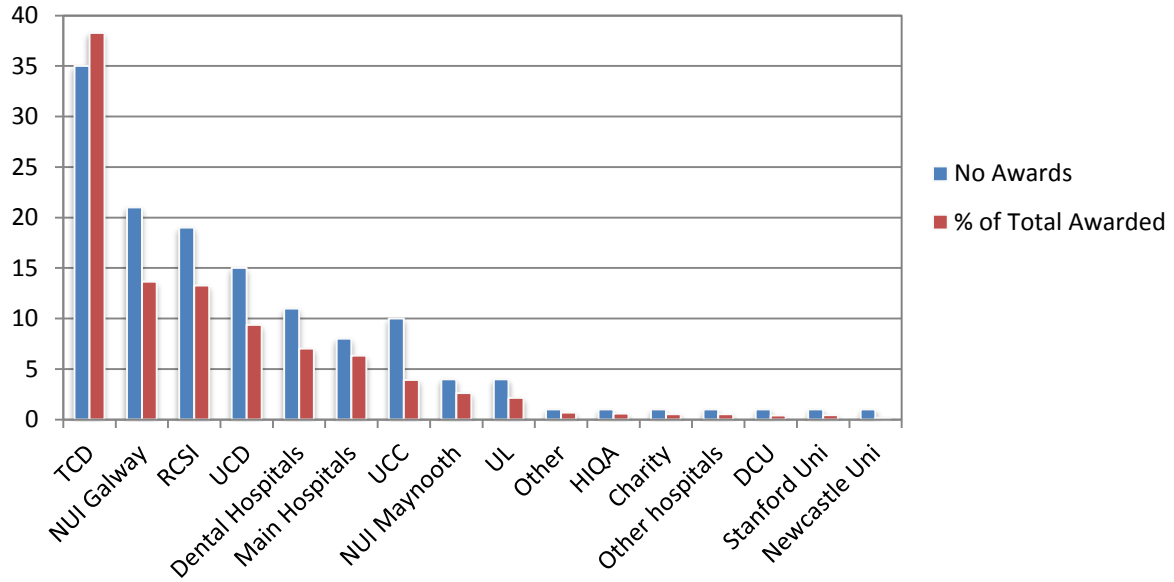
The trend for population health sciences awards that completed between 2008 and 2013 would suggest a decline in the amount of funding being allocated to this area. However, this apparent decline does not match the actual investment being in this area by the HRB, and this anomaly may be due to the number and types of awards that completed over the period. In particular the completion of a large number of grants in this category in 2008/2009, the completion of a Programme Grant categorised as population health science in 2010 and the completion of only smaller awards in 2012 and 2013, are reflected in Figure 4. With an increased allocation to this area from 2010 onwards, this figure would be expected to rise in the coming years as awards made in this area come to completion.

[8] Department of Health and Children (2001) *Making Knowledge Work for Health: A strategy for health research*. Government Publications. Dublin. http://www.DoHC.ie/publications/making_knowledge_work_for_health.html

Distribution of spend by grant host institutions

In relation to the location and hosting of HRB grants, Figure 5 shows the host institutions administering grants that completed in the period 2012/2013.

Figure 5: Distribution of grants across host institutions



Note the variations within institutions between the numbers of awards administered (blue key in Figure 5) versus the proportion of the total amount of funding being administered by that institution (red key in Figure 5). Two PhD Scholars Programmes worth €8.6 million that completed in 2013 were located in Trinity College Dublin (TCD), which explains the disproportionate percentage of funding versus number of awards in this host institution. In most other institutions, the value of individual awards was generally in the range €150-350K for project grants, with fellowships tending to be worth slightly less monetarily.

It should also be noted that the research work on a number of grants 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 5 is most likely an underestimation of the total funding or number of grants awarded to health professionals working in these settings.

1.4 Proportion of grants achieving all objectives

In their original grant application, principal investigators (PIs) outlined specific research objectives that they sought to achieve with their HRB funding. At the completion of their grants, PIs were asked to indicate the extent to which these objectives were fulfilled during the period of the grant.[9]

As shown in Figure 6, almost 60 % of grant holders indicated that they had achieved all of the original grant objectives by the time of completing their grant. This is an increase on the corresponding statistic for grants

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

that completed in the 2008/2009 (43 %) and 2010/2011 (51 %) reporting periods. The reasons for this upward trend are difficult to quantify with any certainly. It may be 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 grant and with the available resources. It may also be due to growing researcher experience of what can be realistically achieved over the lifetime of an award.

Figure 6: Proportion of grants with all objectives achieved

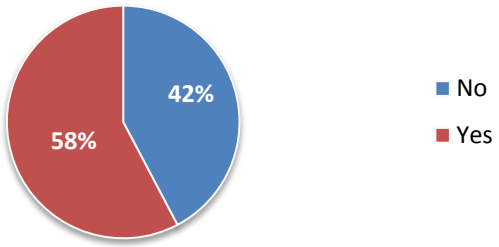
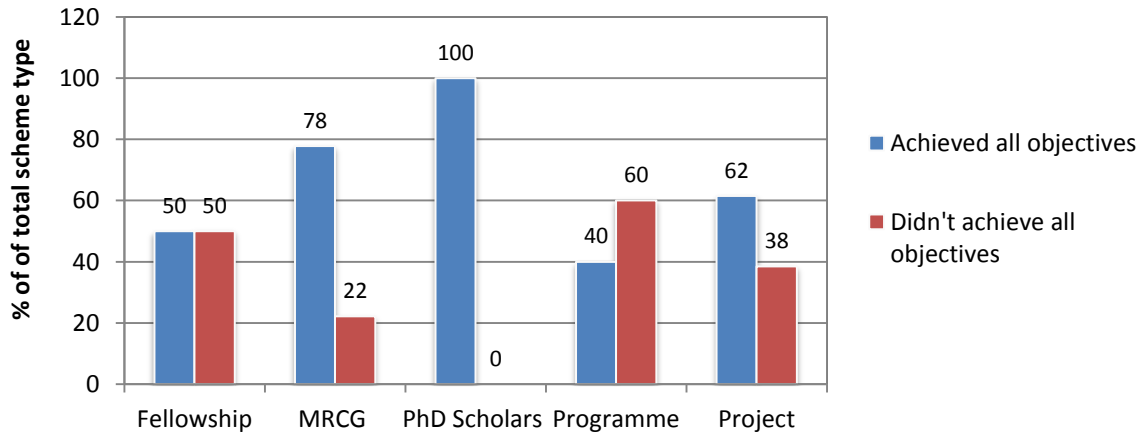


Figure 7 provides a breakdown of the statistic by scheme type. As can be seen, for most scheme types 50 % or more of awards reported that they had achieved all of their original objectives. This rate was particularly high for MRCG Co-fund awards (78 %), Project Grants (62 %) and the two PhD Scholars Programmes that completed in 2013, which both reported that they had achieved all of their objectives.

Three Programme Grants reported that they did not achieve all of their original objectives. The reasons provided were insufficient time to complete the work, which is still ongoing in the case of one Translational Research Award, while another Translational Research Award found that they had insufficient funding to complete the objectives as stated in their application. A Clinician Scientist Award encountered a number of technical difficulties and also had findings that led to a shift in focus of the research and a revision of an original objective to take account of scientific developments elsewhere.

However, it should be noted that, give the scale and ambition of these larger awards, the HRB actively seeks to confirm whether the original objectives are still appropriate and to revise them where necessary. A review of scientific performance of each is carried out by an international panel at the interim stage, who also considers changing external developments that may influence the direction of the research. Their recommendations often lead to a re-focussing of the original objectives.

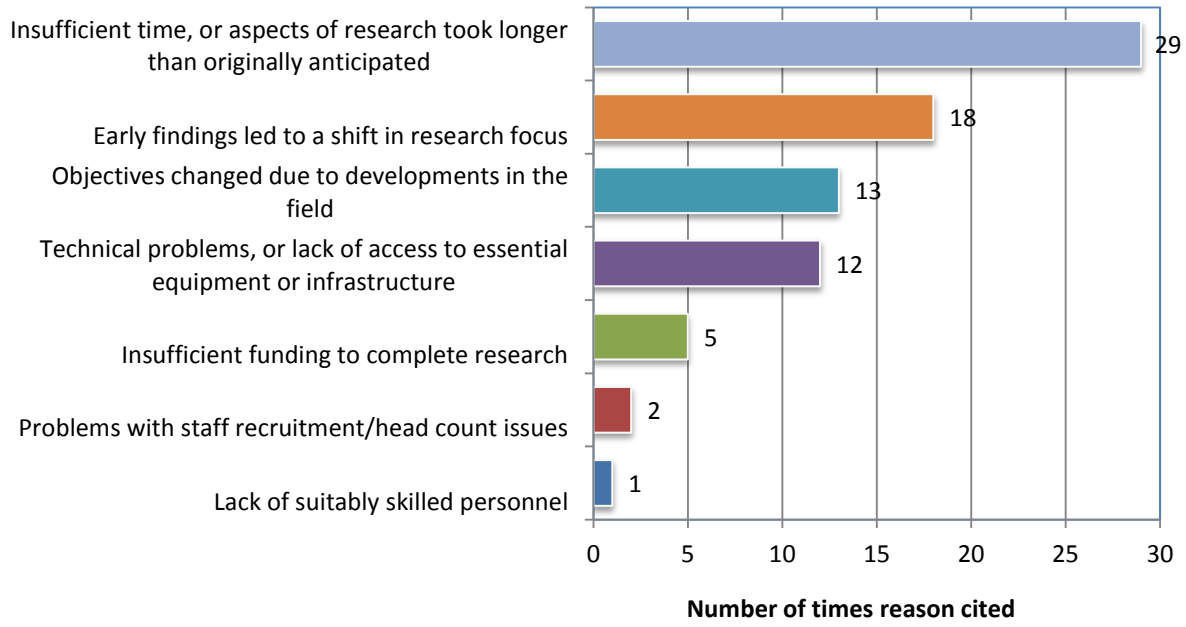
Figure 7: Achievement of grant objectives by scheme type



Reasons cited for non-fulfilment of all original objectives

Grant holders were asked to indicate the reasons behind their inability to fulfil all of the original grant objectives. It should be noted that not all PIs provided a reason for not achieving all of their original objectives and PIs could also choose more than one reason. Figure 8 shows the number of times each of the given reasons was cited.

Figure 8: Cited reasons for non-fulfilment of original grant objectives



The most common reasons cited for non-fulfilment of all of the original grant objectives were 'insufficient time, or aspects of the research took longer than originally anticipated' (36 %); 'early findings led to a shift in research focus' (23 %); or one or more 'objectives changed due to developments in the field' (13 %). Grant holders also cited 'technical problems or lack of access to essential equipment or infrastructure' (12 %). A small number of projects (N=3) pointed to issues with recruitment, either 'problems with staff recruitment/head count issues' or a 'lack of suitably skilled personnel' as preventing them from achieving all of their original objectives. For example, one HRA reported that the two post-doctoral researchers originally recruited to the project left to take up posts in industry during the grant period.

As can be seen in Table 3 the specific reasons offered by PI's for being unable to achieve all of the original objectives vary, and there is often more than one reason as to why a grant might not obtain all of its objectives.

Comment on findings

The finding that 42 % grant-holders did not achieve all of the original objectives should be placed in context.

- There is a significant increase on the percentage of PIs who reported achieving all of their objectives compared, compared to previous reporting periods.
- Half of the grants analysed in this report were categorised as basic or applied biomedical research, fields which are exploratory in nature and therefore it could be expected that objectives would shift in line with early findings or developments in the field.

- For larger awards (Programme Grants, the CSAs, etc) the HRB proactively seeks to confirm whether the original objectives are still appropriate and to revise them where necessary, through an interim review process. This re-focussing of the original objectives is a positive response to changing external developments that may influence the direction of the research.
- In 2009 the HRB completed the process of moving to purely international peer review panels, and to much greater scrutiny of the feasibility of grant proposals, to the extent that proposals can be turned down on the basis of feasibility/over-ambition alone.
- In parallel, the HRB adopted more robust application procedures including requiring applicants to clearly identify their objectives, timelines, deliverables and milestones, justify the appropriateness of personnel and provide more detailed methodology information.
- The HRB also adopted more robust grant 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 change objectives and a practice of granting short no-cost extensions to PI's - when well justified - to complete their research.

Given these conditions, it would be expected that the proportion of grants completing all of the original objectives would increase over time. As is evident from Figure 9, the HRB's emphasis on clarity in the application process, international peer review and on-going grant monitoring would appear to be having a real impact in this regard.

Figure 9: Percentage of grants, by year of award, achieving all of their objectives

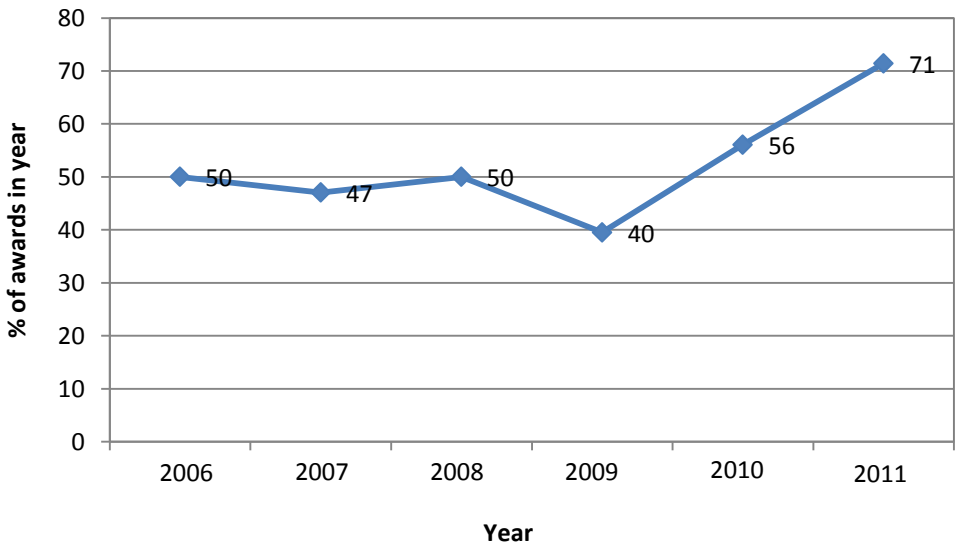


Table 3: Examples of expanded explanations cited by PI's as to why they could not complete an objective(s)

Scheme type	Reasons for non-completion	Description of issue by PI
Project Grant	Early findings led to a shift in focus	It is planned to complete the originally proposed research (animal model section) through alternatively funded mechanism. It should be noted that the HRB funded research project provided important translational evidence to support our hypothesis using human tissue *ex vivo*.

Scheme type	Reasons for non-completion	Description of issue by PI
Programme Grant	Insufficient funding to complete research	The blend identified by us which induces regression of atherosclerosis is not available commercially in a formulation for human intervention studies. Therefore, to formulate and prepare the CLA blend in capsules for human administration requires a significant financial investment which is beyond the capability and budget of this grant.
Project Grant	Objectives changed due to developments in the field	Planned mandatory fortification was shelved due to new evidence giving rise to concern about cancer acceleration - hence I was only able to collect a baseline sample.
Project Grant	Objectives changed due to developments in the field	Based on input from members of the Steering Committee and other stakeholders, self-rated Quality of Life of the resident with dementia (QoL-AD) replaced agitation as the primary outcome objective. The change was formally approved by the HRB. Agitation became a secondary objective.
Fellowship Award	Insufficient time, or aspects of the research took longer than originally anticipated	Some stages of the research such as planning and performing data extraction took longer than anticipated due to the depth of detail necessary which was not anticipated until after training was undertaken.
Programme Grant	Technical problems or lack of access to essential equipment or infrastructure	Technical difficulties were encountered because the tissue microarray sections received from TransBIG were coated with an excess of paraffin (to protect the tissue cores). However the recommended procedure to remove the paraffin also caused significant loss of the cores. Therefore a significant amount of time was spent developing an appropriate procedure to dewax the slides while minimising the loss of cores. The TMAs have now been stained for PgP, MRP1 and EGFR and the staining is currently being graded.
Fellowship Award	Insufficient time, or aspects of the research took longer than originally anticipated	Recruitment in the EFFECT-Dep study finished in November 2012. My analyses used data from this study. Initial results from both plasma proteomics and microRNA in rats and humans were not suggestive of good signal/noise in the analysis, but the extraction of DNA and SNP genotyping led to successful association studies. The emphasis of the research on prediction necessitated the use of multivariate statistical techniques which had to be learned before adequate statistical models of the response to ECT could be developed.
MRCG Co-fund	Early findings led to a shift in focus	Our studies revealed that the peptide-based inhibitors of the TRADD-TRAF2 inhibitors had low biological activity and thus it was decided to design an inhibitor with alternate chemical properties such small chemical compounds. We successfully identified at least two lead molecules able to inhibit the TRADD-TRAF2 interaction and reduce the resulting NFkB activation. Current and future studies aim to optimise the structure of these lead molecules to increase their affinity.
Project Grant	Problems with staff recruitment/headcount issues	Two postdoctoral researchers departed to Industry during the project. This was related to career opportunities and pay/conditions that were more attractive in the private than public sector.

Scheme type	Reasons for non-completion	Description of issue by PI
Project Grant	Lack of suitably skilled personnel	Finding a pathologist with enough time to score the TMAs proved problematic. We have since overcome this problem by using digital pathology to score the immunohistochemistry.
Project Grant	Technical problems or lack of access to essential equipment or infrastructure	Objective 3 relating to relapse was only partially achieved due to: a) Lack of data clarity relating to relapse within patient records and b) Difficulty accessing patient records. The absence of electronic patient records in health care organisations greatly reduced our ability to access and collect this data.

