UK CLINICAL RESEARCH COLLABORATION

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UK Health Research Analysis 2014

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This publication is available at **http://www.hrcsonline.net/pages/uk-health-research-analysis-2014**

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Health Research Analysis Forum 2015

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EXECUTIVE SUMMARY

Executive Summary

The UK Clinical Research Collaboration (UKCRC) is a partnership of the main stakeholders that influence clinical research across the business, public and charitable sectors in the UK. The aim of the UKCRC is to keep the UK a world leader in clinical research[1]. For partner organisations to be able to effectively co-ordinate activities accurate and timely evidence is needed about health research supported across the UK. The UKCRC Health Research Analysis Forum (HRAF) is a subgroup of twelve large public and charity funders of health research, plus the association of medical research charities (AMRC), responsible for periodically analysing the UK health research landscape.

This report is the third UK-wide analysis of public and charity funded health relevant research produced by the HRAF since 2004, and provides the most detailed view so far of UK research in this area. The Health Research Classification System (HRCS)[2] was used to categorise over 17,000 projects supported by 64 funding organisations, corresponding to £3bn of spend in 2014 (£2bn directly on research projects and £1bn on infrastructure).

Analysis of this dataset shows that public funding for health relevant research in the UK, both by taxation via the Government or by donation via medical research charities, has increased significantly over the ten year period. However, almost all growth in this funding is likely to have occurred in the first five years, with analysis of funding in 2004 and 2009 implying a compound annual growth rate (CAGR) of 8.2%, but little difference in total funding in real terms between 2009 and 2014 (CAGR 1.4%). Health relevant research in the UK has had five years of level funding across the public and charity sectors.

Building on the approach used for the 2009/10 analysis, it is estimated that a total of £8.5bn was spent on health relevant research and development in the UK in 2014, a real terms decrease of £780m from the revised estimate for 2009/10, largely due to a decrease in pharmaceutical company spend in this area. Based on higher education statistics agency (HESA) data it is estimated that more of the available funding is being spent in Universities in 2014 than in 2009, and we suggest that some of this is a result of moving some public sector research establishments (MRC Units) to University ownership.

Examining the breadth of research activities undertaken by projects, and comparing 2004 and 2014 data, there has been a decrease in the *proportion* of total funding for underpinning (-9.7%) and aetiological (-5.2%) research, although a *real terms* increase in funding for these areas across the 12 HRAF members of £195m. These fundamental discovery activities still include more than half of UK public and charity spend on health research (52%) and across all 64 funders participating in the analysis £1bn was spent on these activities.

There has been a noticeable additional investment in research important for translation of discoveries into new treatments with work on detection and diagnosis, treatment development, and treatment evaluation all increasing their proportion of total health research spend when 2004 and 2014 data is compared (total +9.3% across HRAF members, a real terms increase of £332m over ten years). This is strong evidence of the strategic re-prioritisation of activities across funders to accelerate the translation of discoveries from the laboratory to the clinic. Funders have complementary research activity profiles with some focussing on discovery, some translation, and others implementation and health services research.

Spend in previously under-represented areas of primary prevention research and respiratory medicine increased as a proportion of overall spend over ten years. The National Prevention Research Initiative (NPRI), a collaboration between 16 Government and charity funding agencies, plays an important role in the increased spend for prevention research, particularly between 2009/10 and 2014.

The largest growth as a proportion of overall spend has been in the area of infections research (+2.4%), possibly due to the renewed emphasis on addressing the challenge of anti-microbial resistance. Research on mental health also increased as a proportion of overall spend (+1.5%). A lower proportion of overall spend was allocated to Neurological diseases (-2.5%)

and Inflammatory and Immune System disorders (-1.5%). However most health categories[3] received a real terms increase in spending comparing 2004 data with 2014.

Analysis of each funder's research portfolio highlights the complementarity between funders. Many charities have a focus on a particular disease type and therefore contribute significantly to spend in particular health categories. While inclusion of a wider range of organisations made little change to the overall picture of spend, important differences were seen at the detailed level (e.g. the contribution of Diabetes UK to spend in metabolic and endocrine disease, the collective contribution of Alzheimer's Research UK, the Alzheimer's Society and Parkinson's UK to neurological disease research, and Innovate UK to treatment development research). Aggregating spend across the charities, research councils and other Government funding lost most of these interesting differences, although with respect to research activity research council funding made up the majority of the *underpinning* category, charity funding spanned *aetiology, detection and diagnosis,* and *treatment development*, whereas other Government funding made up the majority of *treatment evaluation, disease management*, and *health services* research.

The geographical distribution of health relevant research funding has changed little between 2004 and 2014. Over a third of funding is allocated to London although this proportion has decreased slightly between 2004 and 2014 (-1.4%), Scotland has seen a similar decrease in its proportion of total UK spend (-1.2%), Wales a small increase (+0.8%), and Northern Ireland largely unchanged (-0.4%). Oxford has the largest increase in the proportion of total UK spend (+1.9%) of any location.

The monitoring and strategic co-ordination of health research is important given that it represents a substantial part of the UK science base, and has been shown to provide an exceptional rate of return to the UK economy[4].

At a practical level one of the aims of this work was to compile a robust and openly accessible dataset on UK public and charity funded health research. All the data collected in this exercise will be made openly available (**www.hrcsonline.net**) for further analysis. HRCS coding has been a useful approach for initial analysis of the dataset, and extensive quality control of this categorisation has been undertaken. HRAF plan to continue to promote the HRCS as an international standard for health research classification and encourage international access to research portfolio data.

Ian Viney PhD

Chair UKCRC HRAF
MRC Director of Strategic Evaluation and Impact

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1. UK Clinical Research Collaboration (UKCRC) **http://www.ukcrc.org/**
2. Health Research Classification System (HRCS) is described at **www.hrcsonline.net**
3. Only spending in the category *Ear* (research on deafness and normal ear development and function) was lower in 2014 in real terms compared to 2004, although this is due to changes in a small number of awards.
4. Estimating the returns to UK publicly funded cancer-related research in terms of the net value of improved health outcomes *BMC Medicine* (2014) **http://www.biomedcentral.com/1741-7015/12/99** This study commissioned by Cancer Research UK, the Wellcome Trust, and NIHR explored the social returns to public and charity funded research in cancer. It concluded that the returns were 40 per cent i.e. for every £1 of public and charity R&D spend, society gains 40 pence every year over the long term. This work built on an earlier study which found similar returns from cardiovascular disease research.

INTRODUCTION AND
PURPOSE OF THE ANALYSIS

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Introduction and Purpose of the Analysis

The UK Clinical Research Collaboration (UKCRC) was set up in 2004 with the aim of establishing the UK as a world leader in clinical research[5]. The collaboration is a partnership of the main stakeholders that influence clinical research across the business, public and charitable sectors. Part of the remit for the collaboration was to provide evidence of the funding landscape for UK health research, allowing all partner organisations to develop coherent, unified approaches to funding clinical research in the UK.

To provide funding evidence in a unified format across different health funders required a bespoke classification system. Established in 2004, the Health Research Classification System (HRCS) was developed by the UKCRC's secretariat using a dual code system covering both area of health and disease (termed 'Health Category', (HC)) and type of research (termed 'Research Activity', (RA)) to answer strategic questions about health research investment.

Using the HRCS, the *UK Health Research Analysis report*[6] was the first ever UK wide assessment of public and charity funded health research. Published by the UKCRC in 2006, this first report captured data from the 11 largest public and charitable health funders for the 2004/05 financial year, allowing both an overview of UK wide spending across all areas of health research in addition to detailed assessment of individual areas of health and disease.

The first Health Research Analysis had considerable impact, providing the basis for high level strategy discussions[7] and a number of joint funding initiatives[8]. The HRCS and structure of the report were also used by the Association of Medical Research Charities (AMRC) to assess funding activities of 29 medium to smaller charities, and was published in the UKCRC report *From Donation to Innovation*[9] in 2007.

Subsequent to the initial success of the first report, a second Health Research Analysis was commissioned. The UKCRC report *UK Health Research Analysis 2009/10*[10] was published in 2012 and further developed the analysis by inclusion of an assessment of infrastructure spending and an estimation of total UK Health Research and Development spend. Providing a five year follow up showed an overall funding increase of just over 50% in real terms and showed how strategic funding to boost research in the area of prevention had made a quantifiable impact. Comparison of both datasets also allowed for commentary on specific areas of research, geographic distribution of this funding across the UK and a comparison with the World Health Organisation (WHO) data for UK burden of disease.

Given the informative power of repeated, consistent measuring of health funding a third report was commissioned by the UKCRC in 2014. This latest analysis has a dual purpose. Firstly, the 2014 report is intended to replicate the data collection and analysis of the previous reports to provide a ten year view of UK health research. Secondly, the 2014 report has expanded the analysis to include more health research funding organisations and increase the quality of information available for future reporting.

The resulting report contains data from 64 research funders, providing the most comprehensive analysis of UK health research to date. Quality control procedures applied to the data collected has ensured this data is as accurate as possible, and for the first time the dataset provided alongside this report will contain sufficient information to allow researchers to perform their own sub-analysis from the publicly available data.

This report and analysis has been compiled by the MRC, overseen and approved by the Health Research Analysis Forum (HRAF)[11] on behalf of the UKCRC.

5. UK Clinical Research Collaboration (UKCRC) **http://www.ukcrc.org/**
6. *UK Health Analysis* (data from 2004/05), published 2006 by UKCRC **http://www.ukcrc.org/wp-content/uploads/2014/03/Health-Analysis-Report-FULL-final.pdf**
7. The HRCS was used to highlight the characteristics of UK health research in the UK Government's review of publicly funded healthcare research chaired by Sir David Cooksey and published in 2006 **https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228984/0118404881.pdf**
8. **http://www.ukcrc.org/research-coordination/joint-funding-initiatives/**
9. *From Donation to Innovation* (data from 2004/05), published 2007 by UKCRC **http://www.ukcrc.org/wp-content/uploads/2014/03/From_Donation_to_Innovation_Report_071.pdf**
10. *UK Health Research Analysis 2009/10*, published 2012 by UKCRC **http://www.ukcrc.org/wp-content/uploads/2014/03/2UKHealthResearchAnalysis-1.pdf**
11. UKCRC delegated responsibility for the continued governance of the HRCS and production of subsequent analysis to the HRAF, following disbanding of the UKCRC secretariat in 2007/08. The HRAF consists of representatives from the twelve original funders participating in the 2004/05 and 2009/10 analyses and AMRC.

INTRODUCTION AND PURPOSE OF THE ANALYSIS

SCOPE OF THE ANALYSIS

Scope of the Analysis

Participating Organisations

Health relevant research and development activity in the UK benefits from funding provided by the public[12], charity[13] and private sectors. This report focusses on the detail of public and charity funded UK health research and sets this in the context of an estimate of the total funding available for health research in the UK.

One of the objectives of this third analysis was to widen participation beyond the original twelve Health Research Analysis Forum (HRAF) organisations and to examine how this affected representation of funding across disease areas, research activities, and geographic distribution.

Public funders of UK health research

The government bodies involved in the 2014 analysis includes the Department of Health and devolved administration Health Departments, six research councils and two further publicly funded organisations. These are:

1. Arts and Humanities Research Council (AHRC)*
2. Biotechnology and Biological Sciences Research Council (BBSRC)#
3. Chief Scientist Office, Scottish Government Health and Social Care Directorates, Scotland (CSO) #
4. Department of Health, England (DH) #
5. Division for Social Care and Health Research, Welsh Government (DSCHR)[14] #
6. Engineering and Physical Sciences Research Council (EPSRC) #
7. Economic and Social Research Council (ESRC) #
8. Health and Social Care Research and Development Division (HSC R&D Division), Northern Ireland (HSCNI) #
9. Innovate UK (IUK)*
10. Medical Research Council (MRC) #
11. National Centre for the Replacement, Refinement and Reduction of use of Animals in Research (NC3Rs)*
12. Natural Environment Research Council (NERC)*

*= Funding Organisation is new to the HRCS analysis in 2014 (4 total)
#= Funding Organisation is a member of the HRAF (8 total)

As not all these government bodies have a purely health research portfolio, the submissions for this report constitute only funding with a health relevance. For further details of the selection criteria used by each organisation, please see Appendix 1.

Charity funders of UK health research

Previous Health Research Analysis reports featured the four largest medical charities; Arthritis Research UK, British Heart Foundation (BHF), Cancer Research UK (CRUK) and the Wellcome Trust. These four charities are also members of the HRAF. In addition, the Association of Medical Research Charities (AMRC) commissioned their own HRCS report, *From Donation to Innovation*[15], in 2007 featuring 29 medium to smaller charities[16].

For this report, the four HRAF member charities are included once again. Furthermore, in coordination with AMRC, a total of 48 additional charities have been included in this analysis.