Section 2: Knowledge production outputs

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 knowledge production outputs, compared to 2010/2011 and 2008/2009 reporting periods

Knowledge Production	2012/2013 (N=134 grants)	2010/2011 (N=196 grants)	2008/2009 (N = 204 grants)
Peer reviewed publications			
No. peer-reviewed journal publications	584	470	526
Average no. of peer-reviewed papers/grant	4.5	2.4	2.5
No. publications per €1 million spend	13.3	8.6	11.6
Scientific presentations			
No. scientific presentations reported	940	1427	1118
% PIs reporting scientific dissemination activity	95.5 %	87 %	92 %
No. of keynote presentations internationally	35	35	51

* 2010/2011 and 2008/2009 figures were obtained from a Bibliometric study of grants awarded from 2000-2009 and were not available for the 2012/2013 reporting period

2.1. Peer-reviewed scientific publications

The 134 grants that reported on their outputs at completion in 2012/2013 produced 584 peer-reviewed scientific publications[10] from an investment of €44 million. This was an average of 4.4 papers per grant, yielding a productivity rate of 13.3 publications per €1 million spent (or 1 paper for every €75k). This compares to 8.6 publications per €1 million spent for grants that completed in 2010/2011 (or 1 paper for every €115,957) and 11.8 publications per €1 million spend for grants that completed in 2008/2009 (or 1 paper for every €84,544). A further 58 papers were in preparation, had been submitted to a journal for review or were accepted or in press at the time of reporting. While these publications were not included in the analysis, it is hoped to capture them in future analysis at post-completion stage.

Figure 10 shows the distribution of peer-reviewed publications by scheme type for grants that completed in 2012/2013, and the proportion of the total investment of €44 million that each scheme type received. Table 4 looks more closely at the cost of producing these publications as per €1 million spend and as the cost per paper.

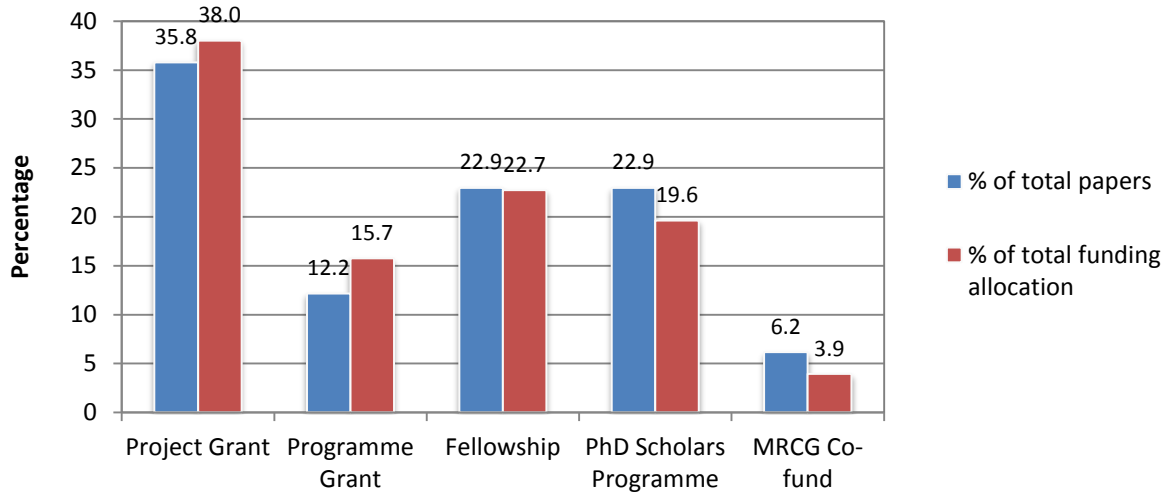
[10] Publications reported by grant holders in end-of-grant reports were excluded from the analysis if the date of publication preceded the grant start date, if the paper was cited as in preparation, revision, accepted, or in press or if the subject matter of the paper was clearly unrelated to the grant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

As can be seen from Figure 10 Project Grants produced over one third of all publications, an expected finding given that this scheme accounted for 38.8 % of total funding. The average number of papers per Project Grant was three and there were 12 papers produced for every €1 million spend (a cost per paper of €80k).

Fellowship Awards were similar to Project Grants in terms of the average number of papers per fellowship (2.9) and number of papers for every €1 million spend (13.4), with a slightly lower cost per paper of €75k. Overall, Fellowship Awards accounted for 23.2 % of funding awarded and produced almost a quarter of the total publications.

The two PhD Scholars Programmes accounted for 22.9 % of all publications from grants that completed in 2012/2013 and 20 % of the total funding allocation. The average number of papers per PhD Scholars award was 67 and there were 15.5 papers produced for every €1 million spend (a cost per paper of €64k). Therefore, this scheme represented slightly better value for money in terms of publication output than either Project Grants or fellowships.

Figure 10: Breakdown of peer-reviewed publications by scheme type



Other programmatic grants (including the CSAs but not including the PhD Scholars Programme) produced 12.2 % of total publications, while accounting for 16.1 % of total funding. The average number of papers per Programme Grant of 11.3 would suggest a higher level of productivity that other scheme types (excluding the PhD Scholars Programme). However, when this scheme type is examined in terms of cost per paper (€98k) and numbers of papers per €1 million spend (10.2), other scheme types offer better return on investment for peer-reviewed publications. This is in keeping with observations from previous reporting periods that, on average, Programme Grants produce fewer papers per €1 million spend than Project Grants.

In terms of both publication to funding ratio and return on investment, the MRCG Co-fund scheme had the best performance of all scheme types for peer reviewed publications. With only 4 % of the funding allocation, this scheme accounted for 6.2 % of total publications. The average number of papers per grant was 4.0 (similar to Project Grants and Fellowship Awards) but the number of papers per €1 million spend was significantly higher (20.8) and the cost per paper was significantly lower (€48k). This might be explained by the type of projects that fall within the MRCG scheme, which tend to be basic or applied biomedical in nature. The findings from several bibliometric studies carried out on the HRB portfolio indicate that basic and applied biomedical projects produce more peer-reviewed publications per €1 million spend that other types of research.

Table 4: Breakdown of publication rate and productivity by scheme type

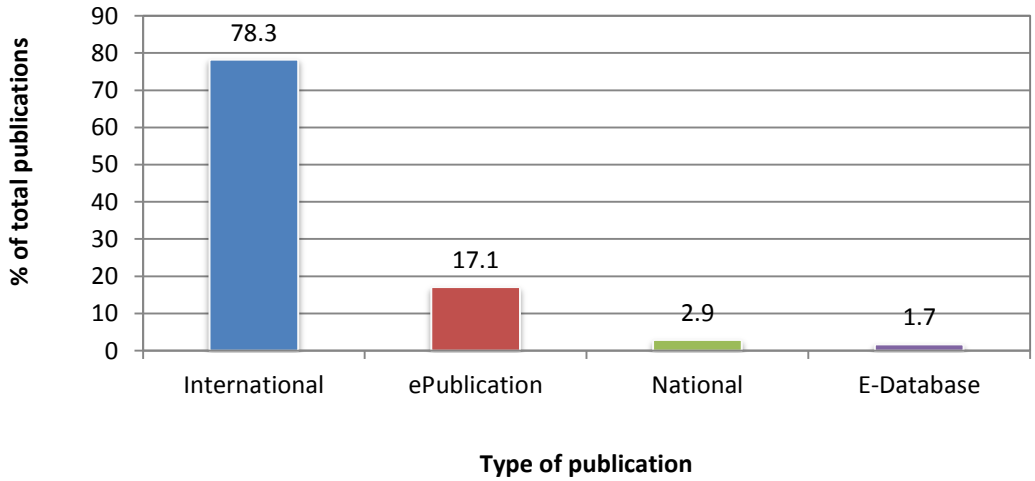
Scheme type	Average no. papers per grant	No. papers per €1 million spend	Cost per paper
Project Grant	3.0	12.5	€80,031
Fellowship Award	2.9	13.4	€74,595
PhD Scholars Programme	67.0	15.5	€64,463
Programme Grant	11.3	10.2	€97,584
MRCG Co-fund	4.0	20.8	€48,018

Figure 11 presents the type of publications that emerged from grants that completed in 2012/2013. Researchers published predominantly in international peer reviewed journals (78.3 % of total publications) and to a much lesser extent in national peer reviewed journals (2.9 % of total publications.)

ePublications accounted for 17.1 % of total publications in 2012/2013 (in 2010/2011 the equivalent statistic was 16.3 %.) In most cases this indicated that the electronic version of the paper was available ahead of printing, although not necessarily in an open access format. However, the number of papers published in the open access on-line journal PLoS increased from 5 in 2010/2011 to 15 in 2012/2013. While this figure is still very low, it is hoped that the HRB Policy on Open Access will have some positive impact on the number of researchers publishing in open access journals or journals that are compliant with open access in the coming years.

Ten systematic reviews were published in the Cochrane Library, primarily by holders of Cochrane Training Fellowships, although one systematic review was published by a Health Professional Fellow.

Figure 11: Breakdown of peer-reviewed publications by publication type



Comparison with 2008/2009 and 2012/11 statistics

A breakdown of the publication rate across the individual years from 2008-2013 is provided in Table 5.

While the number of papers produced by completed grants that reported on their activities in 2012 was less than in other years, the average number of papers per grant was greater than all years except 2013. It should be noted that this figure may, in fact, be an underestimation. 2012 publication figures for grants that

completed in that year were obtained from two sources: a) the results of a whole portfolio analysis of HRB grants awarded between 2000 and 2009 and b) end of grant management reports, which only capture the top three publications from a grant. It is likely, therefore, that not all publication outputs from grants that completed in 2012 have been included in the analysis for this report.

In 2013, evaluation data was collected from all grants at completion via a bespoke Outcomes Tracker survey, the first time the Outcomes Tracker software had been used for this purpose. Therefore, 2013 data is likely to be more complete than 2012. This might partially account for the apparent higher than average number of papers per grant and the productivity per €1 million spend in 2013. However, it is also important to note that in 2013 two PhD Scholars Programmes finished, which between them accounted for 134 peer reviewed publications. Inclusion of these awards in 2013 data increased all measures significantly. The performance of the PhD Scholars Programme as measured by its productivity rate of 15.5 papers per €1 million spend is impressive and well above the average for other scheme types.

Table 5: Summary of publication output 2008-2013

Year	Total no. papers	Aver. papers per grant	Papers per €1m funding	Average journal impact factor score*
2008	234	2.5	10.3	4.4
2009	292	2.6	13.5	4.5
2010	230	2.2	9.5	4.2
2011	240	2.6	7.9	5.7
2012	165	2.8	10.5	NA
2013	419	5.7	14.8	NA

* A Bibliometric analysis of HRB peer-reviewed journal publications arising from grants awarded between 2000 and 2009 provided comprehensive impact factor scores up to 2011. Beyond this year, data is not available.

While it is important to monitor the level of publication activity for HRB-funded research, the real value of publications is their placement in international peer reviewed journals with a wide readership among the academic community. One indicator of the potential reach and credibility of academic publications is the impact factor (IF) of the journal in which they are published. The impact factor is the average number of citations to recent articles published in that journal. It is frequently used as a proxy for the relative importance of a journal within its field, with journals with higher impact factors deemed to be more important than those with lower ones. Impact factors are calculated yearly starting from 1975 for those journals that are indexed in the *Journal Citation Reports*.

The HRB periodically undertakes a bibliometric analysis of the publications arising from its funded research, the last of which was completed in 2012, for publications between 2000 and 2011. From Table 5 it can be seen that the **average** impact factor was relatively consistent from 2008 to 2011 (4.4 to 5.7) and fell within the medium impact category (IF = 2-5). When broken down further, these figures represented 57 % and 55 % of publications within the medium impact category, and 28 % and 31 % in the high (IF>5) to very high (IF>10) impact categories, for grants that completed In 2010/2011 and 2008/2009, respectively. There is no reason to suppose that the average impact factor and range of impact categories for publications arising from grants that completed in 2012 and 2013 would deviate significantly from these statistics.

For further interest, some examples of HRB-funded publications that featured in the top 50 highest ranking medical journals (as measured by Soccus SJR Ranking of medical journals[11]) are included in Table 6. These publications ranged across all scheme types and included research in basic and applied biomedical sciences, clinical research and population health sciences and health services research.

Table 6: Examples of publications in top ranked journals linked to HRB funded grants (SRJ ranking)

Scheme type	Article Title	Journal (Year published)	SJR Ranking
PhD Scholars Programme	Genome-wide association study identifies 19p13.3 (UNC13A) and 9p21.2 as susceptibility loci for sporadic amyotrophic lateral sclerosis	Nature Genetics (2009)	23.8
Translational Research Award	SCIENCE AND SOCIETY Integrating biobanks: addressing the practical and ethical issues to deliver a valuable tool for cancer research	Nature Reviews Cancer (2010)	18.24
Marie Curie Post-doc Fellowship	CD36 coordinates NLRP3 inflammasome activation by facilitating intracellular nucleation of soluble ligands into particulate ligands in sterile inflammation.	Nature Immunology (2013)	17.25
Research Project Grant	Joined-up thinking in reduction of cardiovascular risk.	The Lancet (2011)	11.56
Research Project Grant	Another key issue for cardiovascular medicine.	The Lancet (2009)	11.56
Health Professional Fellowship	Phenotype, genotype and population-based frequency of C9ORF72 repeat expansion in ALS	Lancet Neurology (2009)	11.05
PhD Scholars Programme	Cognitive and clinical characteristics of patients with amyotrophic lateral sclerosis carrying a C9orf72 repeat expansion: a population-based cohort study	Lancet Neurology (2012)	11.05
Translational Research Award	Amyloid-beta protein dimers isolated directly from Alzheimer's brains impair synaptic plasticity and memory	Nature Medicine (2008)	10.99
Translational Research Award	Macrophage PPAR gamma Co-activator-1 alpha participates in repressing foam cell formation and atherosclerosis in response to conjugated linoleic acid	EMBO Molecular Medicine (2013)	8.94
Health Research Award	Systemic low molecular weight drug delivery to pre-selected neuronal regions	EMBO Molecular Medicine (2011)	8.94
MRCG Co-fund	Exome Sequencing Followed by Large-Scale Genotyping Fails to Identify Single Rare Variants of Large Effect in Idiopathic Generalized Epilepsy	American Journal of Human Genetics (2012)	7.86
Post-doc Fellowship	Symptom presentation in women with acute coronary syndrome	European Heart Journal (2011)	6.98

[11] Data retrieved from http://www.scimagojr.com/journalrank.php?area=2700

Scheme type	Article Title	Journal (Year published)	SJR Ranking
Research Project Grant	Sexual Counselling for Individuals With Cardiovascular Disease and Their Partners: A Consensus Document From the American Heart Association and the ESC Council on Cardiovascular Nursing and Allied Professions (CCNAP).	European Heart Journal (2013)	6.98
MRCG Co-fund	Epilepsy, hippocampal sclerosis and febrile seizures linked by common genetic variation around SCN1A.	Brain (2013)	6.3

2.2 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 7). Some of these publications, such as chapters in edited books, were reviewed by peers, while others, such as articles in professional bulletins, journal editorials, 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 7: Other scientific publications emerging from grants that completed in 2012/2013

Publication type	National	International	Total
Book chapter	1	30	**31**
Editorial		4	**4**
Guidelines	2	1	**3**
Handbook		2	**2**
Practice Manual		1	**1**
Health Report	8	5	**13**
Professional Bulletin	6	4	**10**
Review	2	3	**5**
Total	**19**	**50**	**69**

Table 8 provides examples of work that falls within the category of 'other publications'.

Table 8: Examples of other publications linked to HRB funded grants

Scheme Type	Type of publication	Description
Health Economics Fellowship	Guidelines	Complementary document to the Guidelines for Economic Evaluation of Health Technologies in Ireland (2010).
Global Health Research Award	Book chapter	MacLachlan, M. (2012) Rehabilitation Psychology and Global Health. In Kennedy, P. (ed.) Oxford Handbook of Rehabilitation Psychology. Oxford University Press.
Research Project Grant	Editorial	Glynn, L.G., Scully, R. (2010). The edge of chaos: reductionism in healthcare and health professional training. International Journal of Clinical Practice. 64(6):669-72.
Research Project Grant	Handbook	Kulkarni, M., Minor, W., Holladay, C. and Pandit, A (20xx). Gene Therapy. The Biomedical Engineering Handbook 4th Edition, CRC Press.
Global Health Research Award	Health Report: International	Chataika, T. et al. wrote a series of reports on African Policy on Disability & Development in Uganda, Sierra Leone, Malawi and Ethiopia. Published by the Global Health Press.
Research Project Grant	Health Report: National	O'Shea E, Devane D, Murphy K, Cooney A, Casey D, Jordan F, Hunter, A, Murphy, E, J Newell, and Connolly, S. (2010). Reminiscence and dementia care in Ireland. Report published by the Irish Centre for Social Gerontology at NUI Galway.
Translational Research Award	Review	Collins O, Kenny RA (2007) Is Neurocardiovascular instability a risk factor for cognitive decline and/or dementia? The science to date. Review published in Clinical Gerontology, 17; 153-160.
Nursing and Midwifery Research Priorities Study	Book chapter	Murphy, K. Casey, D. and McCarthy, B. (2011). It Takes My Breath Away. In: Case Studies in Gerontological Nursing for the Advanced Practice Nurse. John Wiley & Sons Inc.
Health Professional Fellowship	Review	Buckley, C.M., Perry, I.J., Bradley, C.P., Kearney, P.M. (2014). Does Contact with a Podiatrist Prevent the | Occurrence of a Lower Extremity Amputation in | People with Diabetes? - A Systematic Review and | Meta-Analysis. National Institute of Health Sciences Research Bulletin, Volume 7, Issue 1.
Research Project Grant	Guidelines	Input by M Byrne to: Steinke EE, Jaarsma T, Barnason SA, Byrne M, Doherty S, Dougherty CM, et al. (2013). Sexual Counselling for Individuals With Cardiovascular Disease and Their Partners: A Consensus Document From the American Heart Association and the ESC Council on Cardiovascular Nursing and Allied Professions (CCNAP).
Health Research Award	Practice Manual	Murphy DJ, Ramphul M. (2014). Indications and assessment for instrumental delivery. Chapter 2 of Practice Manual, Operative Vaginal Delivery published by Royal College of Gynaecologists.
Cochrane Training Fellowship	Guidelines	Klimas, J., Cullen, W., Field, C. A. (2014). Problem alcohol use among problem drug users: clinical guidelines for general practice. Irish Journal of Medical Sciences – accepted for publication.
Health Research Award	Review	PF Allen (2011). Oral care for older adults. Review commissioned by PanGlobalMedia, a European based publication with wide circulation.

2.3 Scientific presentations

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. Figure 12 shows the number and type of scientific presentation per scheme type for the 134 grants analysed in 2012/2013. Figure 13 shows the number of dissemination events per €1 million spend per scheme type for the same period.

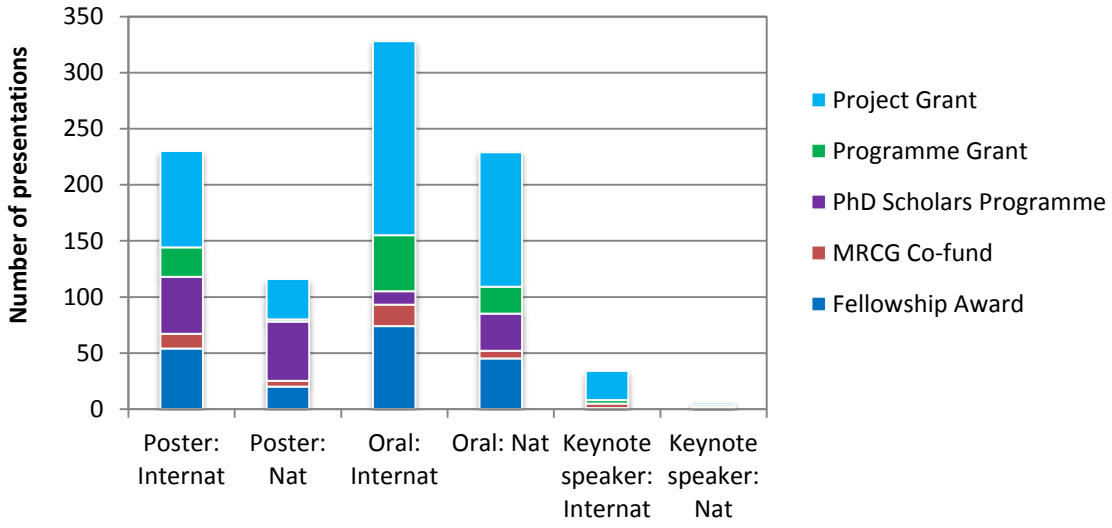
Of the 134 grants completing in 2012/2013 that reported on their activities, 95.5 % of grant holders reported some type of scientific dissemination event to present their HRB-funded research findings. This is an increase on the statistics from 2008/2009 and 2010/2011 grants, where a total of 92 % and 87 %, respectively, of grant holders had presented the results of their HRB-funded research at scientific meetings.

HRB-supported researchers presented their work to peers as either oral or poster presentations at 940 scientific events. It is important to note that this figure **does not** include data from one PhD Scholars Programme (PHD/2004/13) that completed in 2013, which did not report on its outputs in this category (although it did report on scientific publications.) Therefore, this figure is an underestimation of the total number of presentations made by grants that completed in the 2012/2013 reporting period.

Invitations to deliver keynote talks at international conferences are also an important indicator of scientific recognition and prestige among the international community. HRB grant holders whose awards completed in 2012/2013 delivered 35 keynote talks at international scientific conferences. For MRCG Co-fund awards the number of keynote addresses per €1 million spend at both national and international scientific conferences was almost two times higher than all other scheme types.

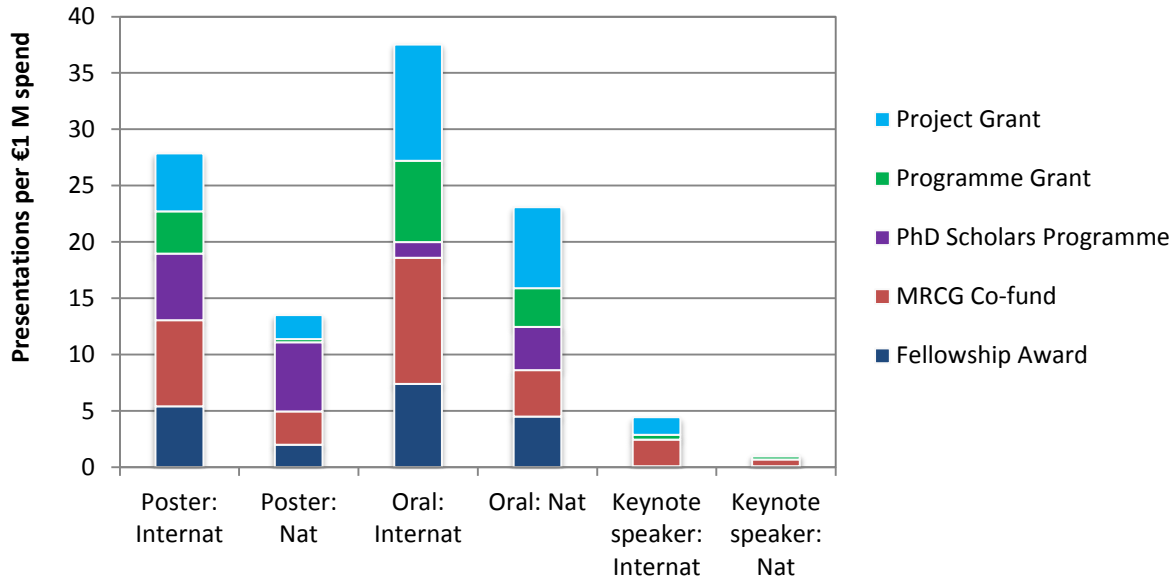
Importantly for networking and academic recognition, HRB-funded researchers are very active on the international scientific stage. Presentation (both oral and poster) at international scientific meetings was the most common scientific dissemination type reported. This statistic is also reflected in the number of presentations per €1 million spend (both oral and poster) at international conferences. Recipients of Project Grants and the MRCG Co-fund were the most active in this regard.

Figure 12: Number and type of scientific presentations per scheme type



The exception to this trend was the one PhD Scholars Programme that reported outputs in this category. For this grant the number of oral presentations per €1 million spend at international conferences was significantly lower (by a factor of 5-7) that other scheme types. This might be explained by the nature of the programme, where researchers were working towards their PhD and would be more likely to make a poster presentation of their data as it emerged, rather than an oral presentation. Of the total number of scientific presentations from this award, 104 were poster presentations, while 45 were oral presentations.

Figure 13: Number and type of scientific presentations per €1 million spend per scheme type



Section 3: Research capacity-building

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 up the career ladder towards independent investigators
- encouraging the development of collaborations and partnerships with academic, health sector, policy and industry partners to maximise the potential impacts of the research

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

Summary of capacity building outputs, compared to 2010/2011 and 2008/2009 reporting periods

Research capacity building	2012/2013 (N=134 grants)	2010/2011 (N=196 grants)	2008/2009 (N = 204 grants)
Human capacity outputs			
No. research related posts created	422	280	296
No PhD students trained	133	72	88
No. post-doctoral researchers supported	130	92	112
% of cohort from health professional background	32.2 %	29 %	NA*
Research collaborations and partnerships			
Total no. new collaborations	278	415	384
% of new collaborations with health bodies	14 %	10 %	NA
Development of research materials/methods[§]			
No. new material/methods developed	112	85 (2011 only)	NA
Ave no. developments per €1 million spend	2.9	1.6	0.6
Recognition and academic awards[§]			
% of awards reporting indicator of recognition	70 %	75 % (2011 only)	NA

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

[§] Data for this metric was collected from 2011 onwards only

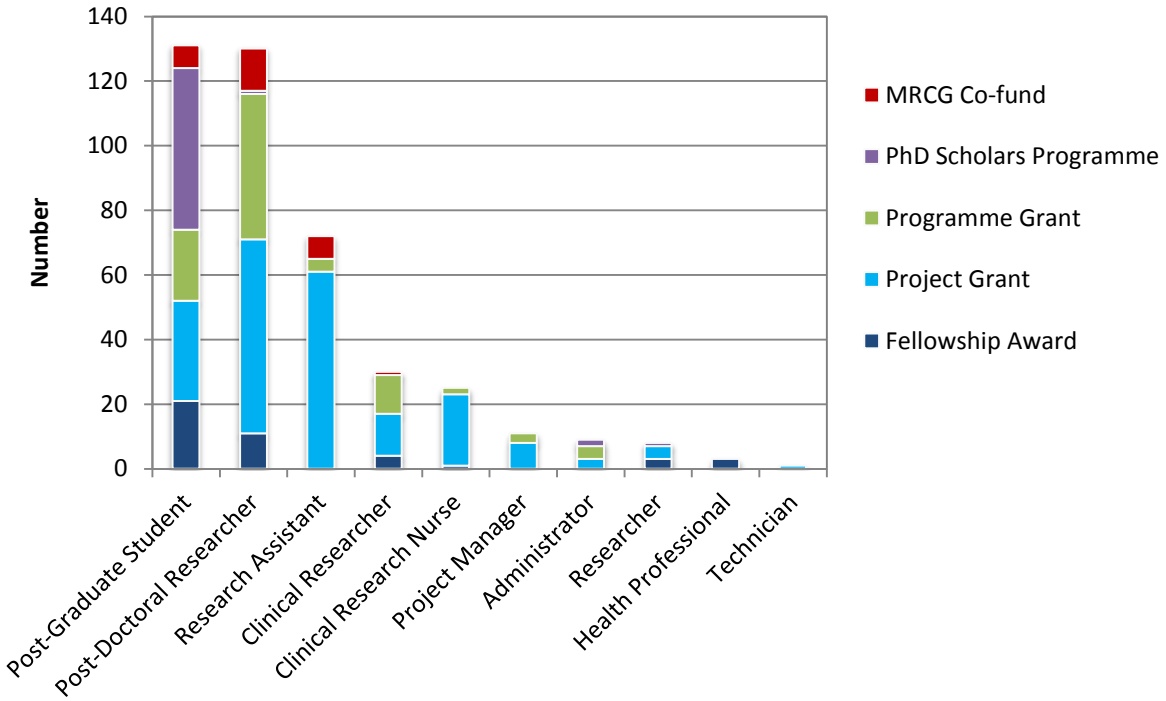
3.1 Human capacity outputs

Types of personnel funded

In total, 422 research-related posts were supported by the 134 HRB grants analysed, that completed in 2012 and 2013. The equivalent statistics from the 196 completed grants reported on in 2010/2011 and the 204 completed grants reported on in 2008/2009 were 280 and 296 posts, respectively. A breakdown of the roles of personnel on the grants supported by the HRB is given in Figure 14, while Table 9 analyses the spend per €1 million on posts, and the average cost per post.

Unsurprisingly, given that this figure includes two PhD Scholars Programmes, post-graduate students accounted for almost a third (n=133) of the total posts. Post-doctoral researchers were the second largest grouping, accounting for 30 % (n=130) of posts on HRB funded awards, the majority being employed on project and Programme Grants. 72 people (17 % of total posts) were categorised by the PI as 'research assistants', primarily employed on Project Grants. This figure included researchers who were not perusing a post-graduate qualification as part of their work on the grant, many of whom were health professionals. There were 66 people (16.6 % of total posts) categorised by the PI as have a 'researcher', 'clinical researcher' or 'clinical research nurse' role, with the majority being employed on Project and Programme Grants. This group consisted primarily of doctors, nurses and allied health professionals. A total of 21 people held project management, administrative or technical roles (4.9 % of total posts).

Figure 14: Number and role of personnel funded on HRB grants per scheme type



Overall, Project Grants accounted for almost 50 % (n=205) of the posts created through HRB awards that completed in 2012/2013, which reflected the number of awards in this scheme type (69 of 134 awards). In terms of the costs of these posts, there were 12.3 posts created per €1 million spend on Project Grants, at an average cost of €82k per post. Programme Grants (not including the two PhD Scholars Programmes) and the CSA Award, while considerably lesser in number (n=6), were larger in scale, accounting for 20 % of the total funding, so it is unsurprising that between them they accounted for almost 34.4 % of total posts (primarily post-graduate and post-doctoral posts.) However, they also represented value for money in this regard; creating marginally more posts (13.3) per €1 million spend than Project Grants, at an average cost of €75k per post.)

The PhD Scholars Programme created 54 posts; representing 6.3 posts per €1 million spend at an average cost of €160k per post. A further 43 posts were created on Fellowship Awards completing in 2012/2013, an average of 4.3 posts per €1 million spend, and a cost of €232k per post.

The most cost-effective scheme in terms of creating posts was the MRCG Co-fund scheme. This created an average of 16.2 posts per €1 million spend at an average cost of €61k per post.

Table 9: Breakdown of posts by scheme type and per €1 million spend

Scheme type	Award total (€)	% Total spend	No of posts	Posts per €1M spend	Average cost (€) per post
Fellowship Awards	9,995,710	22.7	43	4.3	232,458
MRCG Co-fund Awards	1,728,636	3.9	28	16.2	61,737
PhD Scholars Programmes	8,637,989	19.6	54	6.3	159,963
Research Programmes	6,928,534	15.7	92	13.3	75,310
Research Projects	16,726,572	38.0	205	12.3	81,593
Grand Total	**44,017,441**	**100.0**	**422**		

Figure 15 shows the distribution of total numbers of posts created distributed by broad research area. From this it can be seen that grants categorised as biomedical research accounted for 58 % of total posts, of which 8 % were in basic biomedicine and 50 % were in applied biomedicine. Grants focused on clinical research accounted for 22 % of posts created, while population health sciences and health services research accounted for the remaining 15 % of posts created.

Figure 15: Breakdown of total number of posts created by broad research area

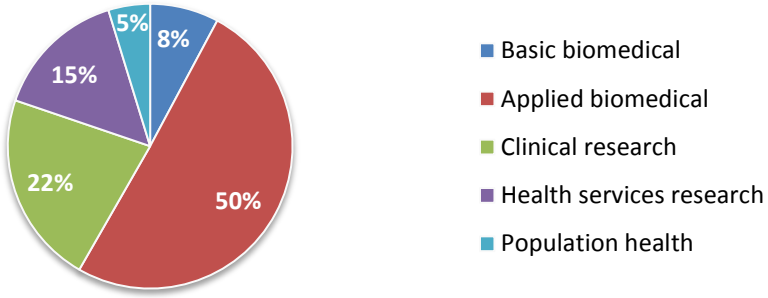


Table 10 provides a comparison from 2008 to 2013, by broad research area, of the total number of PhD students (Table 10a) and post-doctoral researchers (Table 10b). The figures are presented as a percentage of the total numbers for each two year period. The data shows a continuing and significant decrease in the proportion of post-graduates and post-doctoral researchers funded in basic biomedical research across the six year period.

Table 10a: Breakdown of post-graduate students* by broad research area

Broad research area	2012/2013	2010/2011	2008/2009	Total numbers (2008-2013)
Basic Biomedical	4.1 %	11 %	15 %	27
Applied Biomedical	63.1 %	39 %	39 %	153
Clinical Research	17.9 %	18 %	18 %	55
Health Services Research	13.8 %	24 %	17 %	52
Population Health	1 %	8 %	11 %	18
Total	**100 %**	**100 %**	**100 %**	**305**

* 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 10b: Breakdown of post-doctoral researchers* by broad research area

Broad research area	2012/2013	2010/2011	2008/2009	Total numbers (2008-2013)
Basic Biomedical	11.8 %	24 %	29 %	67
Applied Biomedical	44.1 %	59 %	55 %	119
Clinical Research	21.8 %	11 %	11 %	46
Health Services Research	17.7 %	4 %	2 %	25
Population Health	4.5 %	2 %	4 %	12
Total	**100 %**	**100 %**	**100 %**	**314**

* 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.

A significant increase in the number of post-graduate students, categorised as being involved in applied biomedical research in the 2012/2013 period, can be accounted for by the completion of the two PhD Scholars Programmes, both of which were categorised as applied biomedical research. This would tend to be verified by Table 10b, where at post-doctoral level the number of posts categorised as applied biomedical research has shown a year-on-year decline since 2008. Tables 10a and 10b would also suggest that with regards to patient oriented and health services research in particular, which are inherently more complex, the requirement to align the research personnel requested with the scale, complexity and methodology of the project, may explains the shift we are starting to see from post-graduate to post-doctoral researchers in this report

The large number of post-graduate students funded in applied biomedical research, relative to other broad research areas may also account for the apparent decline in numbers funded in clinical research, health services research and population health sciences. Again, Table 10b would tend to support this observation, and shows an increase in the number of post-doctoral researchers in these broad research areas since 2008.

Taken as a whole across the six years, the figures in Table 10a and 10b, show that biomedical research (basic and applied combined) accounted for 59 % of post-docs and 59 % of PhDs. This statistic confirms the need for both the HSR PhD initiative (SPHeRE PhD Programme) and the ICE post-doctoral initiative targeted at increasing the capacity within population health sciences and health services research.

Professional background of personnel

An ambition of the *HRB Strategic Business Plan 2010-2014* is to increase the number of health professions engaged in research at some level, either in training or as researchers. Table 11 presents a breakdown of the professional background of personnel employed on HRB-funded awards by type of scheme on which these personnel were employed.

In total, of the 422 personnel reported on, 136 came from a health professional background, representing 32.2 % of the total personnel cohort. This is an increase on the numbers recorded for the 2010/2011 reporting period, of 82 health professional personnel, or 29 % of the total cohort.

43 of the health professional personnel supported by awards that completed in 2012/2013 were registered for a higher degree, either MSc (n=14) or PhD (n=29). For strategic information purposes, the health professional groupings have been separated out. The category of Nursing and Midwifery includes those from a nursing, midwifery, and clinical research nursing background (a third of this group had registered for a PhD), while the category of Other Health Professional includes personnel with a background in allied healthcare professions other than physiotherapy, speech and language therapy, pharmacy, dietetics and occupational therapy. The

Category of 'Other' primarily included research assistants, most likely from a biomedical sciences background, although this was not specified.

It is also interesting to look at the background professions of personnel employed across the different scheme types. As might be expected from awards categorised as applied biomedical, all of the PhD students supported by the two PhD Scholars programmes were from a biomedical sciences background. The majority of personnel employed on the other six Programme Grants, which were primarily categorised as basic or applied biomedical research (one was categorised as clinical research), were also from a biomedical sciences background. Likewise, the MRCG Co-fund awards were primarily categorised as basic and applied biomedical, and attracted biomedical scientists.