The complete list of charity funders participating in the 2014 analysis are:

- Action Medical Research*
- Action on Hearing Loss
- Alcohol Research UK
- Alzheimer's Research UK*
- Alzheimer's Society*
- Arthritis Research UK*#
- Asthma UK*
- Ataxia UK
- BACP Research Foundation
- Breakthrough Breast Cancer*
- Breast Cancer Campaign*
- British Heart Foundation#
- British Lung Foundation
- Cancer Research UK#
- Chest Heart & Stroke Scotland
- Children with Cancer UK
- CORE
- Diabetes UK*
- Epilepsy Research UK*
- Fight for Sight
- Great Ormond Street Hospital Children's Charity
- Guy's and St Thomas' Charity*
- Juvenile Diabetes Research Foundation
- Kidney Research UK*
- Kids Kidney Research
- Macular Society

- Marie Curie*
- Medical Research Scotland*
- Meningitis Now
- Meningitis Research Foundation
- Motor Neurone Disease Association*
- MQ: Transforming Mental Health
- Multiple Sclerosis Society*
- Northern Ireland Chest, Heart and Stroke
- Orthopaedic Research UK
- Pancreatic Cancer UK
- Parkinson's UK*
- Pharmacy Research UK
- Prostate Cancer UK
- Royal Hospital for Neuro-disability
- Sarcoma UK
- Sparks*
- Stroke Association*
- Tenovus Cancer Care*
- The Brain Tumour Charity
- The British Pain Society
- The Dunhill Medical Trust
- The Lullaby Trust
- Wellcome Trust#
- World Cancer Research Fund
- Worldwide Cancer Research*
- Yorkshire Cancer Research*

* = Charity was part of *From Donation to Innovation* (2007) analysis (21 total).
# = Charity is a member of the HRAF (4 total).

Collectively these 52 charities represent 40 per cent of AMRC total membership (137 total) but 94.9 per cent of the AMRC members' total UK expenditure in 2014 (£1.286bn vs. £1.279bn)[17].

SCOPE OF THE ANALYSIS

Data Criteria

Data included in the analysis

There are a number of elements of funding that are essential to support research activity. We have made a distinction between grants focussed on directly supporting specific research programmes and projects and funding that support more 'indirect' aspects such as infrastructure (which may include administration, building maintenance or support for national facilities). While it is recognised that what we refer to in this reports as 'direct' awards also include elements of 'indirect' costs, in the main it is not possible to attribute infrastructure funding to particular health areas in a meaningful way.

This analysis therefore focuses on the directly funded peer reviewed UK research of the participating funders, but our assessment of overall UK investment in health-relevant research also includes data gathered on indirect supportive/infrastructure funding. The criteria for expenditure data to be included in this report match those of previous analyses:

- Research is funded by a participating organisation
- Research must take place within the UK
- Research is of a health or biomedical relevance
- The award must be active in the calendar year 2014[18]
- Research where funding can be directly attributed to a set of clearly defined research objectives and therefore can be classified by type of research activity and area of health or disease i.e. directly funded research, training awards and projects, plus clearly defined programme and unit awards (direct awards only).

Data excluded from the analysis

While participation and increased coverage of supporting costs has provided a wider analysis than previous reports, there are still areas of UK health research not covered by this analysis:

- Industry funded research
- Research funded by the remaining not-for-profit organisations that are members of AMRC
- Research funded by not-for-profit organisations that are not members of AMRC

- Health relevant research supported by other Government Departments
- Research taking place in the UK funded by non-UK organisations
- Higher education funding councils funding to Universities
- NHS support for clinical academics
- Research funded by participating organisations taking place outside of the UK[19]

As part of the remit for this report was to estimate the UK total health related research expenditure, estimates for some of these additional funding sources are discussed in more detail in Appendices 3 and 4.

Changes in the data collection and analysis: 2009/10 to 2014

In general, the data collection methods for both previous HRCS analyses have been used in this latest report, to ensure as much consistency in reporting as possible. Critically the core inclusion/exclusion criteria and HRCS coding system remain unchanged. However there are three areas in which this report differs from the previous analyses.

Individual funder data collection

Each participating organisation has provided a summary of their data collection procedures. For those organisations in previous HRCS analyses, the process by which awards are selected and coded remains largely the same as previous reports, but with some exceptions that may influence the comparisons with previous reports. All such information can be found in Appendix 1. Details of the standard methodology can be found on page 25, with further information in Appendix 10.

Increased participating organisations

The number of participating organisations (and consequently the number of awards analysed) has increased significantly. To allow comparison between this and preceding analyses, the results from those funders who participated in the 2004/05 and 2009/10 analyses (i.e. the 12 HRAF funders) are shown separately to the combined 'All Funders' data. Any differences between these two 2014 datasets ('HRAF' vs. 'All')

are discussed in parallel with changes seen between 04/05, 09/10 and 2014 data.

Definition of infrastructure and supportive funding

The 2009/10 analysis was the first to present some data for infrastructure support alongside the main HRCS analysis. The analysis was undertaken at a time when significant changes in Government policy had taken effect aimed at improving the sustainability of the higher education sector[20]. The aim of capturing information about infrastructure was to document the main streams of funding for this element in the UK.

For this report, we have enhanced this infrastructure assessment by incorporating the collection of both direct and indirect awards in a single submission. Funders were also asked to sub-classify individual 'Indirect' awards according to broadly defined criteria as one of the following types of support/infrastructure funding:

Infrastructure Supportive Funding
- Capital Infrastructure – building construction, maintenance and core costs
- R&D Support for NHS Providers – principally Clinical Research Networks
- Administrative Support – including library funding and publication costs

Personal Supportive Funding
- Individual salary support
- Costs relating to attending meetings
- Membership of professional bodies

Studentship Supportive Funding
- Studentships, scholarships and other training where no research objectives are available and therefore are not eligible for core HRCS analysis

This has allowed us to look in more detail at the type of indirect funding reported by each funder in 2014. However it should be noted that as a result of changing the criteria for indirect awards the expenditure reported in the 09/10 and 2014 analyses is not directly comparable. In particular support for Clinical Research Networks (CRNs) was not consistently classified as infrastructure in the 09/10 analysis, but has been exclusively assigned to the indirect assessment in this analysis.

Combined Spend Analysis

The combined database from all participating organisations (64 funders) contains 17,021 awards with a combined spend of £3.01bn in 2014. The majority of this spending is from awards that directly fund research (14,934 awards) with a total of £2.03bn. The total for spend across indirect awards (2087 awards) was £984.2m.

To directly compare between 2014 data and the previous analyses, assessment of direct award data from HRAF organisations alone (12 funders) shows a total of £1.90bn. This compares to £1.19bn in 2004/05[21] and £1.77bn in 2009/10[22], showing that the amount of funding submitted for this analysis has increased by more than half (59.7%) in ten years but has increased only slightly (7.3%) in the last five years. The Compound Annual Growth Rate (CAGR) is 4.8 per cent over ten years, with 8.2 per cent from 2004/05 to 2009/10 but only 1.4 per cent since 2009/10. Although funding for health research has increased significantly over the whole ten year reporting period, our results show the majority of this increase was in the first five year period and the rate of growth has slowed considerably in the second five years. We suggest that these results largely reflect real changes in public and charitable health relevant spend due to the global economic downturn. However it should be noted that changes in funder coding approaches and methods for reporting indirect funding will also influence these results.

Report	# of Funders	# Direct Awards	% vs. 04/05	% vs. 09/10	Spend £bn (real terms)[23]	% vs. 04/05	% vs. 09/10	Indirect £m (real terms)	Total £bn (real terms)
2004/05	(12)[24]	9,901	n/a	-13.8	1.19	n/a	-32.6	n/a	n/a
2009/10	12	11,482	+16.0	n/a	1.77	+48.4	n/a	895	2.67
2014 (HRAF)	12	12,696	+28.2	+10.6	1.90	+58.8	+7.0	952	2.85
2014 (All)	64	14,934	+50.8	+30.1	2.03	+69.6	+14.3	984	3.01

Table 1 – *Number and value of direct research awards and indirect spend for 2004/05, 2009/10 and 2014 analyses*
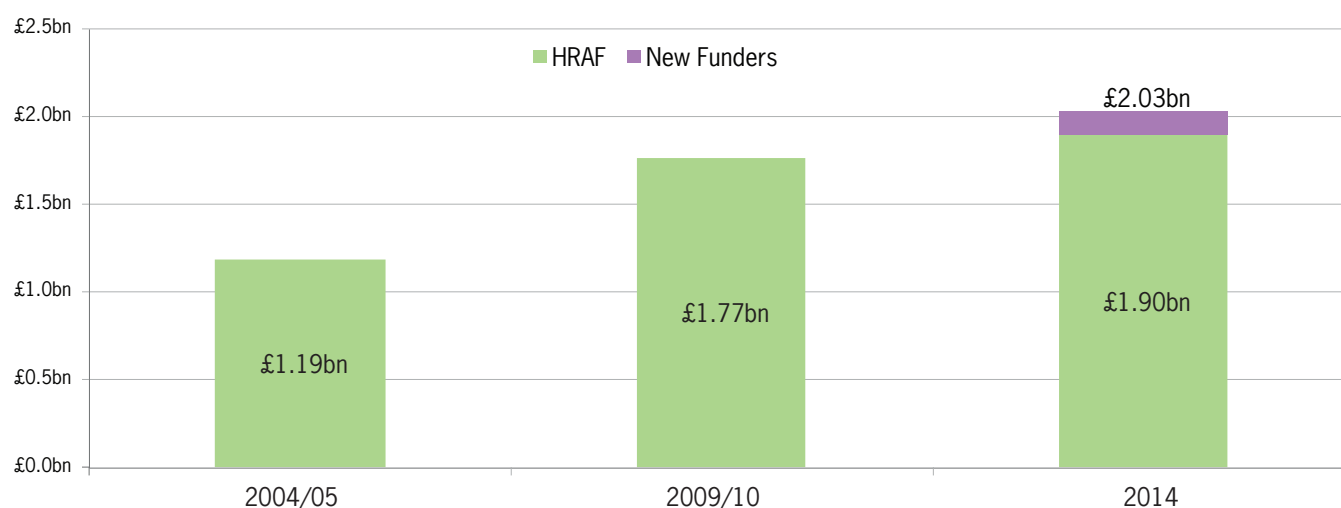
Figure 1 – *Direct spend totals for health research analyses in 2004/05, 2009/10 and 2014. HRAF data (12 funders) and New Funder data (52 funders) are shown together.*

Infrastructure and Supportive Funding Assessment

In total £984m of health relevant funding was reported as indirect funding. The majority of this funding is classified as Infrastructure (£885m, 89.9% of Indirect Award Total), and includes large capital support funds such as MRC's support for the Crick Institute, CRUK's support for their cancer research institutes and Wellcome Trust's support for the Sanger Institute, as well as the Clinical Research Networks. The remaining 10.1% of indirect funding is divided between £79m in funder specific or unclassified awards, un-coded studentships (£18m) and personal awards supporting individual researchers (£1.8m).

The 2009/10 Health Research Analysis was the first to introduce an assessment of indirect funding, with a total of £827m (£895m in real terms). In 2014 indirect funding from the HRAF funders totals £952m. This is an increase of £57m (6.4%) in real terms. However the guidance and criteria for reporting infrastructure and other supportive funding has changed since 2009/10, therefore the figures are not truly comparable. Additionally, the 2009/10 total included £125m (£135m in real terms) from the Charities Research Support Fund (CRSF), and also provided an assessment of additional funding sources beyond the participating organisations and therefore outside of the scope of the main analysis. An assessment of the same sources of funding for 2014 is available in Appendix 3 and includes the CRSF, further devolved government support for health research and NHS support

for clinical academics. These sources of funding, outside of the funding collected in our analysis, are estimated to add a further £1bn to the support for health research in the UK.

New funders to the health research analysis

Inclusion of the 52 funding organisations who did not participate in the 2009/10 analysis adds 2,238 awards and £128m to the total research spend in 2014. A total of 20 of the 48 AMRC medium to smaller charities also participated in the *From Donation to Innovation* report and thus have 2004/05 data available (see Appendix 2). A comparison of the direct awards from these 20 organisations shows a small increase of £5.1m in real terms funding (2004/05 = £42.0m, 2014 = £47.1m). However the *From Donation to Innovation* report did not assess indirect funding. These 20 charities also provide details of 201 awards valued at £13.2m in supportive funding for this 2014 analysis, constituting 21 per cent of their combined total spend of £60.3m. Therefore assessment of direct awards alone may not be a suitable comparison, as this analysis shows that medium to smaller charities make an important contribution to support research as well as directly fund projects.

A full breakdown of all funding organisations (64 total) by award numbers and award value can be found in Appendix 2.

Estimation of total health-related research performed by UK institutions

To set the current analysis in context, work was undertaken to estimate the total health related research and development expenditure by UK public, charitable and private sector institutions for 2014. This is the second estimation of total UK health relevant research spend, and the principles of this process were established in the previous HRCS analysis report. As with the analysis in 2009/10, the approach was "top down" in nature; using information on total research and development activity across the research performing sectors. This estimation is modelled on the Gross Expenditure in Research and Development (GERD) for 2013, full details of which can be found in Appendix 4.

The totals for research performed in the business, private not-for-profit (PNP), university and public research institute sectors for 2014 are displayed in Figure 2 and Table 2 below. The combined total expenditure estimated for these four research sectors is £8.50bn, which to set this in context is approximately 29 per cent of the GERD in 2013.

The detailed spend data included in this analysis from the 64 participatory organisations totalled £3.01bn, and a further £1bn was estimated as available from other sources (funders not participating in the analysis, the CRSF, further devolved government support for health research and NHS support for clinical academics). Taking our "top down" estimate of UK health relevant research spend of £8.5bn

we had therefore accounted in detail for 47 per cent of the total UK health research. The business sector accounts for £4.1bn (48%) of UK health spend, and is outside of the scope of this analysis. Of the remaining £4.4bn, our detailed analysis accounts for 91 per cent of all public and charitable health relevant research in the UK, with only £400m of public and charitable funding unaccounted for. While this analysis incorporates many different funders and data sources, there are still other Government departments that are not included (e.g. funding for large facilities within the Science and Technology Facilities Council). Similarly this analysis specifically excludes overseas funding, which constitutes a considerable proportion of GERD total.

The 2014 estimation of £8.5bn is £780m lower than the revised estimate from 2009/10 of £9.28bn (after adjustment for 2014 prices). The largest decrease was in business (pharmaceutical) expenditure (£700m in real terms). These estimates show a smaller decrease in Public Sector Research Institutes (PSRI) spend (£300m in real terms) but this appears to be off-set somewhat by a small increase to the University Sector by a similar figure (~£200m). Some of the offset between PSRI and the University sector may be accounted for by the transfer of MRC Units (previously classified as Public Research Institutes) to University ownership. Research spending in Private Non-Profit (PNP) institutes remains relative stable at ~£390m (approximate £10m increase in real terms).

- Business – £4.1bn (48%)
- University – £2.71bn (32%)
- Public Sector Research Institutes – £1.3bn (15%)
- Private Non-Profit– £0.39bn (5%)
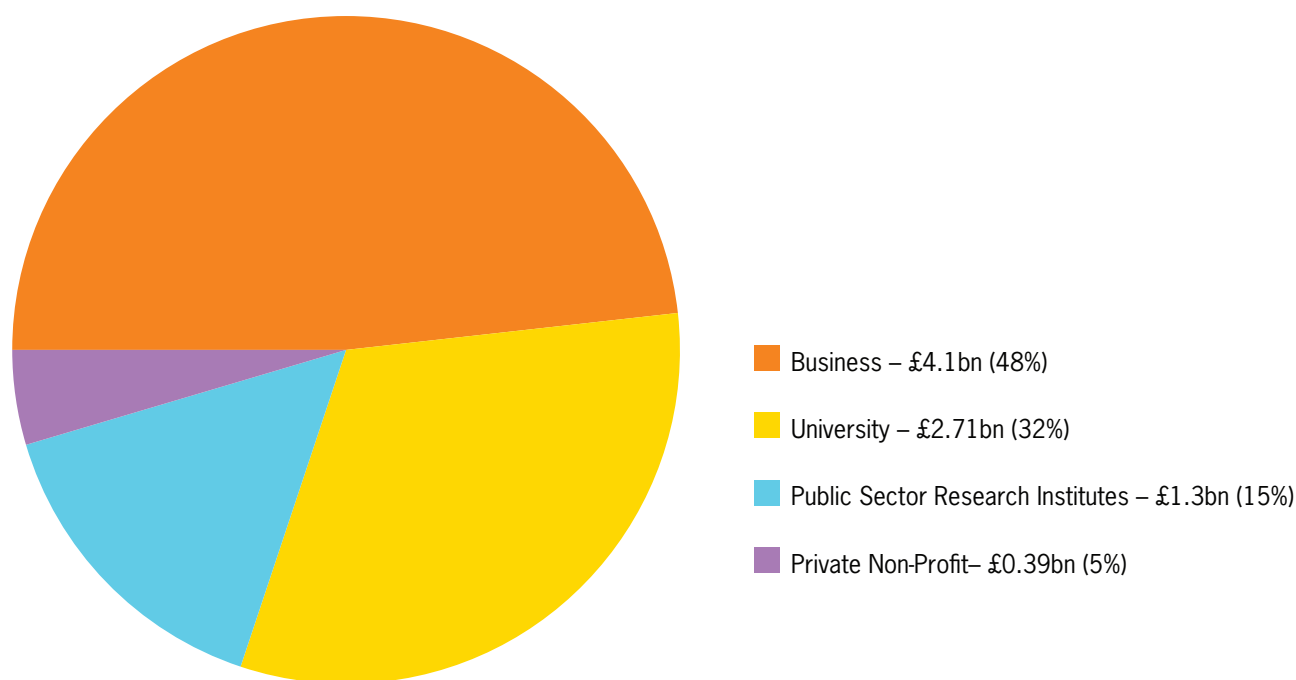
Figure 2 – Distribution of total UK health research expenditure for 2014 within each research sector.

Performing Sector	2009/10 Revised Estimate		2014 Estimate		Difference	
	Spend (£bn) (real terms)	% of total	Spend (£bn)	% of total	Spend (£bn)	%
Business	4.8	51.7	4.1	48.2	-0.7	-3.5
University	2.5	26.9	2.71	31.9	0.21	4.9
Public Sector Research Institutes	1.6	17.2	1.3	15.3	-0.3	-1.9
Private Non Profit	0.38	4.1	0.39	4.6	0.01	0.5
TOTAL	**£9.28bn**	**100.0%**	**£8.5bn**	**100.0%**	**-£.78bn**	

Table 2 – Estimations of Total UK Health-relevant R&D Expenditure for 2009/10 and 2014

12. In this report "Public" refers to mainly UK Government funding provided via UK Government departments (e.g. Department of Health) and non-departmental public bodies (such as the research councils).
13. In this report "Charity" refers mainly to funding provided by organisations that are members of the Association of Medical Research Charities, although there are other UK non-profit private organisations supporting health relevant research.
14. Formerly known as the National Institute for Social Care and Health Research (NISCHR)
15. **http://www.ukcrc.org/wp-content/uploads/2014/03/From_Donation_to_Innovation_Report_071.pdf**
16. Note that several organisations have rebranded since 2007. 'Marie Curie Cancer Care' is now 'Marie Curie', 'Tenovus' is now 'Tenovus Cancer Care' and 'Association for International Cancer Research' is now 'Worldwide Cancer Research Fund'. In addition, 'Breakthrough Breast Cancer' and 'Breast Cancer Campaign' announced their merger in 2014 to become 'Breast Cancer Now'.
17. Data from AMRC research expenditure database 2014, in press at time of publication.
18. The analysis is designed to provide a snapshot of research that was 'live' (i.e. funded research was taking place) at any point on or between the 1st of January and 31st of December 2014. In the previous two analyses participating funders contributed data for financial years 2004/05 and 2009/10. While the data included a whole year of activity participating organisations start and end their financial years at different points, so for the 2014 analysis it was agreed to standardise on a calendar year so that all awards were active in exactly the same time period.
19. In the last report this data was collected and presented in an Annex, although no further analysis was undertaken. In this collection exercise non-UK administered projects and programmes were excluded from the collection.
20. In 2005 the UK Research Councils changed their basis of funding research projects to adopt a 'full economic costing' (fEC) approach. UK Government Departments also committed to move projects to a fully costed basis. **http://www.hefce.ac.uk/funding/finsustain/trac/history/**
21. GDP real terms adjustment is 1.2377 vs. 2014 values (100%). Original value in 2004/05 report = £965m.
22. GDP real terms adjustment is 1.0831 vs. 2014 values (100%). Original value in 2009/10 report = £1.636bn
23. In this report previous analysis figures are expressed in real terms (i.e. 2014 prices) using the UK GDP deflator data as at December 2014. Full details of the calculations can be found in the Methods chapter. **https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-december-2014-quarterly-national-accounts**
24. Only 11 funders feature in the 2004/05 report. Arthritis Research UK joined the HRAF group for the 2009/10 report, and provided retrospective data for the 2004/05 reporting period.

SCOPE OF THE ANALYSIS
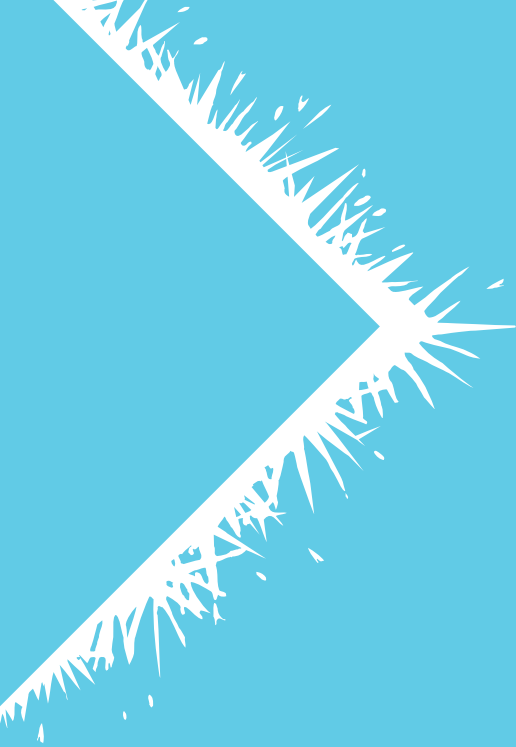
METHODS

Methods

Data Collection, Classification and Quality Control Processing

The data collection for the 2014 analysis from all 64 participating organisations culminated in 17,021 awards submitted. Of these 14,934 awards were considered direct awards, i.e. awards directly contributing towards research, and were fully coded using the HRCS and subject to validation prior to inclusion in the main analysis. A further 1924 awards were classified as indirect awards, i.e. awards supporting research, for use in the separate infrastructure assessment. Finally, a total of 163 awards submitted had sufficient information to show health relevance, but insufficient information to HRCS code or classify as indirect supportive funding.

Data validation for direct awards constituted the following checks:

- The data must match the basic inclusion criteria for the analysis.
- The award had sufficient detail to allow accurate HRCS coding.
- The award had sufficient detail to allow accurate calculation of an annualised value for activity in the 2014 reporting period.
- De-duplication assessment to ensure any matching awards submitted by multiple funders only reported each funder's contribution.

Each funder was responsible for extracting the necessary data for their health relevant research portfolio to be categorised using standardised HRCS coding. Full details of this process are available on the HRCS website (**www.hrcsonline.net**) but to summarise, each award was assigned up to 2 Research Activities (4 for large programmes) according to the type of research performed and up to 5 Health Categories related to the condition of interest. Fully coded data was returned using a standard format and each funder has provided a commentary describing any changes or caveats pertaining to their data submission.

Finally, a total of 33% of awards were subject to coding quality control (QC) procedures. Half of the awards selected underwent QC within individual participating organisations, and the remainder returned to the MRC for formal QC. This consisted of blind independent second pass coding, followed by an un-blind, third 'final decision' coding where both original codes were available.

Further details can be found in the expanded methods section, Appendix 10. This includes:

- Further details on the data analysis methods used.
- Oversight and Ownership of the data.
- Understanding the Health Research Classification System
- Understanding the results of the analysis

We recommend those unfamiliar with the HRCS read this section carefully before reviewing the rest of this report.

DETAILED ANALYSIS:
RESEARCH ACTIVITIES

UK
CLINICAL
RESEARCH
COLLABORATION

igniting our potential

Detailed Analysis: Research Activities

Distribution of funding across Research Activities in 2014

The distribution of the collective research portfolio for all 64 funding organisations across the eight major research activity groups is shown in Figure 3.

Underpinning and Aetiology

Half of all funding is concentrated in *Underpinning* and *Aetiology* (22.7% and 29.3%, respectively). *Underpinning* focuses on understanding normal biological, psychological and socioeconomic processes which forms the basis for subsequent research, whereas *Aetiology* looks at the risks, causes and development of disease. Both *Underpinning* and *Aetiology* are considered together as areas of basic research, although not all is laboratory based; within research activity subgroups include coding options methodology and research design, population surveillance and infrastructure support. For example, most epidemiological studies will be coded under *Aetiology*.

Prevention

Prevention constitutes 5.2 per cent of funding and is focused on primary preventions (i.e. direct interventions to prevent disease) and to promote wellbeing (i.e. indirect interventions to reduce the risks of ill health). Areas of research coded to *Prevention* include vaccines and preventative medicines alongside behavioural and environmental interventions.

Detection and Diagnosis, Treatment Development and Treatment Evaluation

Collectively these three research activity groups cover areas of translational research, building on previous underpinning/ aetiological research to develop new procedures to monitor and treat disease. *Detection and Diagnosis* (10.2%) focuses on biomarker discovery and development, the use of new diagnostic technologies and population screening. *Treatment Development* (13.0%) begins the translation of basic research into experimental medicine in preclinical settings and/or model systems, while *Treatment Evaluation* (9.7%) involves testing and evaluation of interventions in human clinical/ applied settings, such as therapeutic trials.

Disease Management and Health Services

Research in the processes of healthcare will most commonly be coded to one or other of these research activities. *Disease Management* (4.0%) covers research on individual patient needs and practitioner experiences, including research into quality of life, disease self-management and palliative care. *Health Services* (5.8%) examines healthcare at an organisational level, including service provision as well as welfare, economic and policy issues.