Project Grants supported well over half (63 %) of those with health professional backgrounds of some type. This scheme type also attracted personnel from many different professional backgrounds, and for the first time in 2013, three people with an engineering background and one with a computer sciences background were supported through Project Grants. The Fellowship schemes also attracted a wide variety of backgrounds, many of whom were health professionals.

Table 11: Professional background of personnel employed on HRB-funded grants by scheme type

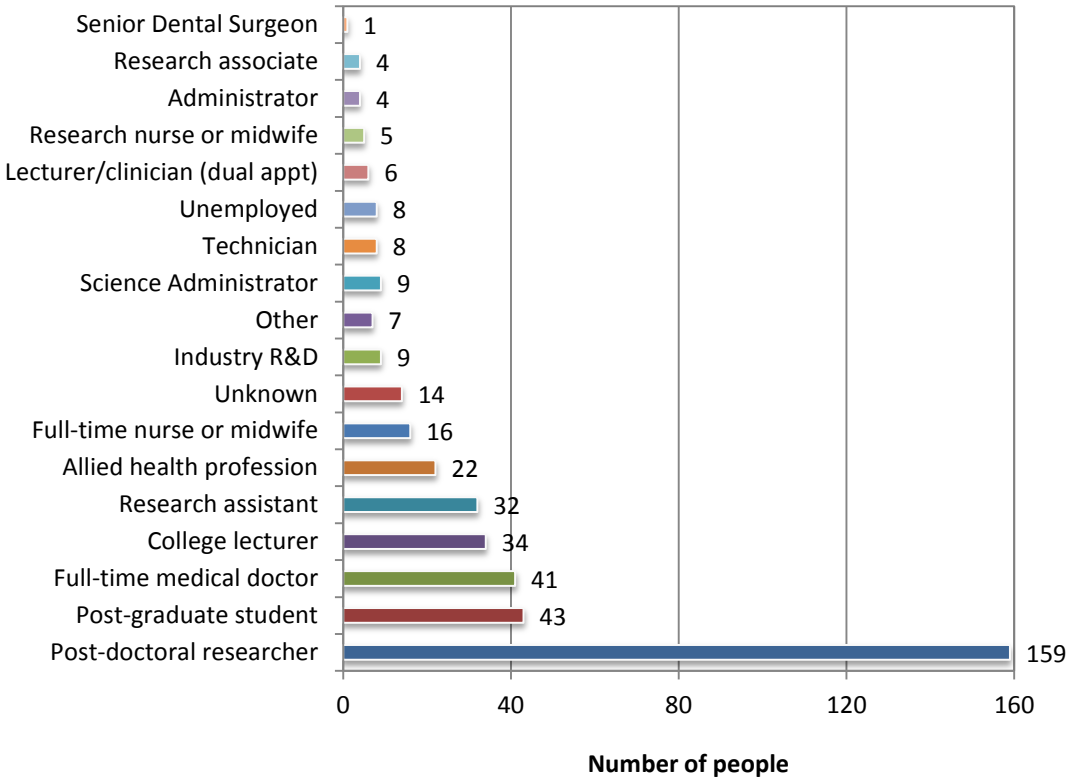
Background	Fellowship Award	Project Grant	Programme Grant	MRCG Co-fund	PhD Scholars Programme	Total
Administrator		3	6			**9**
Biomedical science	9	88	67	23	54	**241**
Computer science	1					**1**
Dentistry		2				**2**
Dietician	1		4			**5**
Engineer		3				**3**
Epidemiology & public health		2				**2**
Laboratory technician		1		4		**5**
Medical doctor	12	14	13	1		**40**
Nursing & Midwifery	4	27	2			**33**
Occupational therapist	1					**1**
Other health profession	5					**5**
Pharmacist	1	1				**2**
Physiotherapist	2	12				**14**
Psychology or behavioural science	2	28				**30**
Social science	3	11				**14**
Speech & language therapist	2					**2**
Other		13				**13**
Total	**43**	**205**	**92**	**28**	**54**	**422**

Current employment destination of personnel

Grant holders were asked to provide information on the current employment posts of research personnel supported by HRB grants. Figure 16 shows the overall breakdown of current employment posts.
Consistent with the 2008/2009 and 2010/2011 figures, by far the most common follow-on employment role reported was as a post-doctoral researcher (37.7 % of personnel) or a research role (as a research assistant, research nurse or midwife, or research associate - 9.7 % of total personnel). 10.2 % of personnel were still completing (or had just commenced) a PhD degree, which was also consistent with figures from the previous reporting periods.

A further 19 % of personnel were reported to be back working in full time clinical practice (either as a doctor, nurse/midwife, allied health profession or dental surgeon). 34 people had secured lectureship posts, while a further six obtained dual lecturer/clinical appointments. Eight people had moved into science administration (all of whom had biomedical science backgrounds); while another nine had secured industry R&D posts. Thankfully, at the time of reporting only eight of the 422 people supported on HRB grants were unemployed. The current occupation of a further 14 was unknown.

Figure 16: Current employment of HRB grant personnel



Current location of personnel

In terms of the current location of personnel who had been supported on HRB grants that completed in 2012/2013, Table 12 looks at the country of current employment for personnel supported by HRB awards that completed in 2012/2013. As might be expected the majority of personnel (71.3 %) were employed in Ireland or Northern Ireland. This is slightly lower that the statistic for personnel supported by grants that completed in 2010/2011 where 77.5 % were employed in Ireland or Northern Ireland.

The current location of 50 personnel was unknown, while the remainder were based overseas. The most common locations were the UK (N=19), the US (N=18), Australia/New Zealand (N=9) and Africa (n=9), the latter comprising of staff who had been employed on global health research projects.

Table 12: Country in which personnel are currently working /residing

Country of employment or residence	Number
Africa	9
Asia	5
Australia/New Zealand	9
France	5
Germany	2
Greece	1
Ireland/Northern Ireland	301
Other European Country	2
South America	1
United Kingdom	19
United States of America	18
Unknown	50
Total	**422**

3.2 Research collaborations and partnerships

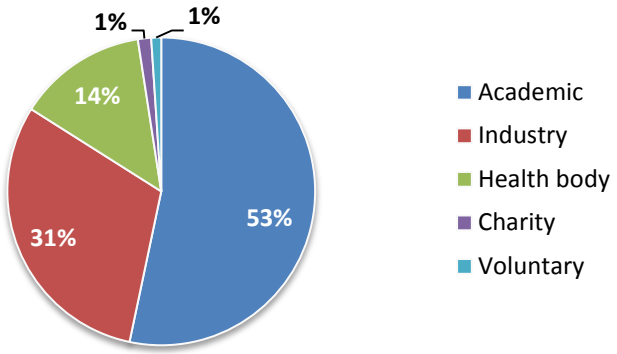
The development of collaborations and partnerships with national and international researchers, industry, charities, and professional health bodies is an important indicator of the quality and potential future impact of HRB-funded research. The development of collaborations is also vital to enable leveraging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

From the 134 completed grants analysed in 2012/2013, grant-holders reported the establishment of 287 new collaborations or partnerships during the lifetime of their HRB grant. It should be noted that one PhD Scholars Programme did not provide data on this metric, so the figures presented are most likely an underestimation of the total number of academic and industry collaborations established.

A breakdown of the 278 new collaborations reported on, by type of collaboration, is provided in Figure 17. As can be seen, over half (53.3 %) of all collaborations reported were those involving an academic researcher, either in Ireland or based overseas. Many researchers also sought to collaborate in some way with industry partners, either national or international. The number of industry collaborations, as a proportion of all collaborations established has increased dramatically from the 2010/2011 reporting period, from 8 % of new collaborations in 2010/2011 to 31 % in 2012/2013. 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.

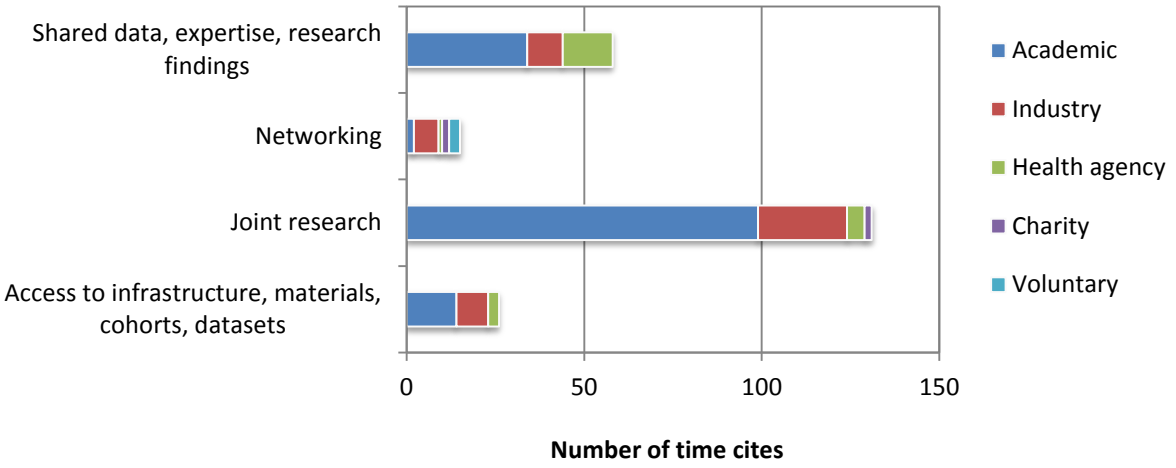
Given that the HRB seeks to have an impact on policy and practice, it was good to note that there were a significant number of collaborations established with health bodies, which included both policy-focused and service delivery-focused groups, health charities and voluntary and community groups. The proportion of collaborations established with health bodies increased from 10 % of total new collaborations in 2010/2011 to 14 % in 2012/2013. Examples of policy focused groups cited were the Oireachtas Health Committee, Health Atlas Ireland, HIQA, the American Heart Associate, WHO and the Sierra Leone Union on Disability. Health service providers included hospitals, the HSE, Stanford Cancer Institute and the Federation of Disabled Persons in Malawi.

Figure 17: Breakdown of collaborations formed by HRB-funded researchers by type



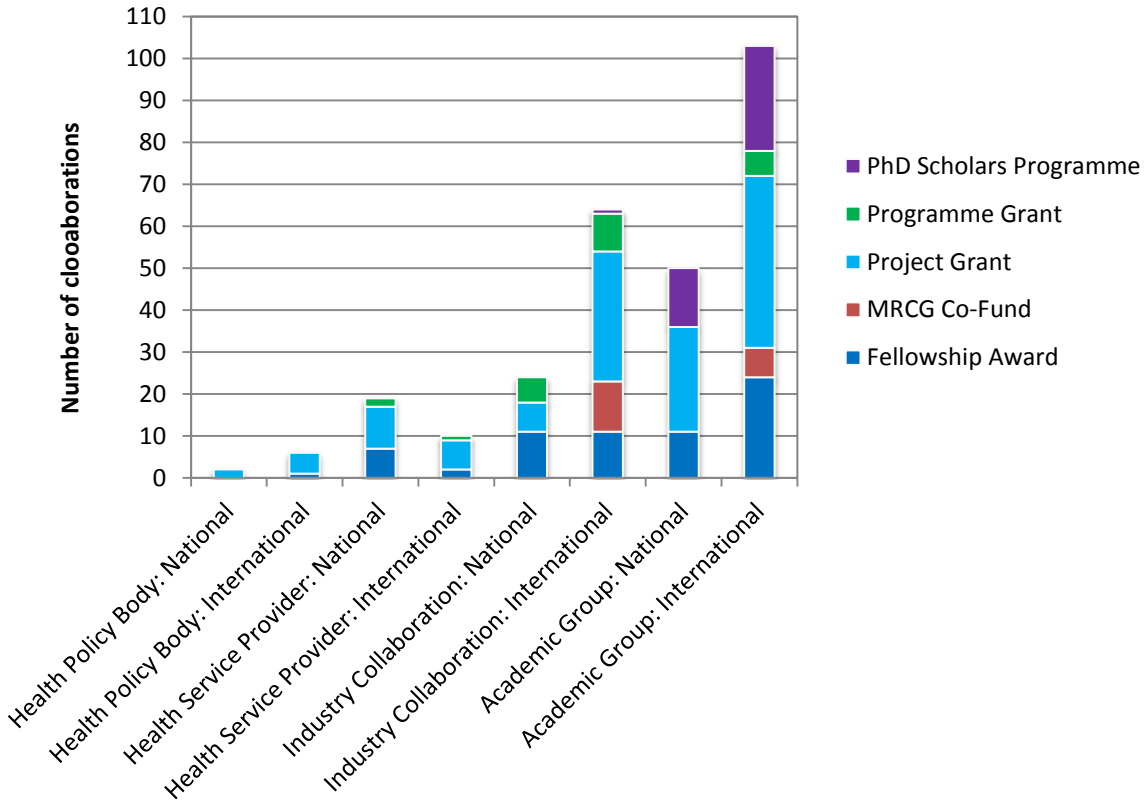
Researchers were also asked about the aim of their collaboration with another group or organisation. Figure 18 sets out the reasons cited. Well over half of researchers (57 % of total collaborations) undertook joint research with academic or industry partners. Sharing of data, expertise and research findings, and the provision of access to infrastructure, materials, cohorts and datasets were also important aims of collaboration with academic and industry partners, accounting for almost 30 % of collaborations established. For collaborations established with health bodies sharing of data, expertise and research findings was the most important aim, accounting for 61 % of collaborations. Collaborations established with the charity and voluntary sectors were primarily aimed at creating networks.

Figure 18: Cited reasons for establishing a new collaboration



Analysis of collaboration activity by scheme type is presented in Figure 19. Overall, there was an average of 2.1 collaborations established per award (an overall average productivity of 7.1 collaborations per €1 million spend.) However, the number and cost of collaborations varied widely depending on the scheme type.

Figure 19: Type of collaboration established by scheme type



Projects grants accounted for almost half of all collaborations reported in 2012/2013 (46 % of total), with 7.7 collaborations established per €1 million spend. Fellowship Awards accounted for just over 24 % of the total number of collaborations, and in terms of productivity were similar to Project Grants, with 6.7 collaborations per €1 million spend. Programme Grants (not including the PhD Scholars Programme) and the Clinician Scientist Award resulted in the establishment of more collaborations per award that either projects or fellowships, but were considerably less productive, producing an overall average of 3.5 collaborations per €1 million spend.

The one PhD Scholars programme for which data was available produced 40 collaborations, or 8.9 collaborations per €1 million spend. This means that this programme was more productive than other scheme types, with the exception of the MRCG Co-fund, which was more productive that other scheme types, producing 11 collaborations per €1 million spend. 12 of the 19 MRCG collaborations were with international industry partners, while the remaining seven collaborations were with academic partners overseas.

3.3 Development of research materials and methods

The development or application of novel research materials, methodologies and/or technologies is an indicator of the extent to which HRB grant holders are advancing research capacity within their field both nationally and internationally. Of the 134 grants analysed in 2012/2013, 112 (52 %) of grant holders reported the development of one or more novel research materials or methods wholly or partly as a result of their HRB

grant. This is a slight increase (6 %) on the 2010/2011 reporting period. Given that no data was provided for this metric by one PhD Scholars Programme that completed in 2013, the overall figure is likely to be a slight underestimation of the actual figures. The PhD Scholars Programme that did provide data for this metric reported the development of three biological sample collections and a novel experimental assay.

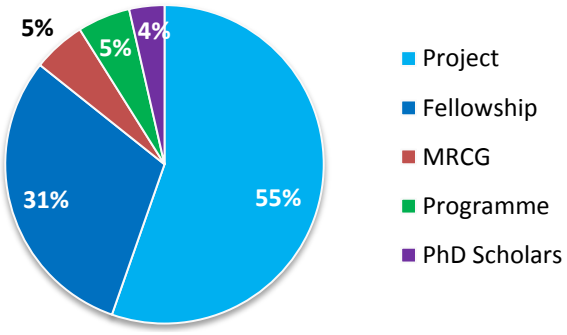
As shown in Table 13, the most common type of research material developed was a novel database or dataset (N=22), followed by the development of a biological sample collection (N=18). Novel experimental assays or data analysis techniques were also highly cited, as was the establishment of a new or improved research infrastructure. For the first time in 2013, a researcher reported the development of a new application for Android tablets that had a clinical application.

Table 13: Number of novel research material/methods developed by type

Type of material/method developed	No. developed
Database/ dataset	**22**
Biological samples/Biobank	**18**
Experimental assay or method	**17**
Data analysis technique	**15**
New or improved research infrastructure	**9**
Physiological assessment or clinical outcome measure	**9**
Animal model of disease	**7**
Training protocol, computer-delivered	**6**
Structured education manual	**4**
Management guidelines	**2**
New research software	**2**
Application for Android tablet	**1**
Total number of new research materials/methods	**112**

Figure 20 shows how these novel materials/methods were distributed across scheme types and the number of novel materials/methods developed per €1 million spend overall per scheme type. Project Grants produced the highest number of novel materials or methods (55 % of reports), followed by Fellowship Awards (31 % of reports). The number of novel materials or methods developed per €1 million spend for both of these scheme types was similar (3.7 for Project Grants and 3.4 for Fellowships Awards.)

Figure 20: Novel material/methods broken down by scheme type and number per €1 million spend



No. novel materials/methods per €1 million spend	
Project Grant	3.7
Fellowship Award	3.4
MRCG Co-fund	3.5
Programme Grant	0.9
PhD Scholars Programme	0.9

The MRCG co-fund scheme accounted for only 5% of reports on this metric, but it was similar to Project Grants and Fellowship Awards in terms of the number of novel material s or methods developed per €1 million spend (3.5). the productivity of both Programme Grants, the Clinician Scientist Award, and the one PhD Scholars Programme providing data for this metric, was less than one (0.9) novel materials or methods developed per €1 million spend. However, given that the aim of the Clinician Scientist Award and the PhD Scholars Programme was to build capacity in the health system by providing leadership and training of future researchers, this result is not surprising.

Table 14 provides some examples of the types of materials and methods developed or refined by HRB funded researchers whose awards completed in 2012/2013.

Table 14: Examples of the types of materials and methods developed from HRB-funded awards

Scheme Type	Type of novel material/method	Description
Health Services R&D Award	Database/dataset	DAFNE Clinical and Research Database; unique type 1 diabetes secure online database developed to collect an extensive range of physiological, psychological, health economic and quality of life variables at baseline and for up to 6 years. Currently has data on over 30,069 UK and Irish patients.
PhD Scholars Programme	Biological sample/Biobank	Blood samples from healthy donors and patients with B cell chronic lymphocytic leukaemia.
MRCG Co-fund	Experimental assay or method	New method to evaluate inflammation in inflammatory lung disease
Translational Research Award	Data analysis technique	Computational Modelling Platforms for Evaluating Apoptosis Sensitivity (DR MOMP and PCCP/APOPTO-CELL)
Health Research Award	New or improved research infrastructure	Established a research DXA facility within the UCD Clinical Research Centre located at the Mater Hospital campus.
Health Research Award	Physiological assessment/clinical outcome measure	A birth weight centile reference curve for Irish children (published in PLoS One 2013)
Research Project Grant	Animal model of disease	New animal model of sleep-disordered breathing, allowing pathophysiological remodelling in the central nervous control of breathing, and assessment of the value of antioxidant therapy for sleep-related breathing disorders.
Research Project Grant	Training protocols, computer-delivered	Online educational programme for GPs covering diagnosis and management of urinary symptoms, suspected urinary tract infection (UTI), and asymptomatic bacteraemia in adults.
Nursing and Midwifery Research Priorities Study	Structured education manual	Structured education programme manuals and CD's available to download through School of Nursing website, and requested within and outside of Ireland.
Health Research Award	Management Guidelines	Development of Irish Nutrition and Dietetics Institute, Renal Panel's Guideline for management of secondary hyperparathyroidism in CKD.

Marie Curie Post-doc Fellowship	New research software	Wearable cameras and associated software analysis tools to measure sedentary behaviour, active travel, and nutrition-related behaviours. Potential to improve understanding of the relationships between lifestyle behaviours and health outcomes.
Post-doctoral Fellowship	Application for Android Tablet	Android tablet application to assist in early acquisition of ECG's from patients with ACS. Currently with the TTO in TCD to establish commercial potential.

3.4 Recognition and research awards

Grant-holders whose grants completed in 2012/2013 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 grant. Awards and recognition received by grant-holders gives an indication of the quality and potential impact of grant-holders' research as perceived by their peers nationally and internationally. In this context, it was encouraging that 70 % of the 134 grants analysed reported that either they or a member of their team received at least one type of award or recognition. The type of recognition or award reported is shown in Figure 21.

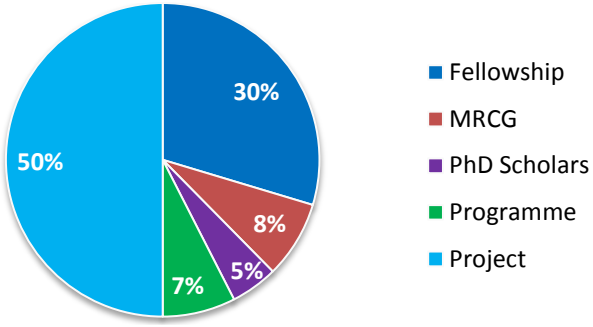
By far the most common form of recognition was the awarding of a research prize, medal or other acclaim. This category includes, for example, travel awards and bursaries, prizes for best paper or poster at a national or international scientific conference. HRB-supported researchers were also invited to participate in international scientific bodies such as advisory scientific committees and journal and book editorial boards, and to contribute as keynote speakers, session chairs and on organising committees at international scientific conferences, Examples of the type of awards, prizes and scientific recognition by peers reported for grants that completed in 2012/2013 are described in Table 15.

Figure 21: Number of grants reporting different types of research awards and recognition

Figure 22 shows that Project Grants and Fellowship Awards accounted 80 % of the reported awards, prizes and other peer recognition and were similar in terms of these outputs per €1 million spend (6.8 and 6.7, respectively). The five Programme Grants, the CSA Award and two PhD Scholars Programmes collectively accounted for 12 % of total reports of prizes, awards and recognition. However, their productivity for this metric was considerably lower than Project Grants or Fellowship Awards, being 2.5 (Programme Grants and CSA) and 1.3 (PhD Scholars Programme) per €1 million spend.

As was the case for a number of other metrics, the MRCG Co-fund award, while accounting for only 8 % of total reports of prizes, awards and recognition, yielded an average of 10.4 awards, prizes or recognition outputs per €1 million spend.

Figure 22: Research awards and recognition broken down by scheme type and number per €1 million spend



No. awards/prizes/recognition per €1 million spend	
Project Grant	6.8
Fellowship Award	6.7
MRCG Co-fund	10.4
Programme Grant	2.5
PhD Scholars Programme	1.3

Table 15 provides some examples of the types of research awards and recognition outputs reported by PIs whose grants completed in 2012/2013 as being linked to their award.

Table 15: Examples of research awards and recognition received by HRB-supported researchers

Recipient	Details of Award/Prize/Recognition
Professor Jochen Prehn Translational Research Award	RIA Life Science Lecture Inaugural Award.
Elizabeth Oliver PhD Scholars Programme	Nutrition Society Post-graduate Award 2010.
Professor Finbar Allan Health Research Award	Appointed to the editorial board of the International Journal of Gerodontology, 2012-5.
Dr Gearóid Ó Laighin Health Research Award	Wounds UK Award for Innovations in Leg Ulcers 2011.
Markhas Rehm Research Project Grant	Appointed Review Editor, Frontiers in Molecular and Cellular Oncology.
Professor Jack James Research Project Grant	A total of four internships arose from this project, one of which lead to a paid posts as a research assistant on the project. Students visited from the USA (3) and Germany (1).
Prof Abhay Pandit Research Project Grant	Invited to present keynote talks at the 38th Annual Meeting and Exposts of the Controlled Release Society and the European Polymer Congress as a result of work facilitated through this HRB grant.
Dr Aiden Doherty Marie Curie Post-doc Fellowship	Guest editor of March 2013 issue of the American Journal of Preventive Medicine.

Recipient	Details of Award/Prize/Recognition
Ruth Ryan PhD Scholars Programme	Keystone Symposia Travel Award to attend the Tuberculosis: Immunology, Cell Biology and Novel Vaccination Strategies conference in Vancouver in Jan 2011.
Professor Afshin Samali MRCG Co-fund award	Appointed as a visiting Research Professor at University of Ghent, Belgium for 3 years (2013-2016)- based partly on work in this project.
Dr. David Bergin MRCG Co-fund award	Awarded travel grant from the ATS Public Advisory Board.
Professor John Laffey Research Project Grant	Elected Deputy Chair of Acute Respiratory Failure Section of European Society of Intensive Care Medicine.
Professor Kieran Murphy Research Project Grant	Invited to host the 20th International Scientific Meeting of the VCFS Educational Foundation 2013 in Dublin.
Professor Larry Egan Research Project Grant	PI elected to membership of the Association of Physicians of Great Britain and Ireland, partly in recognition of work on this project.
Dr Molly Byrne Research Project Grant	Invited to co-author Sexual Counselling for Individuals With Cardiovascular Disease and Their Partners: A Consensus Document from the American Heart Association and the ESC Council on Cardiovascular Nursing and Allied Professions (CCNAP), published July 2013 in Circulation and European Heart Journal.
Dr Tanya M Cassidy Cochrane Training Fellowship	Invited to speak at two international events: HMBANA annual conference in Las Vegas and Workshop on ethics and breastfeeding at Keele University, UK.
Dr Liam Glynn Research Project Grant	Scientific Advisory Board of the PRIMUM Multimorbidity trial, Frankfurt, 2010.
Ms Julie Regan Health Professional Fellowship	Invited to write book chapter: Regan, J. & Walshe, M. (2012) Neuromuscular Conditions. In: Newman, R & Nightingale, J. (Eds.) *Videofluoroscopy: A Multi-Disciplinary Team Approach*. San Diego, Plural Publishing Inc. pp.177-195.

Section 4: Informing policy, practice and the public

A key area of HRB investment is the potential to have an impact on health sector improvement. 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
- dissemination of research finding to a wider, non-academic audience via a variety of media outlets
- engagement with patient groups and the public to disseminate the results of the research

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

Informing policy, practice and the public	2012/2013 (N=134 grants)	2010/2011 (N=196 grants)	2008/2009 (N = 204 grants)
Health policy and practice outputs/influences			
No. policy and practice outputs	127	99	41
% grants reporting policy and practice outputs	38 %	24 %	20 %
No. policy/practice outputs per €1 million spend	2.9	1.8	0.9
Engagement with patients and the public			
No. broader dissemination activities	188	122	NA
% PIs reporting broader dissemination activity	50 %	35 %	NA
No. dissemination events per €1 million spend	4.6	2.2	NA

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

4.1 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 has the potential to 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 grants holders would appear to be increasingly active in this regard. In total, PIs whose grants completed in 2012/2013 reported 127 policy and practice outputs from 52 grants or 38 % of all analysed grants. This compares to 48 grants (24 % of all grants) that completed in 2010/2011 and 41 grants (or 20 % of all grants) that completed in 2008/2009 reporting outcomes in this category. It should be noted that neither PhD Scholars

Programme provided any data for this metric – one programme indicated that it had no outputs to report while the other did not respond to this section of the survey – therefore, it is possible that the numbers reported may be a slight underestimation of the total numbers. Table 16 shows the breakdown of the reported policy/practice outputs and influences by sub-type in 2012/2013.

Table 16: Breakdown of policy/practice outputs and influences by sub-type

Output/influences sub-categories	% grants
Hosted or presented research findings at a stakeholder seminar or workshop	**22.0**
Advisory role, or member of policy/guideline expert panel or working group	**20.5**
Meetings with policy makers, health managers, or other key users to present discussions/findings	**16.5**
Coverage in specialised medical of healthcare publications	**10.2**
Influenced training or education of health professionals and/or policy makers	**9.4**
Citation in Clinical Guidelines, Clinical Reviews or Systematic Reviews	**4.7**
Citation in policy documents or key government reports	**4.7**
Submitted research to a national consultation process	**4.7**
Produced or updated a Cochrane systematic review as part of HRB-funded research	**2.4**
Produced practice or treatment guidelines or a policy report/ brief or booklet	**2.4**
Research featured in newsletter, or on website, of a professional body	**2.4**

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. This approach accounted for 38.5 % of all outputs reported. Researchers also participated in expert panels developing clinical guidelines or policy (20 % of reports). 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 (22.1 % of reports). The results emerging from HRB-funded grants were cited in influential policy and clinical practice documents such as Clinical Guidelines, clinical reviews, policy documents, government reports (9.1 % of reports) or had an influence on the training or education of health professionals or policy makers (9.4 % of reports).

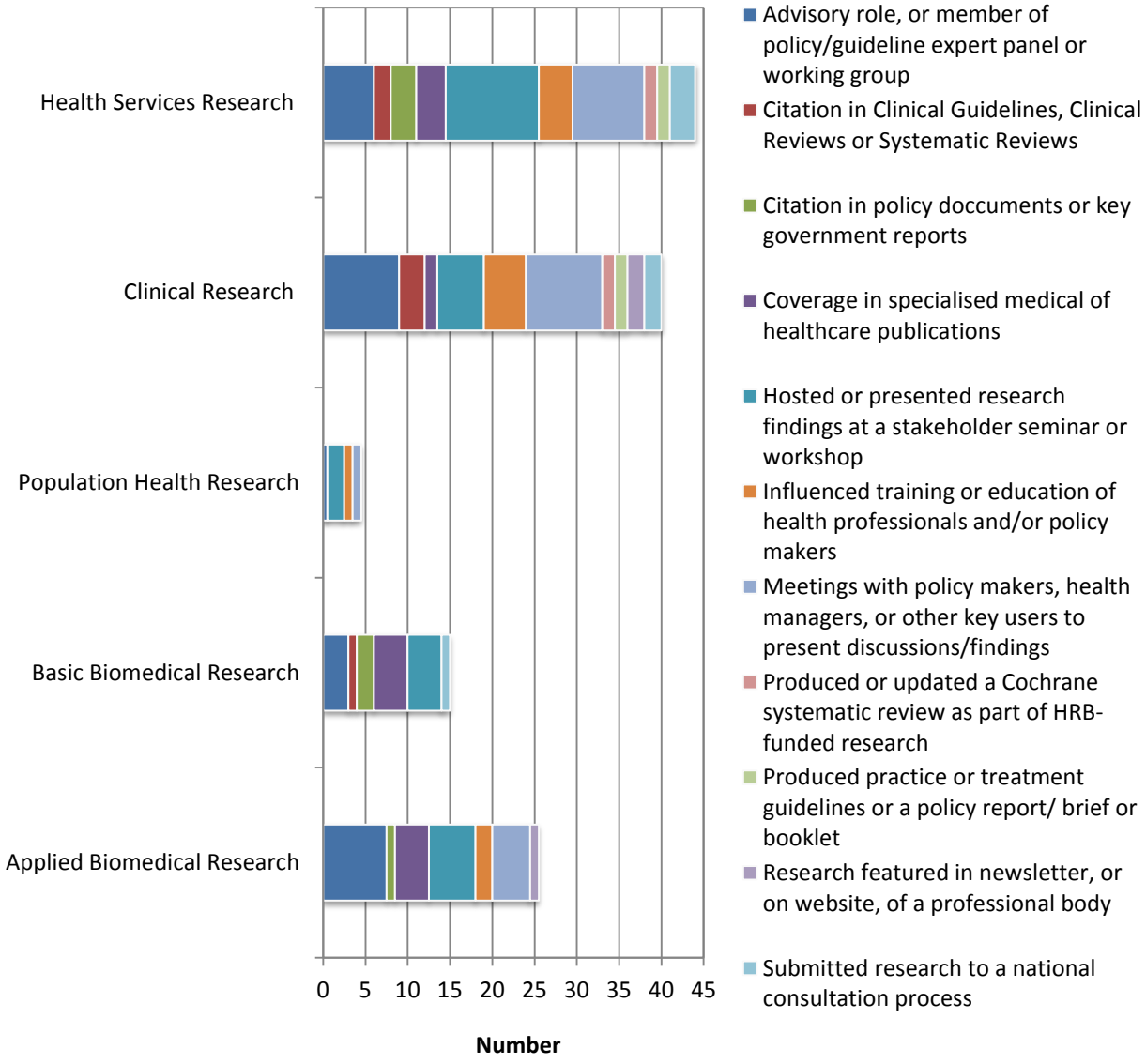
Figure 23 shows the distribution of policy and practice outputs by broad research area while Figure 24 shows the distribution of policy and practice outputs by scheme type and per €1 million spend.

The likelihood of a PI seeking to have a policy or clinical practice influence will be associated to a large extent with the type of research being undertaken. Therefore, research in the clinical, population health 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 23, where these broad research areas accounted for almost 70 % of all policy and clinical practice influences. HSR-focused grants in particular had the highest number of outputs (6.6) per €1 million spend.

On the other hand, grants categorised as biomedical research would be more focused on outputs in the categories of knowledge production and capacity building, rather than in influencing policy and clinical practice. This is borne out by the statistics for applied biomedical research, which accounted for 20 % of all grants but only 1.1 outputs per €1 million spend. The exception to this trend was the relatively high number of policy and practice outputs reported by researchers in the basic biomedical space (12 % of total, with 5.2 per €1 million spend). These outputs were predominantly associated with participation in expert advisory groups,

presentation of research findings at workshops and seminars and publication or citation of results in systematic reviews and specialist healthcare publications (such as Professional Association Newsletters.) In reality, these types of outputs, while important from the perspective of dissemination and networking of researchers with policy and clinical stakeholders, are probably less likely to result in a short to medium-term outcome or impact on policy development or changes in clinical or public health practice.

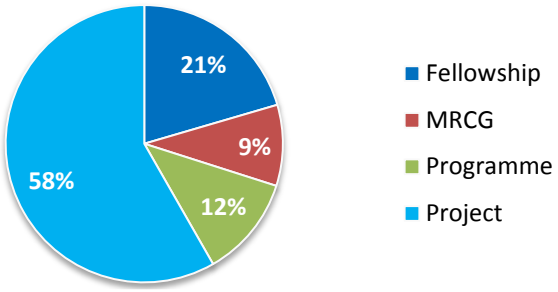
Figure 23: Type of policy and practice output broken down by broad research area



In terms of the distribution of policy and practice outputs across scheme type, Figure 24 shows that Project Grants accounted for almost 60 % of all reported policy and clinical practice outputs, resulting in 4.4 outputs per €1 million spend. Fellowship Awards accounted for 21 % of outputs reported, although they were less productive (2.6 per €1 million spend) than Project Grants. This was a little surprising given that almost 70 % of these fellowships were in the clinical or health services research space. Programme Grants and the CSA collectively accounted for 12 % of reported outputs, and a productivity of 2.2 outputs per €1 million spend. While this is lower than Project Grants, it should be noted that almost 70 % of Programme Grants that completed in 2012/2013 were categorised as basic or applied biomedical research and might not be expected to have policy and practice outputs as a focus of their research.

That said, the MRCG Co-fund scheme was the most productive in terms of policy and practice outputs (6.9 per €1 million spend) even though the majority of MRCG Co-fund awards were categorised as basic or applied biomedical research, and might not be expected to have a focus on this metric. However, the outputs reported were predominantly participation in expert advisory groups and presentation of research findings at workshops and seminars, which might reflect the reputation of the PI rather than the subject of the award, and would be unlikely to results in real outcomes and impacts on policy development of changes in clinical and public health practice in the short to medium term.

Figure 24: Policy and practice output broken down by scheme type and per €1 million spend



No. of reported policy/practice influences per €1 million	
Fellowship Award	2.6
MRCG Co-fund	6.9
Programme Grant/CSA	2.2
Project Grant	4.4

Table 17 provides some examples of the type of policy and practice outputs reported for this metric by PIs whose grants completed in 2012/2013.