- 1 Underpinning – £460m (23%)
- 2 Aetiology – £594m (29%)
- 3 Prevention – £106m (5%)
- 4 Detection and Diagnosis – £207m (10%)
- 5 Treatment Development – £264m (13%)
- 6 Treatment Evaluation – £196m (10%)
- 7 Disease Management – £81m (4%)
- 8 Health Services – £118m (6%)
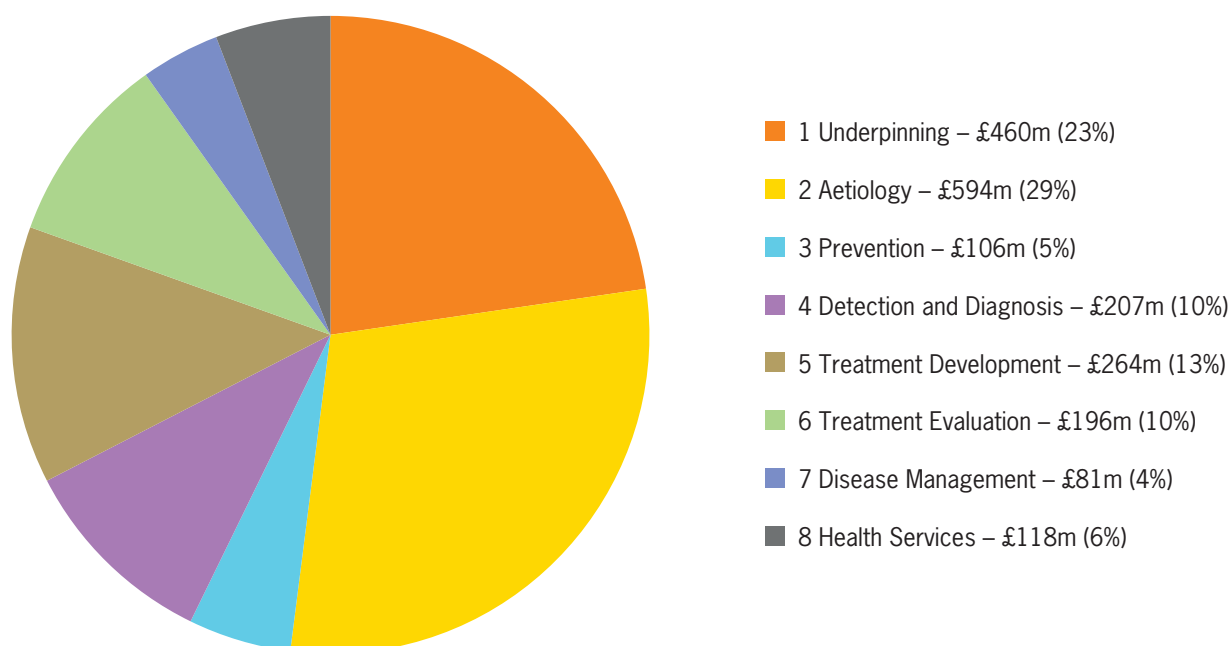
Figure 3 – Proportion of combined spend total by research activity for all 64 funding organisations in 2014

Funding Distribution by Research Activity Group

Previous analyses focused on the twelve largest public and charity funders of health research, who collectively constitute the Health Research Analysis Forum (HRAF). However the 2014 analysis data combines awards from 52 additional funders. Therefore to allow for direct comparison between reports, the following sections of this report will segregate data from the twelve HRAF members to display alongside the combined 'All Funder' data. Data from this comparison is shown in Table 3 and displayed in Figure 4 below.

New Funders to the UK Health Research Analysis

The £129m of research funding from the 52 additional funders produces relatively small shifts (all <2%) in the distribution across research activities compared with the HRAF member only portfolio. These shifts include a decrease in *Underpinning* research (-1.2%) and increase in *Treatment Evaluation* (+0.97%).

The 48 new health charities account for half the additional funding (£73.4m, 57%) whereas the majority of new public funding comes from Innovate UK (£41.9m, 32%); an organisation with a specific remit to fund commercially focused research and development.

DETAILED ANALYSIS: RESEARCH ACTIVITIES

Research Activity Group	2014 (HRAF) (12 funders)		2014 (All) (64 funders)		Difference (%)
	Award Value (£m)	%	Award Value (£m)	%	
1 Underpinning	453	23.9	460	22.7	-1.22
2 Aetiology	558	29.4	594	29.3	-0.12
3 Prevention	102	5.4	106	5.2	-0.14
4 Detection and Diagnosis	189	10.0	207	10.2	0.24
5 Treatment Development	229	12.1	264	13.0	0.97
6 Treatment Evaluation	179	9.4	196	9.7	0.25
7 Disease Management	71	3.8	81	4.0	0.23
8 Health Services	115	6.1	118	5.8	-0.22
Grand Total	**£1.90bn**	**100%**	**£2.03bn**	**100%**	**-**

Table 3 – *Differences in research activity spend 2014 by HRAF funders (12 total) and All Funders (64 total).*
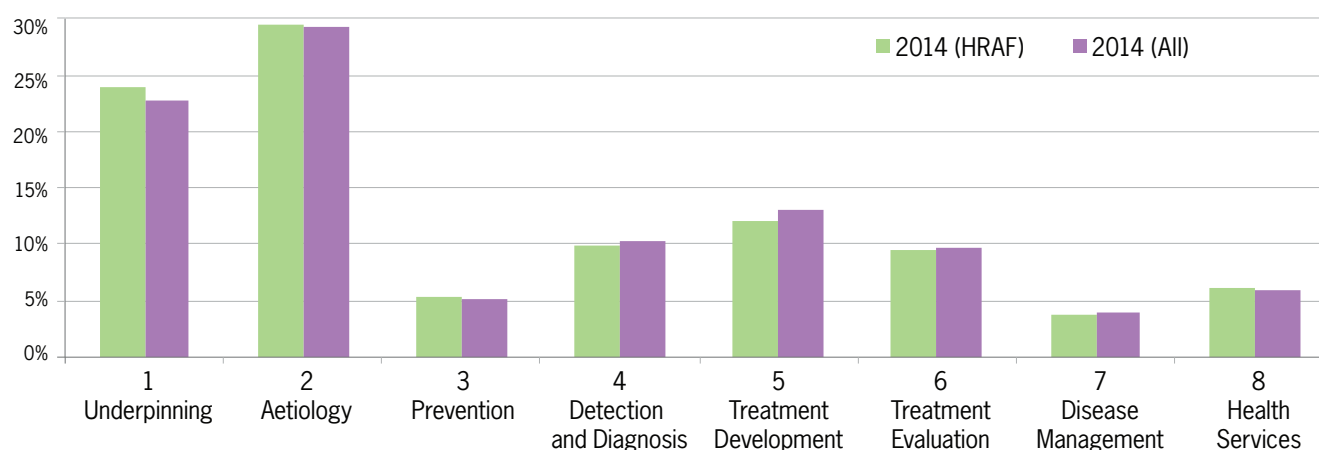
Figure 4 – *Proportion of combined health research spend 2014 by research activity for HRAF funders (12 total) and All Funders (64 total).*

Changes in Research Activities 2004/05 – 2014

Comparing the distribution of research activity funding of the 12 HRAF funders to previous Health Research Analyses there has been a noticeable shift from basic to translational research. The proportion of *Underpinning* research has fallen by 9.7 per cent in ten years, although the increase in total funding over this time means the amount spent on underpinning research has still increased slightly (from £402m to £453m). The proportion of *Aetiology* research has also reduced by 5.2 per cent in ten years, although real terms funding for this activity increased by £144m. So despite a reduction in proportions of funding, spending in these research activities is still higher in 2014 than 2004/05. However between 2009/10 and 2014 spend on *Underpinning*

and *Aetiology* research reduced slightly in real terms (by £35m and £4.7m respectively).

Research Activity Groups 3 to 8 have all increased as a proportion of total spend, although the main increases are observed in 3 *Prevention*, 4 *Detection and Diagnosis* and 5 *Treatment Development* (+2.9%, +4.7% and +3.5% over ten years, respectively). This confirms the trend seen in the 2009/10, where the largest additional spending was in translational research activities. *Disease Management* and *Health Services* have both seen small increases in the proportion of funding since 2004/05 (both +1.4%). While *Health Services* research has decreased slightly since 2009/10 (-1.1%, -£11m), this may relate to changes in infrastructure reporting, principally Clinical Research Networks.

Research Activity Group	2004/05		2009/10		2014 (HRAF)		Difference (£m)		Difference (%)	
	Value (£m)	%	Value (£m)	%	Value (£m)	%	vs. 04/05	vs. 09/10	vs. 04/05	vs. 09/10
1 Underpinning	401.7	33.6	488.7	27.6	453.5	23.9	51.8	-35.2	-9.7	-3.7
2 Aetiology	414.4	34.7	563.1	31.8	558.4	29.4	144.0	-4.7	-5.2	-2.3
3 Prevention	29.6	2.5	66.4	3.7	101.5	5.4	71.9	35.2	2.9	1.6
4 Detection and Diagnosis	62.9	5.3	129.9	7.3	189.0	10.0	126.1	59.1	4.7	2.6
5 Treatment Development	102.9	8.6	189.3	10.7	228.8	12.1	126.0	39.6	3.5	1.4
6 Treatment Evaluation	99.0	8.3	151.5	8.5	179.0	9.4	79.9	27.5	1.1	0.9
7 Disease Management	27.7	2.3	57.3	3.2	71.4	3.8	43.7	14.1	1.4	0.5
8 Health Services	56.2	4.7	126.1	7.1	114.9	6.1	58.7	-11.2	1.4	-1.1
Grand Total	£1.19bn	100%	£1.77bn	100%	£1.90bn	100%	702.1	124.2	-	-

Table 4 – Differences in research activity spend for HRAF funders in 2004/05, 2009/10 and 2014
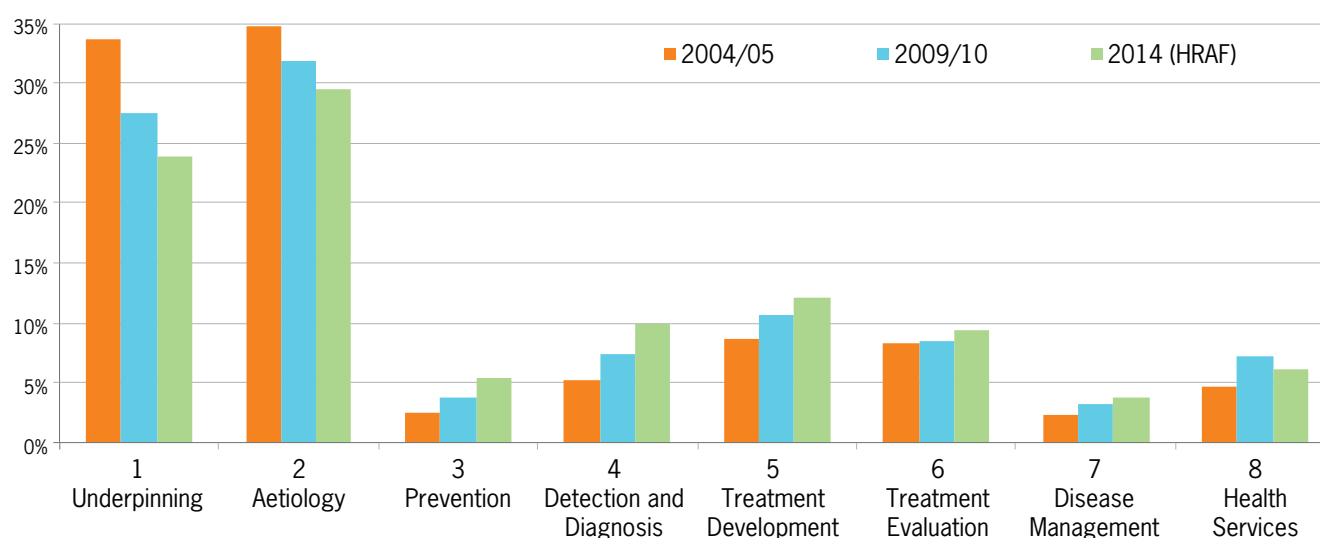
Figure 5 – Proportion of combined health research analysis spend by research activity for 12 HRAF funders for 2004/05, 2009/10, and 2014.

DETAILED ANALYSIS: RESEARCH ACTIVITIES

The transition of funding away from *Underpinning* and *Aetiology* research is in part driven by changes in national and individual funder policies over this time period. Studies in Prevention research were highlighted in the 2004/05 analysis as poorly funded and formed part of the evidence base for support for the National Prevention Research Initiative (NPRI). Founded in 2004, the NPRI combines 16 funding partners from government departments, research council and charities to promote research into chronic disease prevention. The first three funding calls (2004, 2007, 2008) supported 55 research projects with combined commitment of £23m and the latest Phase 4 commitment (2012) supports a further 19 research projects with ~£10m commitment over the next five years[25].

Following the 2004/05 UK Health Research Analysis, the review of UK health research funding conducted by Sir David Cooksey in 2006 was also influential[26]. A key finding of this review was *"that the UK is at risk of failing to reap the full economic, health and social benefits that the UK's public investment in health research should generate."* In response, the review proposed an overarching UK health research strategy by establishing the Office for Strategic Coordination of Health Research (OSCHR) and highlighted two key gaps in the translation of health research:

- *Translating ideas from basic and clinical research into the development of new products and approaches to treatment of disease and illness*
- *Implementing those new products and approaches into clinical practice*

Under direction of the OSCHR board, co-ordinated shifts in funding policy have been made to deliver the changes recommended in the Cooksey Review. These included more programmes specifically for translational medicine, capacity building (e.g. via fellowships), and maximising on current investments (e.g. by combining existing epidemiology/ population data and improving access to health-related data sets). By 2011 OSCHR had delivered on the majority of changes advocated in the Cooksey Review[27]. Given the time needed for awards funded under new initiatives to begin to incur spend this is the first UK health research analysis to fully demonstrate the changes resulting from this co-ordinated action.

Funders have also independently altered funding strategy to promote translational research. For example, prior to the Cooksey Review, Wellcome Trust had established their Innovations Division to promote translational health research. The budget for this division has increased tenfold since 2003.

Changes in Funding Distribution by Research Activity Sub-Group

Assessment of the Research Activity sub groups shows that the changes in funding seen at overall group level is largely mirrored within sub groups. Notable exceptions to this are:

- The reduction in *Underpinning* is almost exclusively due to the most commonly used code, 1.1 (Normal biological development and functioning). Research coded as 1.1 decreased by 4.1 per cent in the last five years (2009/10 to 2014), and 10.3 per cent over ten years (2004/05 to 2014). The amount of funding coded 1.1 in 2014 is still higher in real terms than 2004/05 (by £3.8m) but is £50.9m lower than 2009/10 data.

- The reduction in proportion of *Aetiology* is primarily observed in code 2.1 (Biological and endogenous factors), accounting for approximately 80 per cent of variation seen. Research coded as 2.1 decreased by 1.6 per cent in five years and 3.8 per cent over ten years. The amount of funding in 2014 remains higher than 2004/05 by £81m in real terms, but has decreased by £8.5m since 2009/10. Code 2.2 (Factors relating to the physical environment) showed an overall decrease over the ten year period (-1.5%) but showed a slight increase (+0.6%) between 2009/10 and 2014. This gain in funding (£6m over ten years, £12m in the last five years) may be the result of increased interest in anti-microbial resistance in this period.

- Research in *Prevention, Detection and Diagnosis* and *Treatment Development* all showed increases in proportional funding in the ten year analysis period, at 2.9, 4.7 and 3.5 per cent respectively, with 3.1 (Primary prevention interventions), 4.1 (validation of markers and technologies) and 5.1 (pharmaceutical development) being the sub-groups with largest gains. This appears consistent with continued investment into prevention research (e.g. via collaborative funding schemes like the National Prevention Research Initiative (NPRI), an increased focus on the use of potential biomarkers in personalised medicine and the general focus on bringing novel therapeutic drugs to market. Research in *Treatment Evaluation, Disease Management* and *Health Services* showed small increases in proportional funding (+1.2-1.7%) within similarly small, largely positive proportional changes in subgroups For example, 7.1 (Individual care needs) increased by 1.0 per cent over the ten year period, with a funding increase of £23.4m in real terms.

- One further observation is that in 7 of the 8 research activity groups, the sub-groups for 'Resources and Infrastructure' (codes 1.5, 2.6, 3.5, 4.5, 5.9, 7.4 and 8.5) have all seen proportional increases in funding, with over £146m more funding in real terms since 2004/05. This may be indicative that within awards directly funding research there has been an increased emphasis on providing support for aspects such as establishing and sharing resources (e.g. datasets, sample collections etc.), or accessing shared facilities.

A full table of these data can be found in Appendix 5.

Distribution of funding across research activity by organisation

AMRC Medium to Smaller Charities new to the UK Health Research Analysis

The 48 medium to smaller charities new to the UK Health Research analysis contributed a total of 1,816 awards with a combined value of £73.4m. The number of awards submitted and award value was highly varied, with no one funder contributing more than 10% of this collective total. For the purposes of this report these 48 funders are assessed collectively, however a breakdown of each funder's total contributions can be found in Appendix 2 and any additional sub analysis of this data will be made available via the HRCS website[28].

Figure 6 – Proportion of combined spend by research activity amongst (A) all AMRC medium to smaller charities (48 total) and (B) AMRC charities participating in the From Donation to Innovation *report (20 total).*

Results for the AMRC medium to smaller charities are shown in Figure 6 above. Panel A shows the overall distribution of the 48 charities new to the UK Health Research Analysis. Panel B shows the change in distribution for the 20 charities in the *From Donation to Innovation* report (2004/05) and the current report (2014)[29].

Medical research charities support a wide range of activities. By focusing on *Aetiology* (£29.5m, 40%) to understand why diseases occur, they support the development of new knowledge that will lead to cures. The remainder of AMRC charities spend is prioritised in translational research, but with support for research along the entire development pathway. In particular, there is a strong focus on *Detection and Diagnosis* (£10.3m, 14%) and *Treatment Development* (£14.7m, 20%).

Comparative assessment of the 20 *From Donation to Innovation* charities and the changes between 2004 and 2014 shows the same trend observed at the overall UK level; a shift away from *Underpinning* and *Aetiology* (-8.8% and -5.3% respectively) in favour of translational research, particularly *Detection and Diagnosis* (+4.7%), *Treatment Development* (+2.3%), *Treatment Evaluation* (+3.4%) and *Disease Management* (+3.1%).

Public Funders new to the UK Health Research Analysis

The four public funders new to the 2014 analysis contributed 422 direct awards with a combined annualised spend of £55m. The spend distribution by research activity for each funder is shown in Figure 7 (below), with an accompanying description relating these values to funding strategy.

The **Arts and Humanities Research Council** (AHRC) funds both arts and humanities research with an annual budget of £98m supporting 700 research awards and 2000 postgraduate scholarships each year. Of the £3m in research funding included in this analysis, £1.2m (41%) is attributed to *Disease Management*, specifically 7.1 (Individual care needs), which covers research into how patients cope with the effects of ill health and £539k (18%) to *Health Services* which relates primarily to organisation of services (8.1). A further £581k (19%) in *Underpinning* and £291k (10%) in *Aetiology* associated with methodologies (1.4) and surveillance (2.4) includes studies that develop measurement of populations and the epidemiology of disease, whereas £348k (12%) attributed to *Prevention* relates to interventions to change behaviours (3.1) and environmental risk (3.2).

Innovate UK, formerly known as the Technology Strategy Board (TSB), is an executive non-departmental body sponsored by the Department for Business, Innovation and Skills. Innovate UK supports commercial development of science and technology to drive future economic growth. This broad remit includes the support of micro and small enterprises such as University spin out companies to develop novel commercial products including the development of new treatments and technologies for use in the health care sector.

As a result, the Innovate UK portfolio is primarily attributed to *Detection and Diagnosis* (£7.2m, 17%), *Treatment Development* (£18m, 43%) and *Treatment Evaluation* (£10m, 24%). Development and evaluation of pharmaceuticals (5.1 and 6.1) are the largest sub-groups, with verification of diagnostic markers and technologies (4.1) in third.

The **National Centre for the Replacement, Refinement and Reduction of Animals in Research** (NC3Rs) is the UK's national organisation which leads the discovery and application of new technologies and approaches to replace, reduce and refine the use of animals for scientific purposes. In vivo studies are principally focused on defining the initial causes of disease and pre-clinical testing of new treatments. The NC3Rs health-related portfolio reflects this with 40 per cent (£2.3m) attributed to *Aetiology* and 41 per cent (£2.4m) attributed to *Treatment Development*. In both cases, *Resources and Infrastructure* (2.6 and 5.9) account for the most funding within these research activities, reflecting the role NC3Rs plays in developing improved techniques to minimise the use of animals in research.

The **Natural Environment Research Council** (NERC) is the UK's largest funder of independent environmental science, providing £330m each year in research, postgraduate training and innovation funding. This research focuses on the study and monitoring of physical, chemical and biological processes and those awards of health relevance are therefore predominantly associated with environmental causes of ill health. Consequently the majority of NERC awards are found in *Aetiology* (£3.1m, 74%) and *Prevention* (£854k, 20%).
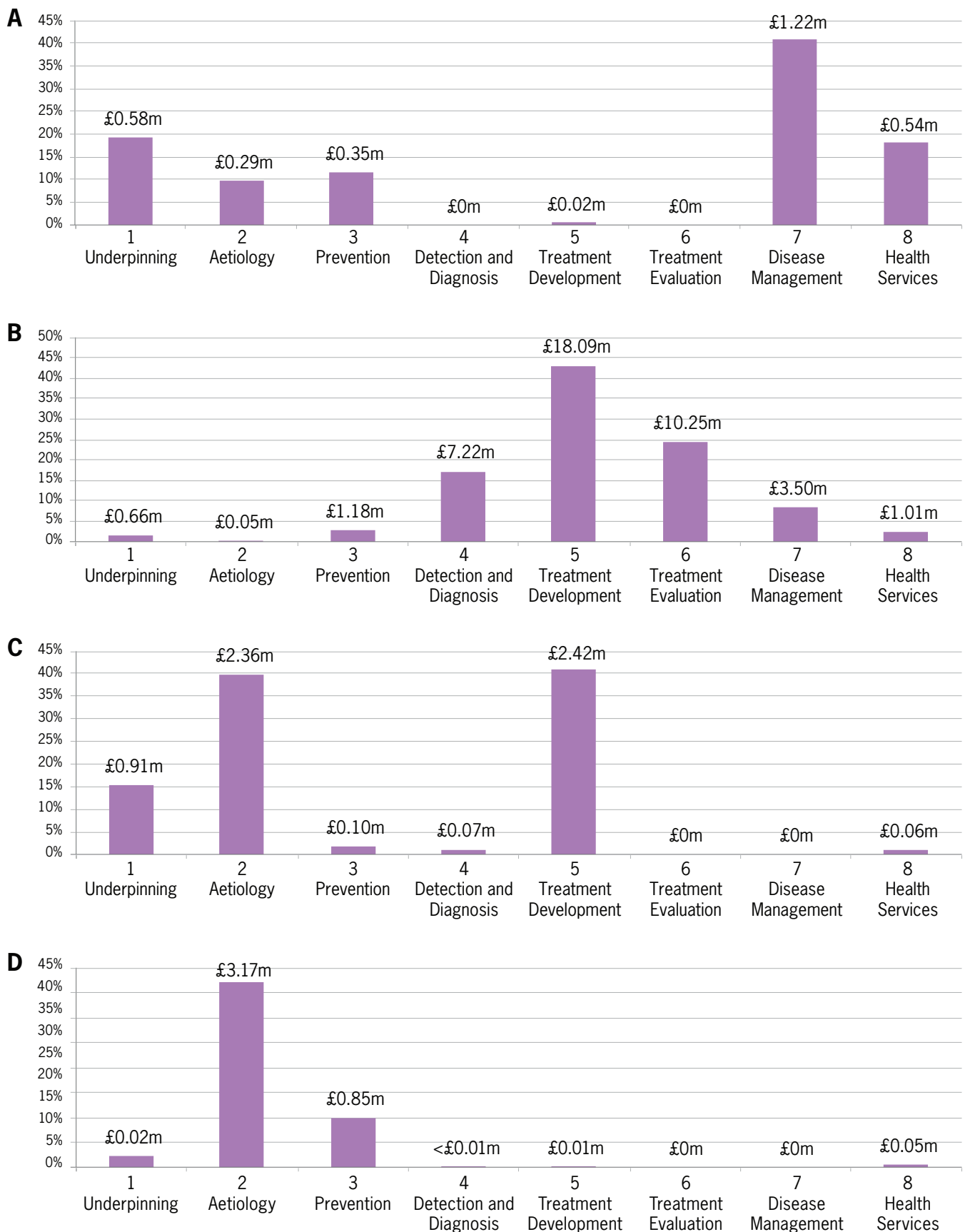
Figure 7 – Proportion of spend by research activities for the public funders new to UK Health Research Analysis in 2014; (A) AHRC, (B) Innovate UK, (C) NC3Rs and (D) NERC.

Analysis of HRAF member Research Activities

There are 12 funders who have participated in both 2004/05 and 2009/10 UK Health Research Analyses and constitute the HRAF advisory group. As the third in a series of quinquennial reports this is the first analysis to assess potential trends in individual funder spending over the 10 year reporting period. However three time points of data is still insufficient for formal trend analysis. Critically, any shift in the coding approach between funders or reports could influence the potential trends observed.