Table 17: Examples of policy and practice influences

Grant type	Type of policy and practice outputs	Details of policy/practice output
MRCG Co-fund Award	Advisory role, or member of policy/guideline expert panel or working group	Member of committee on European standards for care of individuals with CF and of research review board of Alpha one foundation.
Health Research Award	Citation in Clinical Guidelines, Clinical Reviews or Systematic Reviews	Co-author of RCOG Clinical Guideline on Operative Vaginal Delivery.
Health Research Award	Citation in policy documents or key government reports	The C&AG Office sought advice from the project team on auditing of day surgical services. Elements of the project documentation were adopted for use by the C&AG office.
Health Research Award	Hosted or presented research findings at a stakeholder seminar or workshop	Public Awareness Symposium: A World of Vision: Preventing Blindness. Supported by Fighting Blindness Ireland and HRB and hosted by TCD.
Research Project Grant	Meetings with policy-makers, health managers or other key users to present/discuss findings	Discussions with midwifery and hospital management with a view to introducing change and implementation of a programme of hospital based antenatal education are ongoing.
Clinical Therapies Professional Fellowship	Produced practice or treatment guidelines or a policy report/brief or booklet	Alzheimer Report Launch at the Dementia Strategy Conference. TCD, 18 January 2012.

Grant type	Type of policy and practice outputs	Details of policy/practice output
MRCG Co-fund Award	Research featured in specialised medical or health press	1. 'RCSI research could lead to new treatments for smoker's emphysema' Medical Independent. 2. 'Irish team in emphysema breakthrough' published in IrishHealth.
Health Research Award	Influenced training or education of health professionals and/or policy makers	The PISA clinicians trained to deliver the intervention as part of this project have also delivered additional groups beyond the lifetime of the project, which have been of benefit to service users in these areas.
Cochrane Training Fellowship	Produced or updated a Cochrane systematic review as part of HRB-funded research	This is a new Cochrane systematic review examining the evidence relating to psychosocial interventions for benzodiazepine use, abuse or dependence.
Health Research Award	Research featured in newsletter, or on website, of a professional body	Article written by the DCU research team highlighting the unique needs of individuals with recurrent suicide attempts - published in Irish Association of Suicidology (IAS) newsletter, Autumn 2011. Report on the suicide awareness conference hosted by DCU and partners (RTE Yellow Asylum Films, SOS, SOSAD) - published in IAS newsletter, Summer 2012.
Joint Research Project Grant in Cancer	Submission to a national consultation process (e.g. service review, health policy or legislative consultation)	Ugandan National Population Report (within the Ministry of Finance and Economic Development). Influenced disability inclusion in the Sierra Leone HIV and AIDS National Strategic Plan and invited to comment on Draft Finance Bill, plus the 2010 National Development Plan of Uganda (Tsitsi).

4.2 Engagement with patients and the public

Wider dissemination of research findings to non-scientific audiences is vital for improving the public understanding of science, for recruiting patients to clinical trials, and for promoting the benefits and value of health research to non-scientific stakeholders. Such activities include: coverage of research in the national and international press; presentations to lay audiences (general public, patient groups, school talks etc.); radio or television interviews relevant to their HRB-funded research; reference to their research in newsletters or online publications; and press releases describing significant research findings.

When asked if they had engaged in wider dissemination of their research through various fora, 50 % of grant holders reported 188 outputs in this area. This is an increase of 15.5 % on the number of grant holders reporting engagement in this type of activity for the 2010/2011 reporting period.

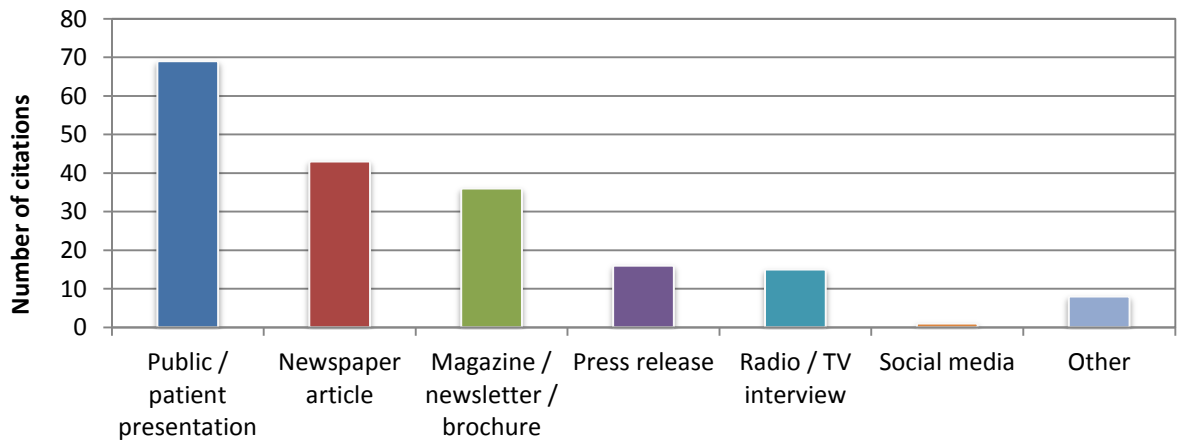
Table 18 shows a breakdown of public/patient engagement outputs by type. From this it can be clearly seen that publication in non-specialist media such as newspapers, popular magazines and patient information booklets was a popular form of communication, accounting for just over 40 % of dissemination outputs reported by researchers. Presentations to various stakeholder groups including school children was another common form of engagement chosen by researchers, accounting for over 34 % of reports. It is also noteworthy that researchers cited 16 instances of 'Communication of academic research to colleagues' within this metric of public and patient engagement. These reported outputs were not included in further the analysis of this metric.

Table 18: Breakdown of dissemination activity by type

Type of activity	No. of outputs
Presentation to / interactions with patients, charities, advocacy groups or public	**69**
Coverage in local, regional or national general press	**31**
Produced material (i.e. information booklet) for patients or the public	**25**
Press release issued on subject of HRB-funded research	**16**
Coverage in international general press	**12**
Radio or TV interview in Ireland	**12**
Popular magazine feature or other popular media	**11**
Interacted with school students	**6**
School talk on subject of HRB-funded research	**2**
Radio or TV interview in another country	**3**
Social media coverage	**1**
Total	**188**

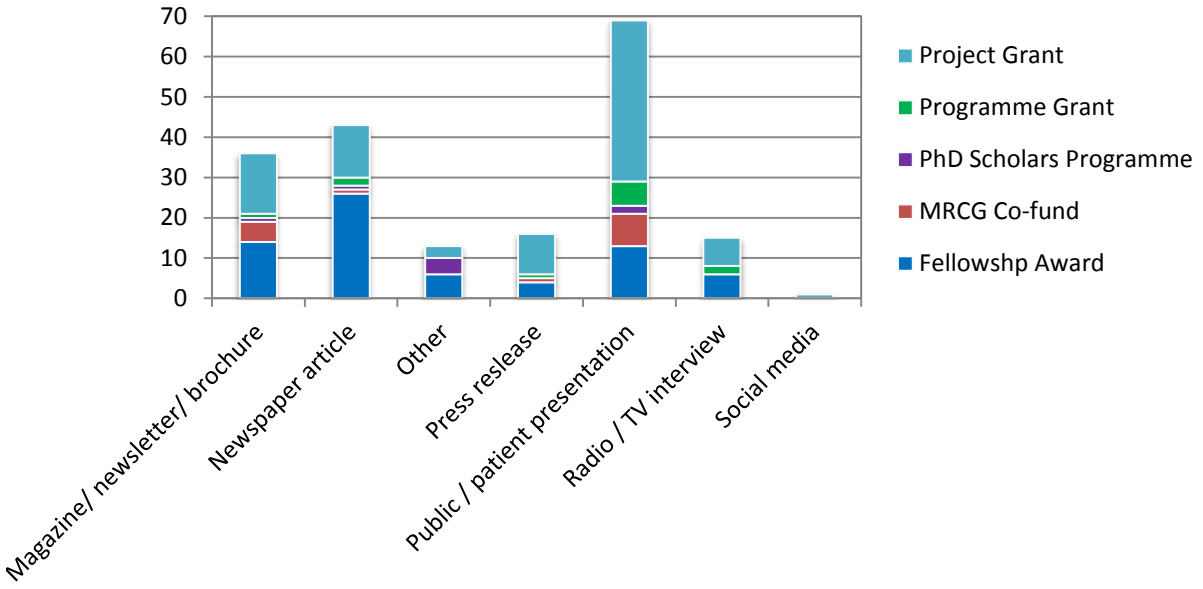
Figure 25 shows the distribution of dissemination events reported by HRB grant holders according to the scheme type and media type. In contrast to the 2010/2011 reporting period, when coverage of research results in the national and international press was the most common outlet, in 2012/2013 presentations to lay audiences (general public, patients/patient groups, school talks etc.) was by far the most popular method chosen to communicate with a wider audience, accounting for 36.7 % of all reported outputs. However, HRB researchers were also very successful in getting their research covered in the print media, as well as on radio and television, which between them accounted for almost 31 % of coverage. Just over 19 % of reported dissemination was through references to their research in popular magazines and newsletters or via patient leaflets or brochures. In 2013 for the first time, one researcher reported the use of social media to disseminate their findings. The 'other' category refers to interactions with school students, participation in science fairs etc.

Figure 25: Breakdown of dissemination events by media type



The distribution of dissemination outputs broken down by media type and by type of scheme type is shown in Figure 26.

Figure 26: Engagement outputs broken down by media and scheme type



As was the case with a number of other metrics in this report, MRCG Co-fund awards, while small in number, were very productive in terms of public engagement outputs per €1 million spend (8.7), followed by Fellowship Awards and Project Grant holders, who were also active in disseminating their research findings to a wider audience, and accounted for 6.6 and 5.4 outputs per €1 million spend, respectively. Collectively, the Programme Grants (including the PhD Scholars Programme) and the CSA Award were less productive with regards to wider dissemination, although with only one exception (a Joint Research Programme Grant in Cancer) all of these scheme types reported at least one output for this metric, with all Translational Research Awards having at least three outputs for this metric.

Table 19 provides some examples of the type of dissemination activity in which HRB funded PIs and their teams engaged in order to communicate the results of their research beyond the scientific community.

Table 19: Examples of public/patient engagement outputs

Grant/PI	Type of engagement	Description of engagement activity
Health Research Award	Presentation to / interactions with patients, charities, advocacy groups or public	Launch lecture on current status of Alzheimer's research at Alzheimer's Foundation meeting - City Hall Cork, February 2005. Audience included members of the public including patient groups. Also, Neurofocus February 2012 Presentation to public and young students interested in diseases of the brain.
Health Research Award	Coverage in local, regional or national general press	PI, was interviewed by Claire O'Connell and an article based on this interview was published in the Irish times health supplement in April 2012. The interview focused on responding to someone who is suicidal and promoted the work being carried out on the PISA project. An article based on an interview with the PI on boosting a sense of value in individuals as a way to

Grant/PI	Type of engagement	Description of engagement activity
		prevent suicide also appeared in the Irish Times Health Supplement in 2010.
MRCG Co-fund Award	Produced material (i.e. information booklet) for patients or the public	Alpha One Foundation Annual Report 2009 and 2010. This report provided to all patients is a brief overview of the research, activities and the progress being carried out within the Alpha One Foundation, Beaumont Hospital.
Health Research Award	Press release issued on subject of HRB-funded research	NUI Galway issued a press release when the PIs paper was published in Molecular Cancer Therapeutics.
Post-doc Fellowship	Coverage in international general press	Article in Las Vegas Herald Online, on elements of the PIs work on gendered presentation in acute coronary syndrome.
Translational Research Award	Radio or TV interview in Ireland	Interviewed on RTE current affairs programme "Morning Edition" relating to facts and figures about Coronary Heart disease.
Health Professional Fellowship	Popular magazine feature or other popular media	Irish Times Insight Magazine Article -It's Big Brother on the Smartphone (Nov 2012).
PhD Scholars Programme	Interacted with school students	BT Young Scientist Exhibition 2014. PI discussed the potential for the compounds discovered over the course of this research programme to be used for the treatment of prostate cancer. Engaged the students/ teachers/ parents in discussions around the impact that biomedical research can have on the treatment of disease.
Health Research Award	School talk on subject of HRB-funded research	Over the period of the grant the PI delivered a lecture to transition year students in approx. three schools per year.
Marie Curie Post-doc Fellowship	Radio or TV interview in another country	BBC Radio interview with James Cannon, BBC Radio Oxford, February 2013, on the types of behaviour change interventions that may or may not work.
Health Economics Fellowship	Social media coverage	Symposium at which results were presented was live-streamed and had a twitter feed.

Section 5: Health sector innovations

Health research is the basis for many product innovations in the commercial life sciences and biotech sectors as well as treatment and service innovations in the healthcare sector. In this context, grant-holders were asked whether their HRB-funded research led to, or significantly contributed to, the development 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. Grant-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.

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

Health sector innovations	2012/2013 (N=134 grants)	2010/2011 (N=196 grants)	2008/2009 (N = 204 grants)
Health sector innovations			
No. health sector innovations	43	48	32
% grants reporting health sector innovations	24.6 %	21 %	15 %
No. health sector innovations per €1 million spend	1	0.9	0.7

5.1 Health sector innovations

In total, 43 grants (24.6 % of total grants) that completed in 2012/2013 reported that their HRB-funded research had either directly led to or contributed to the development of a total of 43 innovations. This is slightly lower than 2010/2011 figures where a total of 41 grants (21 % of total) reported the development of 48 innovations, and is an increase on 2008/2009 figures where a total of 31 grants (15 % of total) reported the development of 32 health innovations. Table 20 shows the breakdown of the 43 innovations by type.

Table 20: Number of HRB-funded health-related innovations in development by type

Type of healthcare innovation	Number developed
Care model or service	**11**
Clinical Decision Support Tool	**3**
Diagnostic Tool: Non-Imaging	**7**
Prognostic tool: Non-Imaging	**1**
Preventative Intervention: Behavioural Risk Modification	**3**
Preventative Intervention: Nutritional or Chemoprevention	**1**
Preventative Intervention: Physical/Biological Risk Modification	**2**
Strategy to manage disease or condition	**1**
Therapeutic intervention: Cell or Gene Therapy	**1**
Therapeutic Intervention: Medical device	**1**
Therapeutic intervention: New drug or Indication	**5**
Therapeutic Intervention: Psychological/Behavioural	**6**
Therapeutic Intervention: Vaccine or Immunotherapy	**1**
Total	**43**

A wide range of healthcare interventions was reported including diagnostic, prognostic, preventative and therapeutic interventions. The most common single type of healthcare innovation reported was the development or improvement of a health care model or service (25 % of reports). Development of non-imaging diagnostic tools, psychological or behavioural therapeutic interventions, and development of a therapeutic intervention based on a new drug or a different indication for an existing drug between them accounted for almost 42 % of reported innovations. Preventative interventions of all kinds accounted for almost 14 % of reports, while disease management strategies and decision support tools accounted for over 9 % of reports.

Figure 27 plots the stages of development of the innovations. 44 % of interventions were in early stage development, while a further 40 % of interventions were in the late stages of development or were being tested and refined as part of the award. In terms of uptake of innovations, PIs reported that 14 % (N=6) of their innovations had been adopted on a small scale, while one PI reported that their innovations had been adopted on a large scale. Work on implementing and evaluating a new model of ongoing self-management for Type I diabetes lead to the development of national guidelines by the HSE.

Figure 27: Stages of development of HRB-funded health innovations

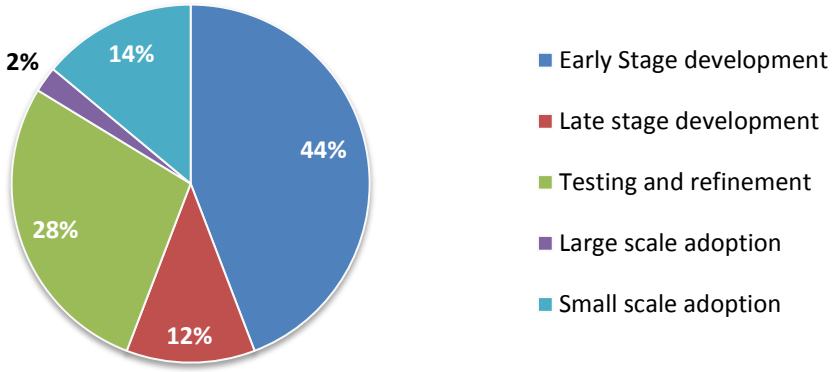


Figure 28 shows the distribution of healthcare innovation types by scheme type. Projects Grants accounted for 67 % of reported healthcare innovations and were distributed across almost all types of innovations (excluding clinical decision making tools, development of cell/ gene therapies and vaccines/immunotherapies). In terms of productivity, there were 1.7 innovations reported per €1 million spend.

MRCG Co-fund awards may have reported only three healthcare innovations, but as has been observed for other metrics but had the same productivity per €1 million spend as Project Grants (1.7). The PhD Scholars Programme reported one healthcare innovation (development of a gene therapy), and given the investment in this scheme had a low productivity of 0.1 innovation per €1 million spend. However, since the focus of this programme was training of researchers, this is not unexpected.

Fellowship Awards and Programme Grants (not including the PhD Scholars Programme) each accounted for 12 % of reported healthcare innovations, whose types were quite similar (development of care models, clinical decision support tools and not-imaging diagnostic techniques.) In addition, the work of one Cochrane Training Fellow made a significant contribution to the development of a therapeutic intervention for the treatment of problem alcohol use in drug users, which is currently being implemented as a clinical guideline in general practice. Both Fellowship Awards and Programme Grants had similar productivity per €1 million spend, of 0.5 and 0.7, respectively.

Figure 28: Healthcare innovation outputs broken down by scheme type

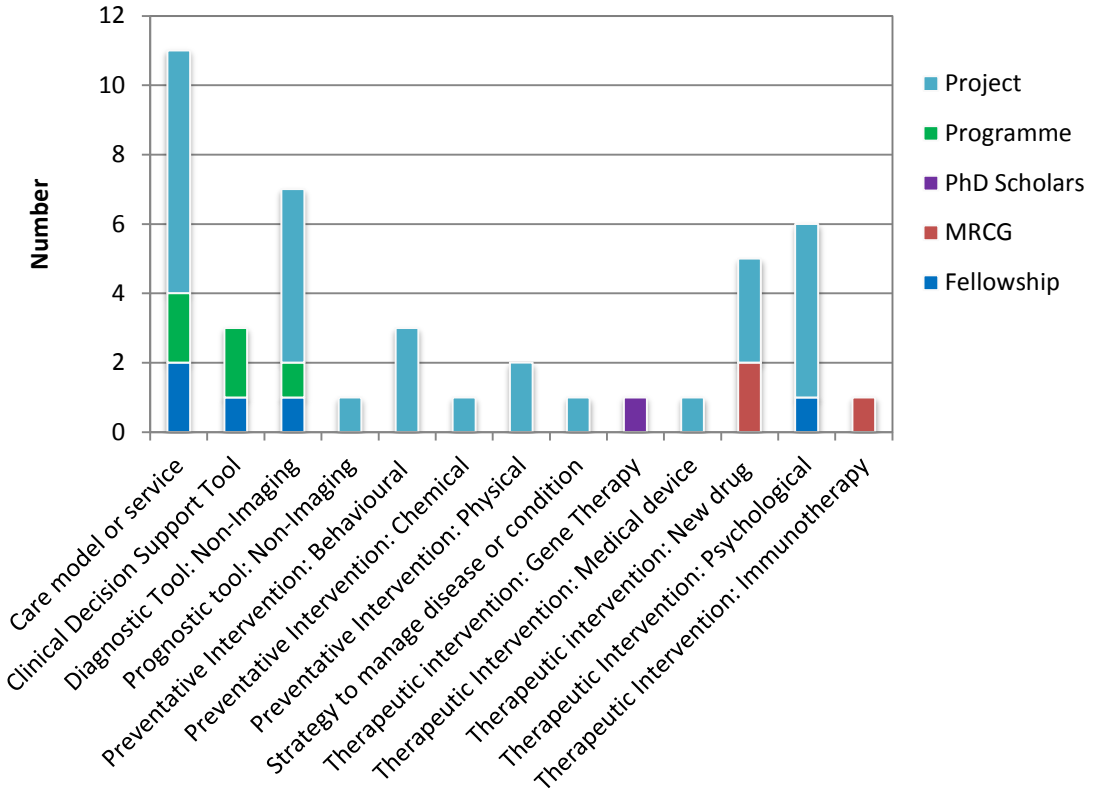
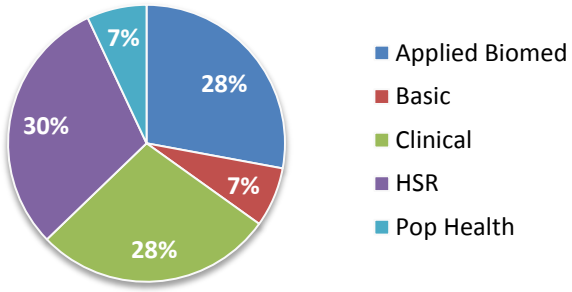


Figure 29 shows the distribution of innovations by broad research area. Three research awards categorised as basic research (all MRCG Co-fund Awards) reported the development of therapeutic interventions (2 drug/1 immunotherapy). Two of these therapies, for Alpha-1-antitripsin deficiency, had attracted additional industry funding to further develop them, while the third, for an immunotherapeutic, was reported to be in late stage development.

Figure 29: Healthcare innovation outputs broken down by broad research area and per €1 million spend



No. of innovations per €1 million	
Applied biomedical research	0.5
Basic research	1.0
Clinical research	1.1
Health services research	2.0
Population health	2.2

Of the 43 healthcare innovations reported, 24 (56 %) were developed by grants categorised as applied biomedical or clinical research. Of these, six had already attracted further funding (three from industry) to develop their innovations, while another five expressed their intention to seek additional funding for this purpose. These innovations were spread across a number of scheme types (PhD Scholars Programme,

Translational Research Awards, Health Professional Fellowships and Research Project/Health Research Awards.)

Grants categorised as population health and health service research accounted for the remaining 37 % of reported healthcare innovations (N=16). These were spread across a number of scheme types (Fellowship Awards, Project Grants and Programme Grants). Unsurprisingly, given the focus of these awards, the types of healthcare interventions reported were targeted at improvement of care models, clinical decision making and strategies for disease management (N=7), behavioural or psychological therapeutic and preventative interventions (N=5) and non-imaging based diagnostic interventions. Six PIs reported having attracted further funding (one from industry) to continue the development of their work.

Table 21 shows some examples of the types of healthcare innovations developed or refined by PIs whose grants completed in 2012/2013

Table 21: Examples of healthcare innovations in development

Grant	Type of innovation	Description of innovation
Nursing and Midwifery Research Priorities /study	Care model or service	Developed a structured education programme which was published with the help of an educational grant from PZifer. The programme was given to the HSE COPD Clinical Lead for use in services and is now being used by teams providing PR in the community.
Health Professional Fellowship	Diagnostic Tool: Non-Imaging	Adapted Functional Lumen Imaging Probe (FLIP) to measure upper oesophageal sphincter (UOS) distensibility and opening patterns during swallowing to advance the assessment and treatment of adults with dysphagia (difficulty swallowing.)
Research Project Grant	Therapeutic Intervention: Psychological/Behavioural	RCT to examine if supporting people, who have an ongoing mental health difficulty to socialise, will help them to feel more a part of their community, to feel better about themselves and to reduce symptoms of their mental health condition.
MRCG Co-fund Award	Therapeutic intervention: New drug or indication	Pioneered aerosol therapy with alpha 1 anti-trypsin in cystic fibrosis and have instituted one of the earliest studies of this mode of therapy in alpha 1 anti-trypsin deficiency. This work led to a major clinical trial in CF, the only trial of aerosolized alpha one anti trypsin for individuals with deficiency of the protein. This also led to the PIs involvement in the only gene therapy worldwide for alpha one.
Post-doctoral Fellowship	Clinical Decision Support Tool	Development of a Clinical Application for use on Android Tablet, to assist triage nurses in the Emergency Department to assess cardiac patients who have atypical symptoms - the tool prompts the nurse as to the urgency of an ECG for that patient. The tool has potential in rural settings, GP practice and for ambulance crews.
Health Research Award	Preventative Intervention: Behavioural Risk Modification	Development of training modules for carers aimed at understanding and minimising the trauma of transition from Child to Adult Mental Health Services in Ireland (ITRACK).

Grant	Type of innovation	Description of innovation
Health Research Award	Preventative Intervention: Physical/Biological Risk Modification	Based on an individual's genetic make-up and the characterisation of genetic variants that regulate response to diet and exercise, develop lifestyle programs for individuals at risk of developing chronic illnesses, and in the management of those who have developed conditions.
Translational Research Award	Prognostic tool: Non-Imaging	Dr MOMP is a prognostic tool based on a systems analysis of Bcl-2 family protein interactions that explores the ability of cancer cells to activate apoptosis, indicative of response to classical, genotoxic therapy. Also designed to predict therapy responses to Bcl-2 antagonists, a novel class of apoptosis sensitisers currently in clinical development/clinical trials.
Health Research Award	Preventative Intervention: Nutritional or Chemoprevention	Research provided an important indication of the cut-off level of circulating selenium in the blood that is associated with colorectal cancer risk, especially in women. From this attempting to estimate required selenium intake levels in the diet, as calculations indicate that current dietary intake levels for selenium in many Europeans are too low.
Research Project Grant	Strategy to manage disease or condition	Based on the results of the project obtained follow-on HSE funding to launch two interdisciplinary training workshops in psychological treatments for chronic pain.
PhD Scholars Programme	Therapeutic intervention: Cell or Gene Therapy	Utilising siRNA screening methodologies developed during this award a stem cell-based therapeutic target for oesophageal cancer have been defined.
Health Research Award	Therapeutic intervention: Material or medical device	In the elderly, reduced peripheral sensation is associated with recurrent falls and fractures. In diabetes, peripheral neuropathy is a significant risk factor for falls, foot ulceration and ultimately amputation. Restoring this lost sensation would greatly improve quality of life and prognosis for these and other groups. However, currently there is no treatment available. This project developed and tested a new sub-sensory electrical stimulation technique to enhance sensory perception.
MRCG Co-fund Award	Therapeutic Intervention: Vaccine or Immunotherapy	The TNF receptor superfamily of transmembrane proteins is specifically activated by TNFα-like cytokines. Agents that manipulate the signalling of these receptors are being used or showing promise toward the treatment and prevention of many human diseases such as rheumatoid arthritis, coronary heart disease, transplantation rejection, insulin resistance, multiple organ failure, and neoplasm. This project generated small peptides for blocking the TRADD-TRAF2 interaction.

Section 6: Economic and commercial benefits

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. In order to advance any enterprise opportunities identified it is also important that HRB-supported researchers can leverage additional funding from both exchequer and non-exchequer sources to sustain their research work.

The successful commercial exploitation, or "commercialisation", of health research can offer an additional source of economic benefit without impinging on the pursuit of better healthcare and research capacity. Commercialisation is the process of converting scientific and technological advances resulting from research into marketable products or industrial processes.

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

Health sector innovations	2012/2013 (N=134 grants)	2010/2011 (N=196 grants)	2008/2009 (N = 204 grants)
Further funding leveraged			
No. additional research awards	149	113	117
Total value of leveraged funding	€39.5 million	€34.8 million	NA*
Amount leveraged per Euro of HRB investment	€0.89	€0.64	NA
Commercial and enterprise activity			
No. patents filed	16	11	12
No. licenced technologies developed	5	3	3
No. start-ups/spin-outs established or in train	2	2	2
No. industry collaborations established	88	25	10

* Data was not available for all metrics for every reporting period.

6.1 Further funding obtained

In the case of HRB grants that completed in 2012/013, 149 additional awards were obtained on the back of research findings derived in whole or part from the original HRB grant. This was an increase on the 113 additional awards secured by HRB grant holders in the 2010/2011 reporting period.

The combined total value of these leveraged awards was €39.48 million, which was an increase of almost €5 million leveraged by grant holders in the 2010/2011 reporting period. Per Euro of HRB investment this accounts for €0.89 leveraged funding. Almost €17.9 million came from Irish exchequer sources such as the HRB, SFI and Enterprise Ireland, while €21.6 million came from non-exchequer sources in Ireland and oversees such as the EU, charities and industry. This was the first since this metric began to be collected by the HRB in 2008 that non-exchequer funding exceeded exchequer funding leveraged by HRB grant holders.

Table 22 shows the number and value of these 149 leveraged awards according to their funding source, nationally and internationally. In terms of EU and other collaborative awards, funding may have been awarded on the basis of participation (rather than primary leadership) of the PI within a wider research consortia, and the amounts shown in these cases reflect the allocation to the PI, as opposed to the total value of the award.

Table 22: Number and value of awards leveraged by PIs

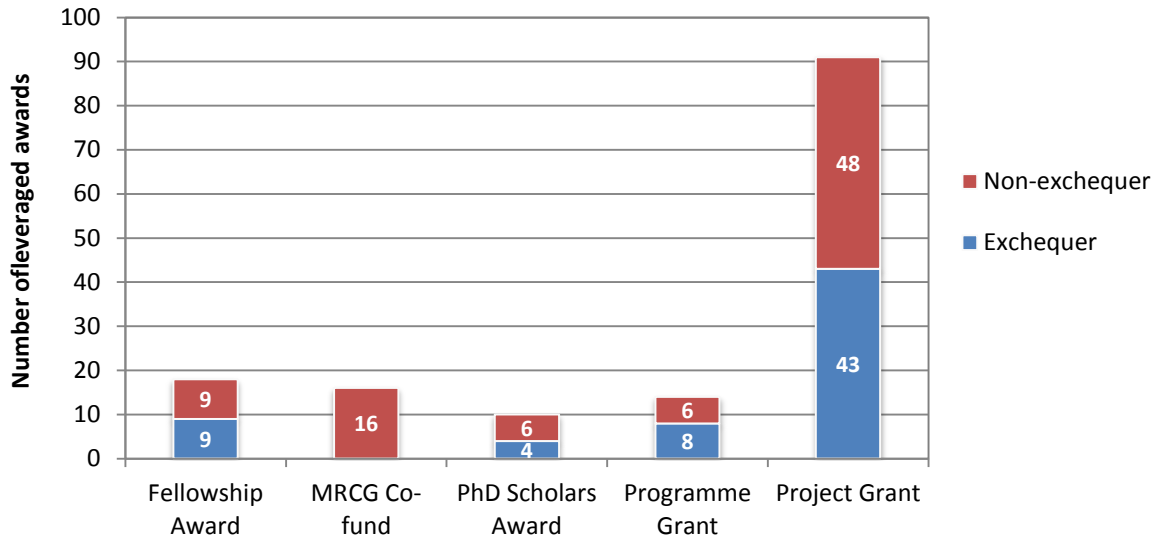
	Amount (€)	Number	Average value (€)
Exchequer			
HRB	10,804,174	28	385,863
Science Foundation Ireland	5,603,990	17	329,646
Enterprise Ireland	671,927	9	74,659
IRCSET	626,127	8	78,266
JPI (HRB/SFI funding)	90,000	1	90,000
Teagasc	88,000	1	88,000
Non-Exchequer			
EU Framework Programmes	13,916,028	22	632,547
Other National	2,677,343	17	157,491
Charity International	1,319,366	10	131,937
Other International	1,155,509	14	82,536
Charity National	954,711	9	106,079
Medical Research Council UK	719,000	3	239,667
Industry: National	587,579	3	195,860
Philanthropic	130,000	2	65,000
European Research Council	80,000	1	80,000
Industry: International	55,180	4	13,795
Total	**€39,478,935**	**149**	

While the amount of additional funding leveraged by researchers was significant, and was an increase on the previous reporting period, there was a slight decrease in the number of additional awards secured by PIs. Overall, 35 % of PIs were successful in securing additional funding on the back of their HRB award that completed in 2012/2013, compared to 42.5 % for the 2010/2011 reporting period. A further 25 PIs indicated that their applications for funding were either unsuccessful or the results were pending.

The number of successful applications for funding, distributed by schemes type is shown in Figure 30, while the value of awards leveraged as a percentage of the total additional funding secured and per €1 million spend are shown in Figure 31. These figures should be interpreted with caution as some grant-holders may not yet have submitted applications for further funding by the end-of-grant stage.

Project Grants were very successful in leveraging additional funding, from both exchequer and non-exchequer sources, and accounted for 61 % of all leveraged awards, and 59 % of the total amount leveraged. This represented a return on investment of €1.38 million for every €1 million spend on this scheme type. Programme Grants and the CSA Award collectively accounted for only 9.7 % of the total number of leveraged awards, but represented 28 % of the total value of leveraged awards. This represented a return on investment of almost €1.6 million per €1 million spend. The size of these awards varied hugely from €25K for an SFI Short Term Travel Fellowship to €850k for an EU FP7 award (as part of a €2.95 million award).

Figure 30: Number of leveraged awards (Exchequer and non-exchequer) across scheme type

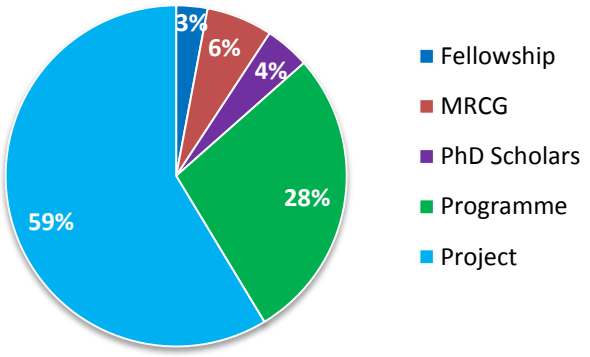


12.1 % of fellowship holders (N=18) had gone on to secure additional funding by the end of their award - this was an increase from 7 % in the 2010/2011 reporting period. These awards accounted for 3 % of the total value of leveraged awards, or a return on investment of €117K for every €1 million spend, considerably less than Project or Programme Grants. The value of individual leveraged awards varied greatly, from €18K for a HRB KEDS award, to €1 million for a Medical Research Council NPRI Award.

The PhD Scholars Programme was similar to Fellowship Awards in that the total number of awards secured (10), which accounted for 4 % of the total value of the leveraged awards, represented a return on investment of €194K per €1 million spend. The average value of awards secured by students on the PhD Scholars programme was €168K. Given that the focus of scholarship and Fellowship Awards is to train researchers and build capacity, it is not unexpected that these scheme types would report low figures for this metric.

Holders of MRCG Co-fund awards reported securing 16 additional awards, valued at 6 % of the total value of leveraged awards. This represented a good return on investment of over €1.4 million for every €1 million spend on this scheme type, and was equivalent to both Project Grants and Programme Awards.

Figure 31: Leveraged awards broken down by scheme type and per €1 million spend



Value (€) of leveraged awards secured per €1 million spend	
Fellowship Awards	116,891
MRCG Co-fund	1,431,966
PhD Scholars Programme	193,894
Programme Grant	1,587,666
Project Grant	1,384,038

Table 23: Examples of leveraged awards

Grant	Details of additional grants leveraged
Marie Curie Post-doc Fellowship	1. Oxford Martin School, University of Oxford, €57k:Developing an open access web-based application modelling disease burden 2. Medical Research Council NPRI, £853k: Using wearable cameras to develop intervention with respect to food labelling 3. 2012-16 EU FP7 IRSES, £55k: Work package leader on using wearable sensors to measure behaviours with Australia/New Zealand partners 4. Enterprise Ireland Commercialisation Fund, £187k: Developing mobile phone sensing software to measure human behaviour 5. Enterprise Ireland Innovation Voucher, £4k: Project with local business to test efficacy of computer generated memory prompts
MRCG Co-fund Award	1. EU FP7, €323k: Epilepsy Pharmacogenomics: delivering biomarkers for clinical use 2. EU FP7, €151k:MicroRNAs in the pathogenesis, treatment and prevention of epilepsy
PhD Scholars Programme	1. Fondation Thierry Latran, €98k:Biomedical research project funding, 2. ALS Association of America Milton, €100k: Safenowitz Postdoctoral Fellowship, 3. IRCSET, €72k: Investigation of 5-lipoxygenase inhibitors in obesity-driven oesophageal adenocarcinoma 4. HRB, €400k: Oesophageal cancer towards new therapies 5. HRB, €326k: Defining the Role of Human Dendritic Cell Subsets in Host Immune Responses to Mycobacterial infection. 6. National Children's Research Centre, €169: Clinical PhD Funding Stream 7. Molecular Medicine Ireland, €90k: Translational approaches to enhance Human T lymphocytes targeting of non-small-cell lung cancer 8. IRCSET, €72k: The role of natural killer T cells in the control of immune regulation, antigen presentation and antibody production by human B lymphocytes 9. EU FP7, €200: Lead Optimisation of Novel Androgen Receptor Small Molecule Modulators - Improving Treatment of Prostate Cancer 10. National Charity, €148k: Oesophageal cancer metastasis: investigation of the scaffolding protein RACK1 as a key player and therapeutic target
Translational Research Award	1. SFI Short Term Travel Fellowship, €25k: Effect of CLA Diet Supplementation on Circulating Monocyte uptake using Multiphoton Intravital Microscopy Imaging 2. UCD, €75k: CLS Strategic and Innovation Fund 3. EI and IDA, €275k: Enterprise Ireland and IDA Technology Centers Programme "Food for Health Ireland"(total value €12 million)
Health Research Award	1. SFI Research Frontiers, €285: Characterising the neural basis of social cognition deficits in schizophrenia using imaging genetics 2. Other International, €68k: Genetic Determinants of Schizophrenia Intermediate Phenotypes 3. IRCSET, €112k: Making connections: Characterising the contribution of structural connectivity to deficits in social cognition in schizophrenia.