To allow appropriate interpretation of this data, please refer to both the descriptive passages accompanying these graphs and the coding approach descriptions provided by each funder (see Appendix 1).
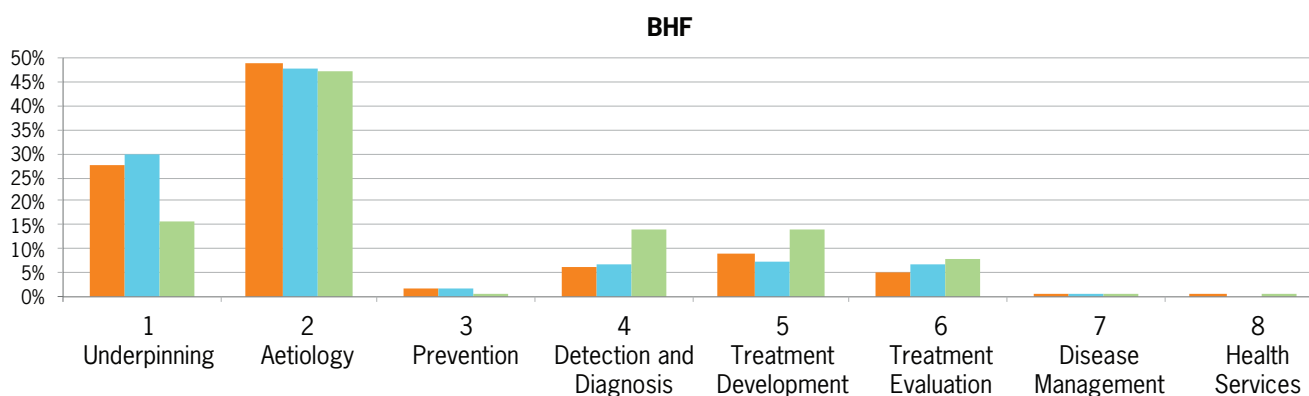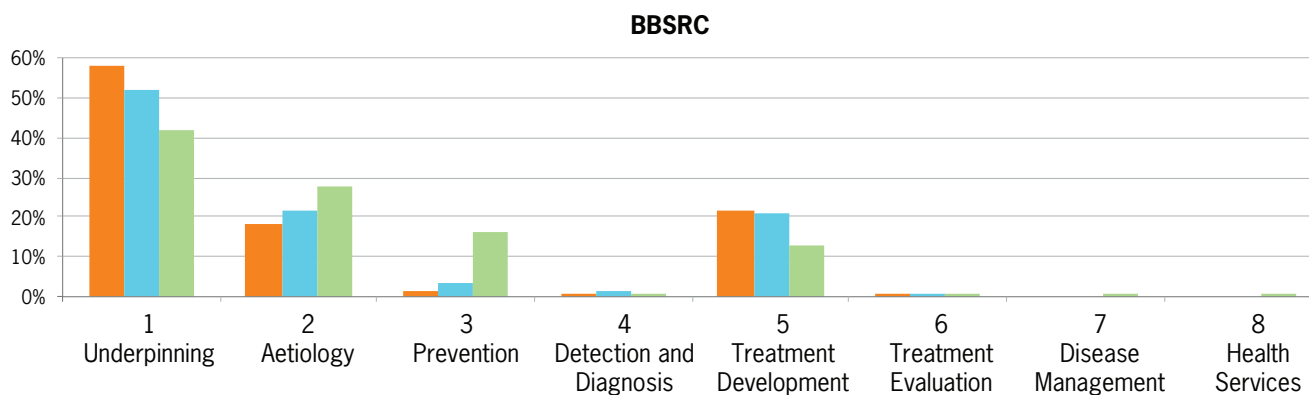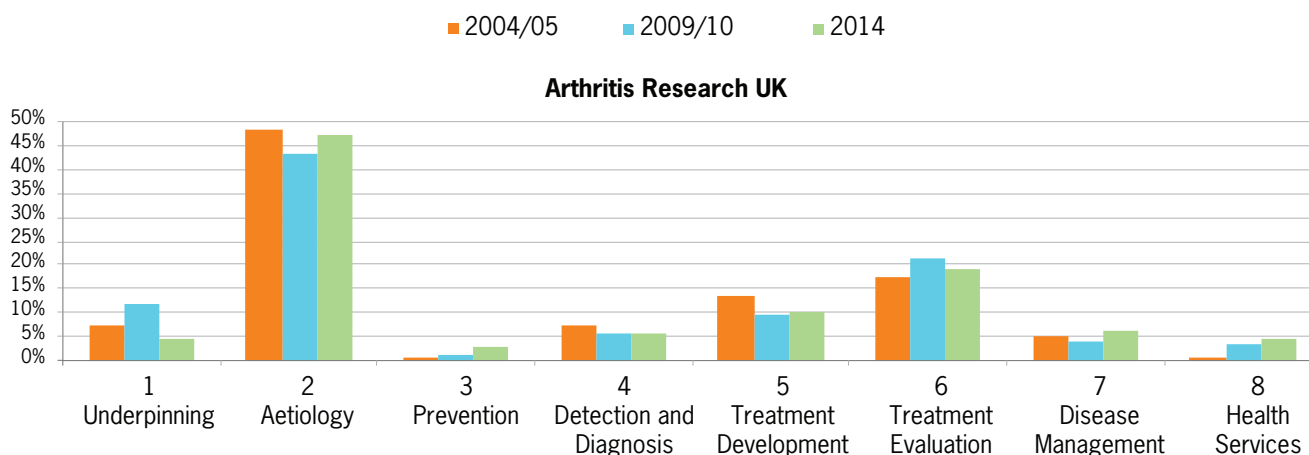
Legend: ■ 2004/05 ■ 2009/10 ■ 2014

Arthritis Research UK

BBSRC

BHF

CRUK

CSO

DH
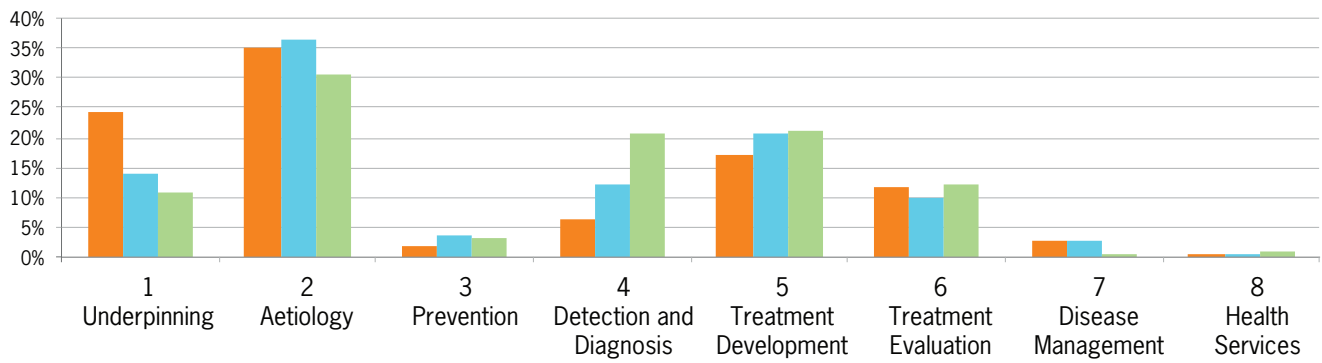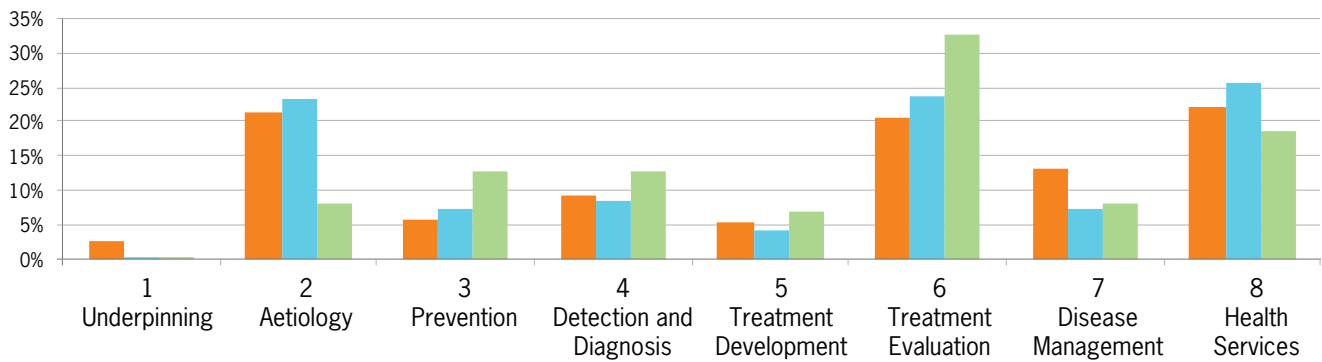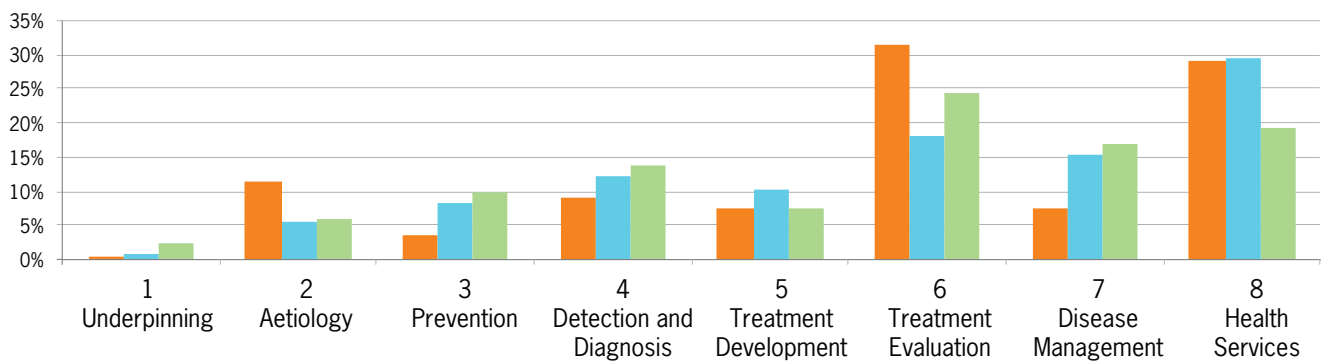
DSCHR
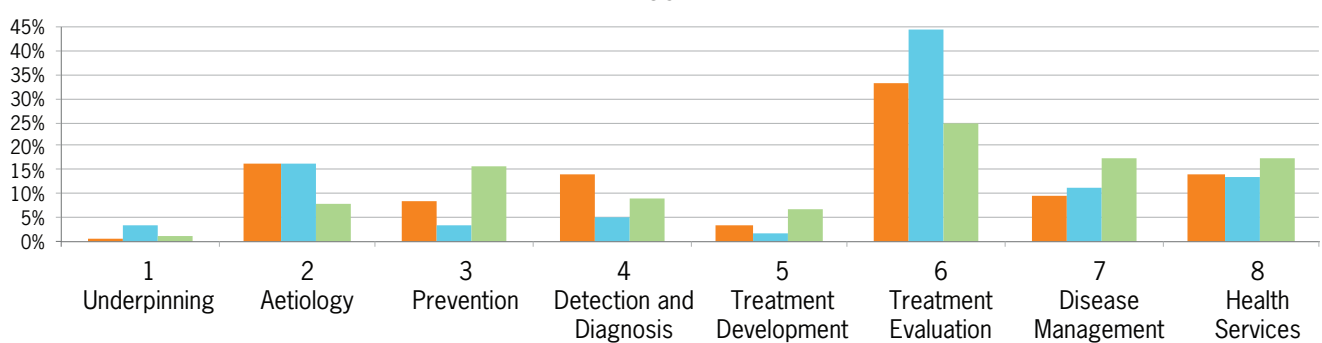
EPSRC

ESRC

HSCNI

MRC

Wellcome Trust
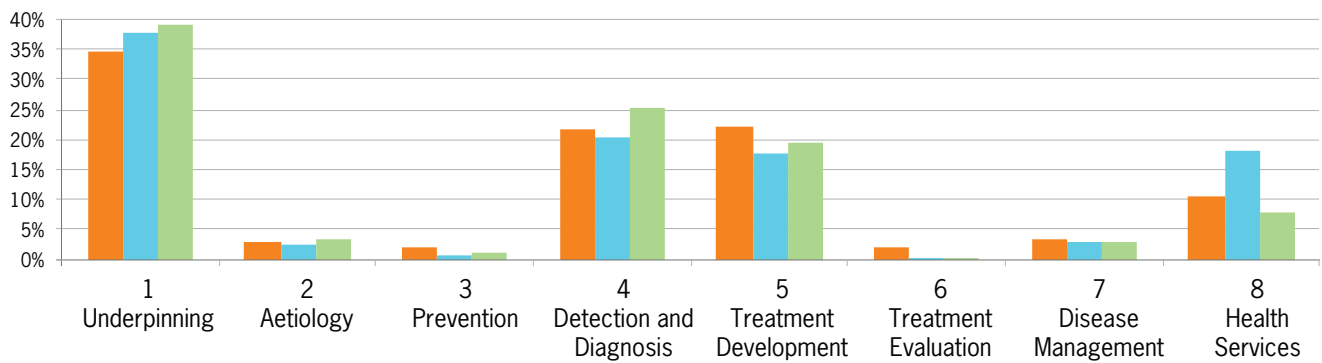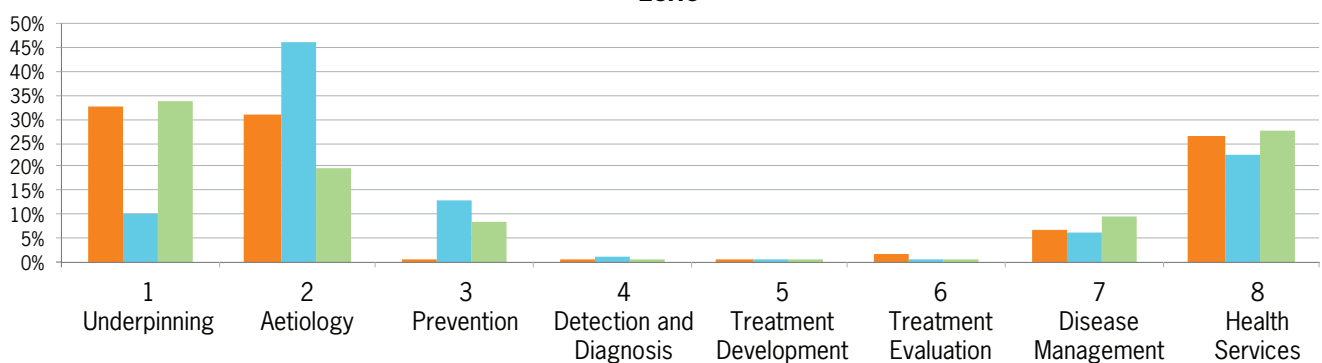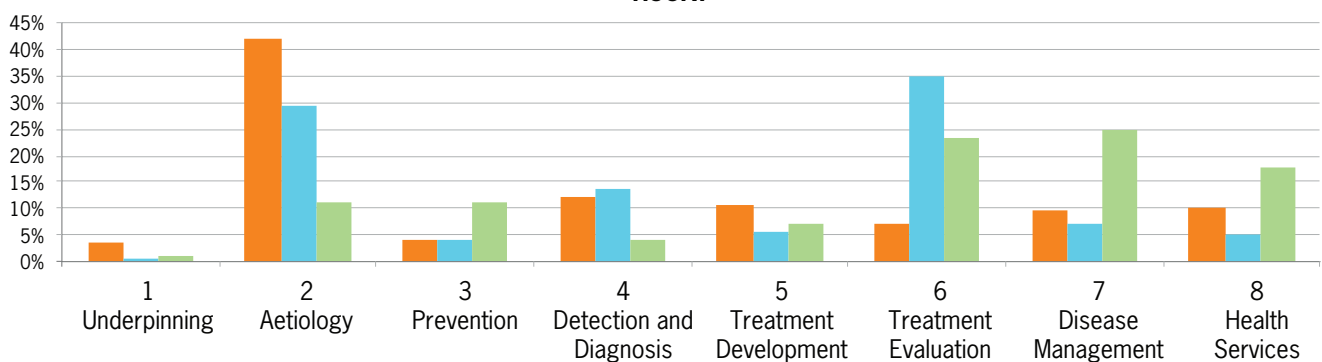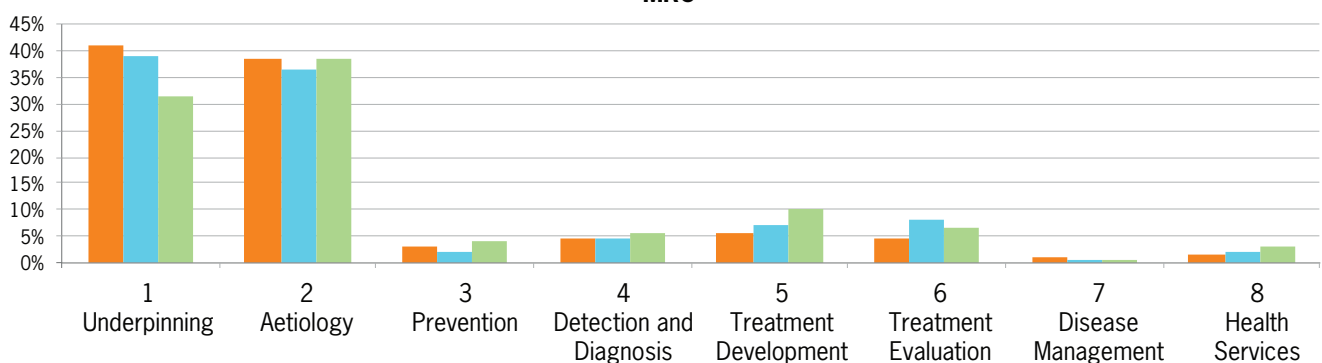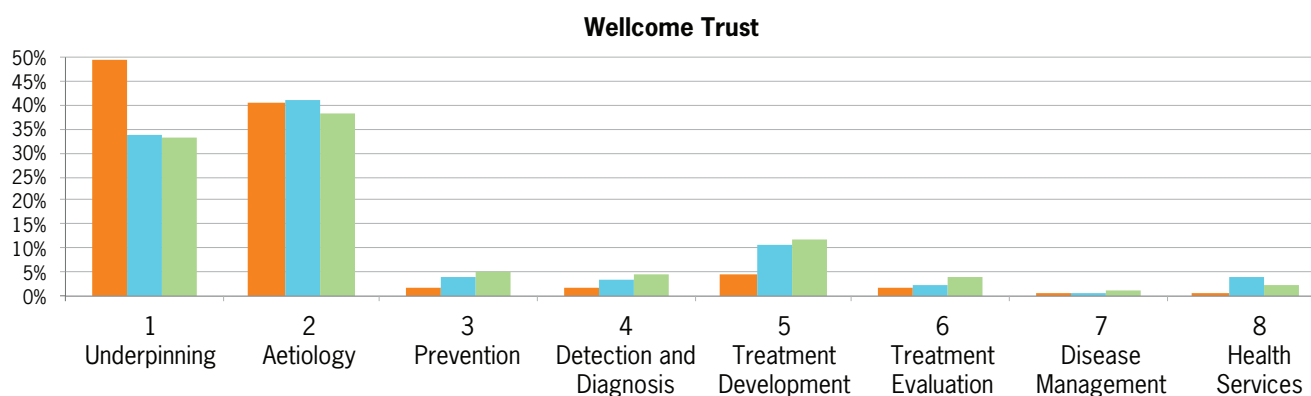
Figure 8 – Differences in proportion of spend by research activity by HRAF funders in the UK Health Research Analyses 2004/05, 2009/10 and 2014.

Arthritis Research UK

Since 2009/2010 there have been relatively modest changes in Arthritis Research UK funding by research activity coding. However the charity has continued its investment in strategic research, including strategic Clinical Studies and Centres, which now number thirteen. There has also been a continued reduction in the funding entirely dedicated to infrastructure and academic support.

Over the past 5 years Arthritis Research UK has developed several strategic partnerships with other funders, which is an approach that the charity looks to replicate over the coming years. There is on-going growth in funding of transitional research with the development of a specific funding call in this area.

Biotechnology and Biological Sciences Research Council (BBSRC)

The Biotechnology and Biological Sciences Research Council (BBSRC) supports world-leading bioscience research, investing over £509m in world-class bioscience in 2014/15. Over 20% of the portfolio is classified as "bioscience for health". This research encompasses work to build a deep, integrated understanding of healthy systems across the life course, including understanding biological mechanisms underlying normal physiology, the role of food and nutrition, with the aim of improving the health and welfare of both humans and animals. Consequently the majority of BBSRC awards are found in the basic research categories Underpinning and Aetiology.

British Heart Foundation (BHF)

The British Heart Foundation has increased its overall annual expenditure on active awards from £46m in 2004/2005 and £65m in 2009/2010 to £84m in 2014. Of this, £71m is included in the 2014 analysis of direct awards. A further £13m was spent on 4 year PhD programmes, strategic awards, awards supporting infrastructure, six Research Excellence Awards and three Centres of Regenerative Medicine. The research profile in the figure reflects the BHF's support for underpinning research and research investigating the aetiology of cardiovascular disease, with continuation of the trend to support research with a translational focus (detection, treatment development and evaluation). The increase in spend on detection and diagnosis in part reflects a change in coding practice, with research into genetic biomarkers of cardiovascular risk or disease coded as Research Activity Code 4.2 in the 2014 portfolio compared with Research Activity Code 2.1 in 2009/10.

Cancer Research UK (CRUK)

The shift in research profile in Figure 8 for CRUK over 10 years reflects a strategic focus on working to help prevent cancer, diagnose it earlier, develop new treatments and optimise current treatments by personalising them and making them even more effective, whilst maintaining a strong base of basic research. Since 2004/2005, Cancer Research UK has increased its overall investment in cancer research from £222m to £350m (year ending 31 March 2014). Around two thirds of CRUK's annual expenditure on research has been included in this report. A further £100m is spent on essential research infrastructure, scientific meetings, building costs and technology transfer activities designed to hold, develop and exploit intellectual property rights arising from

research to ensure that any discoveries that could lead to new drugs, diagnostics or vaccines reach the clinic.

Chief Scientist Office, Scotland (CSO)

The aim of the CSO is to support and to promote excellent research in NHS Scotland, that is likely to make a real difference to clinical practice and the health of the citizens of Scotland, the UK and internationally. The CSO therefore fund little basic research and gears funding towards the applied end of the spectrum.

Department of Health, England (DH)

The Department of Health continues to prioritise patient needs. As seen in the analysis, most of its coded portfolio concentrates on supporting the translation of fundamental biomedical research into clinical research that benefits patients. For the 2014 report, improved coding procedures have led to the inclusion of additional large-scale research spending, such as Patient Safety Translational Research Centres and Healthcare Technology Co-operatives. A significant proportion of Department of Health funding supports its infrastructure, which cannot be coded. This support allows the Research Councils, Charities and industry-funded research to cost-effectively access the NHS and undertake research of patient benefit.

Division for Social Care and Health Research, Welsh Government (DSCHR)

Relative to 2009/10, DSCHR's spend profile shows more of a balance between spend on treatment evaluation, disease management and health services research. It also shows an increase in spend on prevention research.

In so far as the figures are comparable, this change partly reflects Welsh Government policy and the focus of DSCHR's grant schemes, and partly the quality of the applications submitted to eligible grant schemes.

Economic and Social Research Council (ESRC)

The increase in the number and value of ESRC awards reported compared to the 2009/10 data collection exercise could be due to a number of reasons. The profile of ESRC funding in the area of health has continued to increase over the last five years. Over this time the Council's responsive mode portfolio of health related awards has at least been maintained and the Council has also been involved in the development of more collaborative activities with partner organisations.

Examples of these include the cross-council programme on Lifelong Health and Wellbeing and collaboration with NIHR on Dementia. ESRC's strategic approach to longer, larger awards may account for the increase in spend relative to the number of awards. Similarly, ESRC's approach to data collection may also account for more awards being included in our analysis. Indirect spend includes our data infrastructure awards including our Centre for Longitudinal Studies, Understanding Society, Administrative Data Research Network and the UK Data Service.

Engineering and Physical Sciences Research Council (EPSRC)

The number and value of EPSRC awards has continued to increase since 2009/10, with £16m real terms increase in health-relevant spend on direct awards and a total of £36m on research infrastructure. The majority of EPSRC's spend (92%) is shared between four research activities. Funding for Underpinning research has increased consistently since 2004/05; funding for Detection and Diagnosis also shows a net increase over the same period, whereas for Treatment Development there has been a smaller net decrease. The reduced value and share of funding for Health Services since 2009/10 is due to a re-focussing of EPSRC support for manufacturing research.

EPSRC continues to support multidisciplinary collaborations, such as the UK Regenerative Medicine Platform, in addition to its own calls. Such awards support researchers to develop innovative technologies, arising from research in engineering and the physical sciences, that will help to prevent, diagnose, and treat disease in a more effective, personalised, and collaborative way.

Health and Social Care R&D Division, Northern Ireland (HSCNI)

Consistent with the 2009/10 report, a sustained emphasis on the strategic aim of supporting research which is closer to patients/service users has driven increases in funding of the relevant HRCS activities. In particular, Disease Management and Health Services research show significant growth, while Treatment Evaluation continues to be a significant activity. Consequent decreases have been seen in Underpinning and Aetiology research. In line with the other UK Health Departments we have shown demonstrable increases in the amount of Prevention research. As outlined in the 2009-10 report, this has been supported through the UKCRC Centres

of Excellence for Public Health initiative and through the establishment of the Northern Ireland Public Health Research Network in March 2012.

Medical Research Council (MRC)

In 2004/05 MRC expenditure on research was £476m[30]. The 2004 Government spending review set out an ambitious ten-year plan to grow the funding for UK research with an initial 5.8% real terms growth via the Science and Innovation Framework 2004-2014[31]. The 2007 spending review allocation for the MRC allowed new funding of £132m to be directed toward translational research in support of the priorities set out in the 2006 review of health research chaired by David Cooksey. Via a series of strategic initiatives the MRC had committed more than £250m to enhancing the volume and capacity for translational research by 2010. It was expected that this re-prioritisation and strategic investment would establish a noticeable growth in the proportion of MRC's portfolio focussed on translational research from a low base, while maintaining high quality underpinning research (which still comprises around 70% of the MRC portfolio).

In June 2009, the MRC published a five-year Strategic Plan "Research Changes Lives, 2009-2014"[32], it defined the MRC's role in contributing to faster and more effective ways for medical research to flourish at all stages. In 2009/10 with the economic downturn fully evident, the MRC's gross expenditure on research had reached £758m[33]. Recognising the importance of medical research to economic growth, the Government spending review in 2010 protected MRC's funding in real terms[34]. This led to MRC gross expenditure remaining approximately level for the next five years (MRC expenditure in 2014/15 was £772m[35]). Even so, in its 2011/12 – 2014/15 delivery plan[36] the MRC made its most ambitious commitments to date to strategically support areas such as; dementias

research, regenerative medicine and translational research overall. These commitments included £60m for experimental medicine, £130m for regenerative medicine, £60m for stratified medicine and £133m aligned with Innovate UK via the biomedical catalyst. All these promises have been realised and in most cases exceeded.

These changes in the MRC portfolio have continued the trend seen in the earlier half of the last ten years, gradually building up the proportion of research which is translational (via support such as experimental medicine, confidence in concept etc.) while ensuring that high quality discovery science at every step in the research pathway is pursued. The MRC strategy was refreshed in 2014, setting out MRC's goals to 2019[37].