6.2 Commercialisation and enterprise activity

An increasingly important indicator of the impact of publicly-funded research in Ireland is the proportion of research grants that are producing commercialisable outputs 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. Grant-holders were also asked if they had established industry collaborations. A summary of the reported outputs for 2012/2013 and a comparison with outputs for the 2010/2011 and 2008/2009 reporting periods is presented in Table 24.

Table 24: Number of commercial outputs by type

Output Type	2012/2013 No.	2010/2011 No.	2008/2009 No.
Filed invention disclosure or in discussions with TTO	20	9	9
Patents filed (includes pending or lapsed status)	16	11	12
Licenced technologies	5	3	3
Start-ups established or in train	2	2	2
Academic-industry collaborations established	88	25	10
Commercialisation grants secured from EI	5	4	6
Total	**136**	**54**	**42**

From this it can be seen that HRB researchers whose awards completed in 2012/2013 were very active in the enterprise arena, with a total of 136 outputs reported. For almost all metrics there has been an increase in numbers, sometimes dramatic, reported in the 2008/2009 and 2010/2011 reporting periods.

For grants that completed in 2012/2013, 32 HRB grant holders (23 % of total) reported that they had discussed the commercial potential of their work with a university Technology Transfer Office or potential industry partner. Of these, 20 ideas were the subject of Invention Disclosure filings and 16 patents have either been filed or are pending. Two PIs reported an output in terms of start-up companies. One company, Aquila Bioscience (AquilaBio) is a new start-up life science company developing glycomic solutions to improve human health and veterinary medicine. It has secured a significant industry contribution and has two staff currently, with a further three new employees to be recruited in the near future. The second PI is currently seeking funding to establish a molecular and cellular diagnostic and prognostic company that will also provide advice on lifestyle intervention strategies based on individual's genetics.

In terms of the jurisdiction of filing, of the 16 patent filings reported, six were filed with the EU Patents Office (one was also filed with the UK Patent Office), three with the US Patents Office, two with the UK Patents Office, one patent was filed under the Patent Cooperation Treaty (PCT)[12], the jurisdiction of four patents was not specified and one patent is still pending. In addition to patent protection of intellectual property, one PI (Dr Ladislav Timulak) reported that they have secured copyright and a contract for a book (Transforming Emotional Pain in Psychotherapy: An Emotion-Focused Approach) that draws heavily on their HRB project.

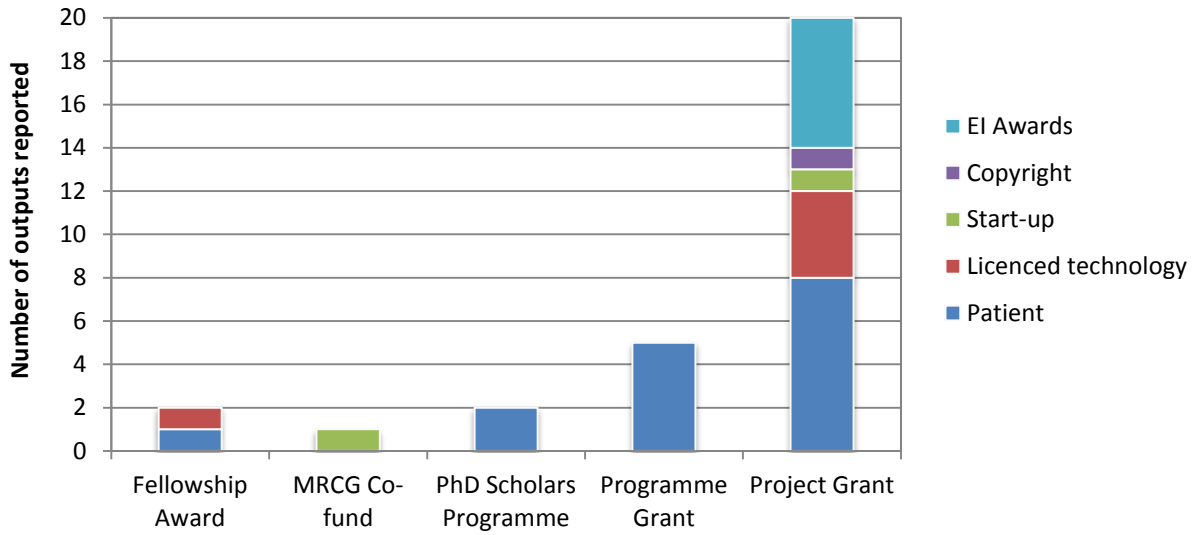
Figure 32 shows the distribution of commercialisation outputs (start-ups, licenced technologies, patents, Enterprise Ireland commercialisation awards and copyright), reported for grants that completed in 2012/2013,

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

broken down by scheme type. From this it is clear that the greatest number of commercialisation outputs of all types arose from Project Grants (N=20), representing 1.2 outputs in this category per €1 million spend. Two Translational Research Awards between them produced five patents, resulting in an overall productivity of 0.7 outputs per €1 million spend for Programme Grants.

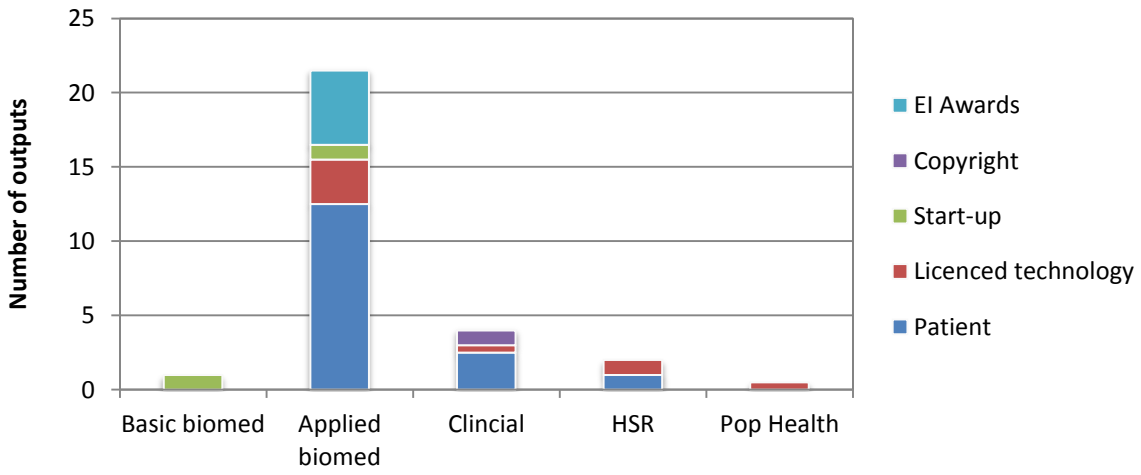
The PhD Scholars Programme and Fellowship Awards each produced two commercialisation outputs, and had an overall productivity of 0.2 outputs per €1 million spend. The MRCG Co-fund scheme reported a single commercialisation output, with a resultant 0.6 outputs per €1 million spend.

Figure 32: Distribution of commercialisation outputs by scheme type



The distribution of broad research areas in which grants with commercialisation outputs were categorised is show in Figure 33. From this it is clear that grants that are focused on applied biomedical research are the most likely to produce commercialisation outputs of all type (with the exception of copyright.) This broad research area accounted for almost 90 % of all commercialisation outputs, and was the only area that reached 1.0 output per €1 million spend.

Figure 33: Distribution of commercialisation outputs by broad research area



Clinical research accounted for almost 17 % of commercialisation outputs and a productivity of 0.4 outputs per €1 million spend. Basic biomedical, population health and health services research each had 1-2 outputs in total and had productively rates of between 0.3 and 0.6 outputs per €1 million spend.

It is not clear why grants that completed in 2012/2013 showed such a significant increase in the number of collaborations being forged with industry partners. The purpose of these collaborations was: to share, data, expertise or research findings; to conduct joint research; to provide either the academic or industry research team with access to infrastructure, materials, cohorts or datasets; or as a means of establishing networks. Figure 34 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. Note that when collecting evaluation data in 2012, it was not mandatory for PIs to cite a reason for their collaboration so a proportion of grants are categorised as 'unspecified'.

Figure 34: Cited reasons for establishing new industry collaborations (national or international)

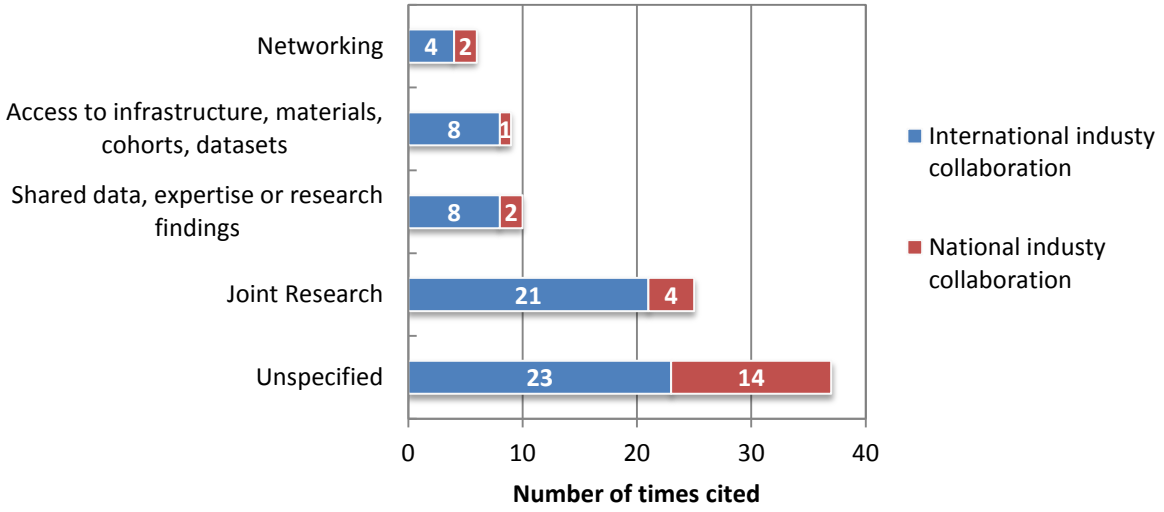


Table 25 provides examples of the type of enterprise outputs reported by researchers whose grants completed in 2012/2013.

Table 25: Examples of commercial activities

Grant/PI	Activity type	Details of activity
MRCG Co-fund Award	Start-up company	Aquila Bioscience (AquilaBio) is a new start-up life science company from NUI Galway. Through its innovative and unique combination of technologies AquilaBio is committed to developing glycomic solutions to improve human health and veterinary medicine (http://www.aquilabioscience.com/)
Translational Research Award	Patent Filed	1. Prehn JHM, Rehm M, Huber HJ, A Computer-Implemented System and Method for the Prediction of Cancer Response to Genotoxic Chemotherapy and Personalised Neoadjuvant Treatments (PCCP), EP 11172277.3., US 61/503,302 2. Prof Ken McDonald (RP/2007/313) – Patent filed: "Biomarkers of cardiovascular disease including LRG." WO2011092219 Filing date 26.01.2011

Grant/PI	Activity type	Details of activity
		3. Prehn JHM, Lindner AU, Huber HJ, DR_MOMP: Dose-Response Medicinal Outcome Model Predictor and Method, EP12166187.0 4. Prehn JHM, Concannon CG, Title: Treatment and Prognosis of Solid Tumour Cancers. Official US Provisional Patent Application Number: US 61/469,978
Health Research Award	Licenced technology	Exosomal microRNAs as early ribobiomarkers of diabetic kidney damage.
Translational Research Award	Invention Disclosures / Discussions with TTO	Invention Disclosure Form Submitted to TTO, NOVA UCD, January 2014 relating to CLA induced monocyte population shifts.
Health Research Award	Commercialisation grant	Enterprise Ireland Proof of Concept Award: Development of a Micro Molecular Index Card of Cardiovascular Health: Next Generation Prognostic and Diagnostic BioChip (€97k).

Section 7: Conclusion

The analysis displayed in this report demonstrates a wide variety of outputs produced by HRB-funded research in terms of scientific output, capacity-building, health sector and economic benefits. When compared to the 2008/2009 and 2010/2011 analysis, the data shows that HRB-funded research completing in 2012/2013 led to more policy and clinical/public health practice outcomes, produced slightly less publications per grant and produced an increased number of commercialisation outputs and opportunities in the form of patents, licenses and industry collaborations.

A number of observations can be made from the data presented in this report:

- Grants in the biomedical and clinical sciences produced the most scientific publications and commercial opportunities such as patents and industrial collaborations;
- Grants in health services research, population health sciences and clinical research produced the most health policy and practice outcomes, healthcare innovations and provided the most research training opportunities for health professionals;
- The MRCG Co-fund scheme was the most productive in terms of number of outputs per €1 million spend across a range of metrics.

The number and level of healthcare innovations (N=43) and the increased proportion of grants that led to policy and practice outputs (almost 40 % of all grants, compared to 24 % and 20 % of all grant in the 2010/2011 and 2008/2009 reporting periods, respectively) and the development of intellectual property is impressive. These statistics stand up very well when compared to data on similar outputs captured by UK funders, such as the MRC and Wellcome Trust, collected as part of the HRB Analysis of its portfolio from 2000-2009. Therefore, in terms of delivering on a key HRB objective of improving people's health and health care provision, HRB funded research appears to be producing the type of outputs that have the potential to have real impact in this area.

The implication of a shift away from basic biomedical and applied biomedical research that is not specifically patient-oriented, towards greater investment in patient oriented research, population health sciences and health services research, is that over the coming years we may see a slight decrease in scientific 'productivity' (e.g. number of peer-reviewed publications per €1 million spend) and commercial impact (e.g. patents, industry collaborations), since these outputs tend to arise predominantly from the former types of research activity. However, there is no reason to believe that a decrease will occur in indicators of scientific quality (e.g. field-normalised citation impact).

The new HRB funding initiatives in Clinical Research, Population Health Sciences and Health services research, based on the multi-disciplinary collaborative funding model, along with the emphasis placed by international peer review panels on methodological rigour, ensures that only high-quality research is funded with the potential for both scientific and health impact. Therefore, possible decreases in productivity metrics will be more than offset by a concomitant increase in health sector outcomes such as development of healthcare innovations (e.g. interventions, therapies) and influences on policy and practice (e.g. clinical guidelines, policy briefs, advisory roles) which tend to be associated with these broad research areas.

Appendix 1: Impact Assessment ("Payback") Framework

Based on the Payback Framework of 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 targeting	○ 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 system ○ Research personnel attracted from overseas ○ Spin-off projects developed and further research funding leveraged ○ 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 ○ Level of all-Ireland collaboration and benefits accruing from this ○ 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 ○ Commissioned reports or projects from government departments or agencies ○ 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 ○ Patents and other IP applications and award of commercialisation support grants 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
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) ○ Success of HRB-funded personnel in attaining additional research funding, for example though the EU's Framework Programmes ○ Success of HRB-funded researchers in commercialising the outcomes of their research (through invention disclosures, patents, licences, formation of start-up and spin-out companies) ○ 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 outputs from 2012/2013 End-of-Grant reports by scheme

Impact Category / Key Indicator (No.)	Project Grants (70 grants)	Fellowship Awards (47 grants)	Programme Grants/CSA (6 grants)	MRCG Co-funded (9 grants)	PhD Scholars Programme (2 grants)
Scientific outputs					
No. peer-reviewed publications (N=584)	209	134	71	36	134
Mean no. peer-reviewed publications per grant	3	2.9	11.8	4	67
No. publications per €1 million spend	12.5	13.4	10.2	20.8	15.5
Average cost per paper	€80,031	€79,595	€97,584	€48,018	€64,463
Research capacity outputs					
Mean no. personnel per grant (total=422)	2.9	1	15.3	3.1	27
No. PhD degrees (total=131)	31	21	22	7	50
No. health professionals trained (total=136)	86	30	19	1	-
No. research collaborations established (N=278)	128	67	24	19	40
No. collaborations established per €1 million spend	7.7	6.7	3.5	11.0	8.9
Policy and practice outputs					
No. policy/practice outputs (total=127)	74	26	15	12	-
No. policy and practice outputs per €1m spend	4.4	2.6	2.2	6.9	-
No. of patient/public engagement outputs (total=188)	87	66	12	15	8
No. patient/public engagement outputs per €1 million spend	5.4	6.6	1.9	8.7	1.8
Healthcare innovation outputs					
No. health innovations developed (total=43)	29	5	5	3	1
No. healthcare innovations per €1 million spend	1.7	0.5	0.7	1.7	0.1
Leveraging and commercialisation outputs					
No. leveraged additional grants (total=149 grants worth €39.5 million)	91	18	14	16	10
Amount of exchequer/non-exchequer funding leveraged	€13.6/€9.6 million	€0.9/€0.3 million	€2.5/€8.5 million	€0/€2.5 million	€0.9/€0.8 million
No. patents filed or pending (N=16)	8	1	5	-	2
No. licenced technologies developed (N=5)	4	1	-	-	-
No. start-ups companies established or in train (N=2)	1	-	-	1	-
No. industrial collaborations established (N=88)	38	22	15	12	1
No. commercialisation outputs per €1 million spend	1.2	0.2	0.7	0.6	0.2