Wellcome Trust

Since the last UK Health Research Analysis Report was published in 2012 the Wellcome Trust has continued to support high quality research with the aim of improving health. The rise in the proportion of Wellcome Trust spend on Treatment Development is likely driven by the expansion of the Trust's Innovations Division; established in 2003 as the Technology Transfer Division to promote explicitly translational health research, and with a budget which has increased tenfold over the last decade. Among the objectives stipulated by the Wellcome Trust's Strategic Plan for 2005-2010 was a pledge 'to increase the opportunities for the development of products, devices, and enabling technologies for health benefit.'

Additional information and a complete dataset are available via the HRCS website[38].

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25. National Prevention Research Initiative **http://www.mrc.ac.uk/research/initiatives/national-prevention-research-initiative-npri/**
26. Sir David Cooksey, December 2006. *"A review of UK health research funding"* **https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228984/0118404881.pdf**
27. **http://www.mrc.ac.uk/about/spending-accountability/oschr/**
28. **http://www.hrcsonline.net/pages/uk-health-research-analysis-2014**
29. Arthritis Research UK also participated in the *Donation to Innovation* report before joining the HRAF. Their data is included in the HRAF funder section on page 37.
30. **http://www.mrc.ac.uk/news-events/publications/annual-report-and-accounts-200405/**
31. **http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/spending_sr04_science.htm**
32. **http://www.mrc.ac.uk/news/publications/strategic-plan-2009-14/**
33. **http://www.mrc.ac.uk/news-events/publications/annual-report-and-accounts-200910/**
34. 2010 Spending Review (HMT) paragraph 2.49 **https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/203826/Spending_review_2010.pdf**
35. **http://www.mrc.ac.uk/news-events/publications/annual-report-and-accounts-2014-15/**
36. **http://www.mrc.ac.uk/news-events/publications/delivery-plan-201112-201415/**
37. **http://www.mrc.ac.uk/research/strategy/**
38. **http://www.hrcsonline.net/pages/uk-health-research-analysis-2014**

DETAILED ANALYSIS:
HEALTH CATEGORIES

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Detailed Analysis: Health Categories

There are 21 distinct Health Categories used in the HRCS, of which 19 related to a specific area of health or disease. The health categories cover both normal function and disease state. For example, studies of liver diseases, such as cirrhosis, and normal hepatic function will both be coded under *Oral and Gastrointestinal*. It is also important to consider that many research projects span a range of health categories, where multiple codes can be applied to each award (5 maximum). For example, studies of sexually transmitted diseases will often be considered both *Infection* and *Reproduction*.

The two remaining health categories are used slightly differently. The *Other* category is used for diseases of unknown or disputed aetiology or research that is not applicable to the other health categories[39], and *Generic Health Relevance* is used for studies that are applicable to all diseases and/or general health. *Generic Health Relevance* can therefore cover a wide range of research types, from basic cell and molecular biology to geographical evaluation of health services, and is often used in coding for large programme awards with a broad research remit.

New Funders to the Health Research Analysis

When comparing the combined portfolio of HRAF member organisations (12 funders) and the combined all funder data (64 funders), there is relatively little change (less than ±1%) in distribution across health categories. The addition of the 52 new funders decreases the proportion of *Generic Health Relevance* funding by 1.03 per cent (to 23.6%).

This is primarily driven by the inclusion of AMRC member charities, which have a specific (i.e. non-Generic) disease focus corresponding with small increases (≥0.3%) in *Cancer, Metabolic and Endocrine* and *Neurological*. A full breakdown of the changes between both 2014 datasets can be found in Appendix 6.

Changes in Health Categories 2004/05 to 2014

When compared to previous Health Research Analyses, the 2014 (HRAF) data shows the overall health categories funding landscape remains relatively unchanged (see Figure 9 and Table 5).

Generic Health Relevance remains the largest area of research funding (£467m, 24.6%), and while the amount of funding has increased (by £166m in ten years, £37m in the last five years) the proportion of total funding in this area has decreased slightly from 24.2 per cent in 2009/10 (-0.6%) and 25.2 per cent in 2004/05 (-1.6%). This may represent an improvement in coding direct research awards or better segregation of indirect funding, as more awards of *Generic Health Relevance* are included in the infrastructure assessment (see page 12). However *Generic Health Relevance* is frequently used when the underpinning research could be applicable to all areas of health. Therefore

the decrease in *Generic Health Relevance* funding may also represent the shift away from underpinning research to investment in more specific translational research areas.

The second largest health category, *Cancer*, remains stable at ~20 per cent with an increase in real terms funding of £128m since 2004/05 (£23m since 2009/10). The maintenance of spend in this area is of interest as the 2009/10 analysis showed a small decrease in the proportion spent on cancer research. The third largest health category, *Infection*, shows a proportional increase in funding of 2.4 per cent in ten years (a real terms funding increase of £108m) and this may result from increased interest in research on anti-microbial resistance during this period.

Despite the continued importance of dementia and other neurological disorders associated with ageing, in this analysis

the proportion of *Neurological* funding appears to show the largest decrease, falling from 11.6 per cent in 2004/05 to 9.0 per cent in 2014 (-2.5%), although real terms funding has grown by £33m over the ten year period, the funding in 2009/10 was £3.0m higher than 2014. Interestingly the proportion of funding to *Mental Health*, the most common shared category with *Neurological*, has increased slightly (+1.5%, £58m real terms increase) over the ten year period. If viewed collectively, these two health categories have increased funding by £91m since 2004/05 although the proportion of total health funding has still decreased by 1 per cent. Recent changes in policy to direct more funding towards dementia are not yet represented in the 2014 data, so should become evident in future analyses.

Inflammatory and Immune System research has also decreased by 1.5 per cent as a proportion of total funding (5.9% to 4.4%), but an increase in real terms funding of £12.8m. The remaining 15 health categories remain relatively stable, with changes of less than ±1 per cent in their respective proportions of total funding. Only one category, *Ear*, showed a decrease in real terms funding over ten years (£15.0m in 2004/05, £10.6m in 2014, a difference of -£4.4m) although this could be due to small changes in the number of awards relevant to this area. Four categories (*Blood, Inflammatory/Immune System, Neurological* and *Other*) showed a decrease in real terms funding since 2009/10. A full breakdown of the spending portfolios for the HRAF funders can be found in Table 5. Comparison of 2014 data between HRAF and all 64 funders is shown in Appendix 6.
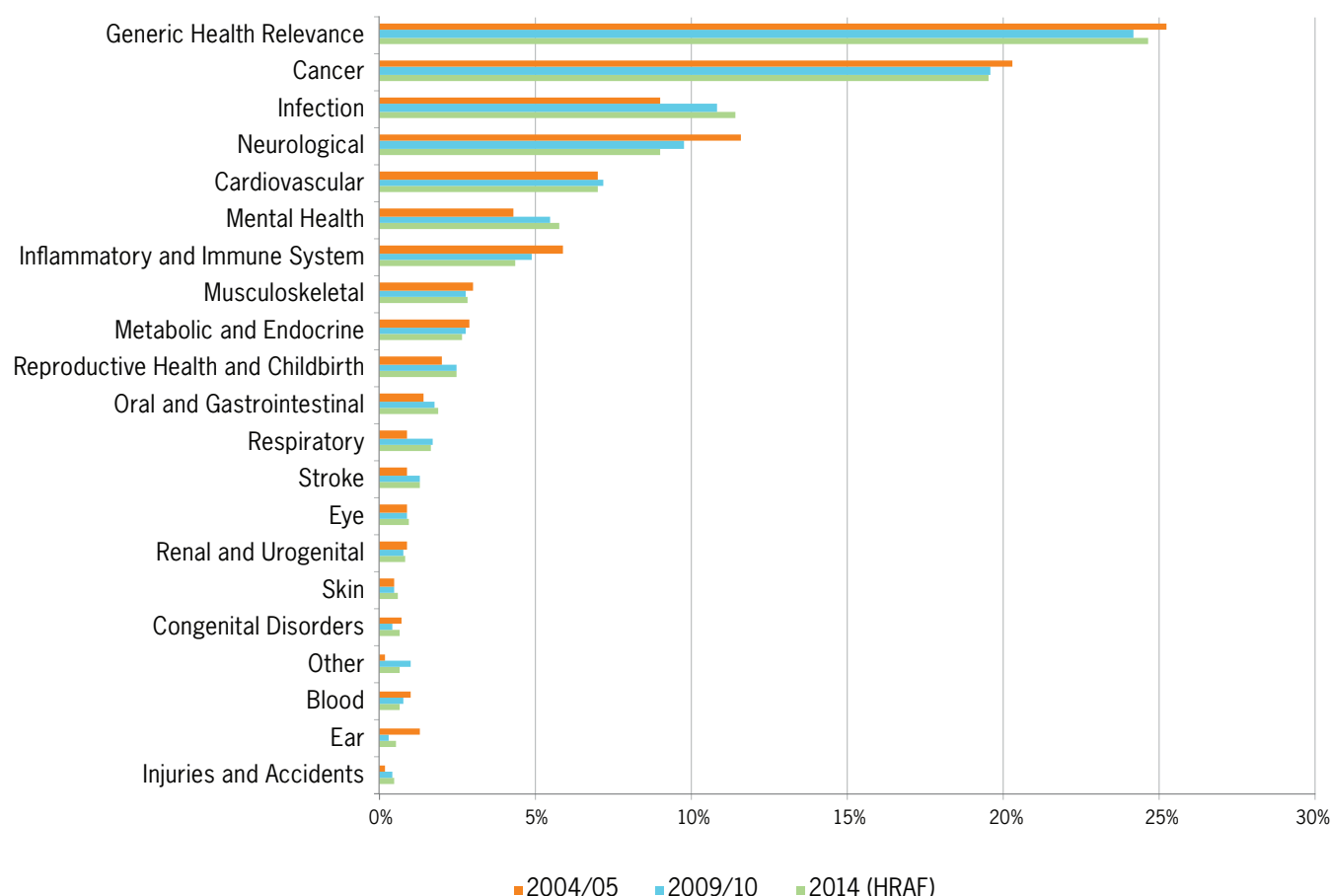
Figure 9 – *Proportion of combined spend by health category for 2004/05, 2009/10 and 2014 (HRAF, 12 funders).*

DETAILED ANALYSIS: HEALTH CATEGORIES

Health Category	2004/05		2009/10		2014 (HRAF)		% Difference	
	Spend (£m)	%	Spend (£m)	%	Spend (£m)	%	vs. 04/05	vs. 09/10
Blood	12.0	1.0	13.6	0.8	12.7	0.67	-0.33	-0.10
Cancer	242.2	20.3	347.4	19.6	370.4	19.53	-0.75	-0.07
Cardiovascular	83.7	7.0	127.5	7.2	133.2	7.02	0.01	-0.18
Congenital Disorders	8.6	0.7	6.2	0.4	12.4	0.65	-0.06	0.30
Ear	15.0	1.3	6.0	0.3	10.6	0.56	-0.70	0.22
Eye	10.4	0.9	15.3	0.9	17.7	0.93	0.06	0.07
Generic Health Relevance	300.9	25.2	429.7	24.2	467.1	24.63	-0.56	0.39
Infection	107.9	9.0	192.1	10.8	216.3	11.41	2.37	0.57
Inflammatory and Immune System	70.1	5.9	86.5	4.9	82.9	4.37	-1.50	-0.51
Injuries and Accidents	2.7	0.2	6.3	0.4	9.0	0.47	0.24	0.12
Mental Health	51.1	4.3	96.9	5.5	109.4	5.77	1.48	0.30
Metabolic and Endocrine	34.2	2.9	48.9	2.8	50.9	2.68	-0.18	-0.08
Musculoskeletal	36.1	3.0	49.5	2.8	53.5	2.82	-0.21	0.02
Neurological	138.0	11.6	174.3	9.8	171.4	9.04	-2.52	-0.80
Oral and Gastrointestinal	16.8	1.4	32.5	1.8	36.0	1.90	0.49	0.07
Other	2.1	0.2	16.9	1.0	12.4	0.66	0.48	-0.30
Renal and Urogenital	10.4	0.9	14.8	0.8	16.4	0.86	-0.01	0.03
Reproductive Health and Childbirth	24.3	2.0	44.3	2.5	47.0	2.48	0.45	-0.02
Respiratory	11.3	0.9	30.7	1.7	31.0	1.64	0.69	-0.10
Skin	5.7	0.5	8.8	0.5	11.5	0.60	0.12	0.11
Stroke	10.6	0.9	23.9	1.3	24.8	1.31	0.42	-0.04
GRAND TOTAL	£1.19bn	100%	£1.77bn	100%	£1.90bn	100%	-	-

Table 5 – *Differences in combined spend by health category by HRAF funders in 2004/05, 2009/10 and 2014.*

DALY comparison

As previously outlined in the *Understand the Results* section (Appendix 10, page 84) there are multiple factors that influence the level of research funding in any area, including scientific opportunity, research workforce capacity, 'researchability' or tractability, burden of disease and fund raising potential. Burden of disease is a factor that has previously been used as a comparator for research investment across different diseases. There are many metrics to assess burden of disease such as incidence, prevalence, mortality, morbidity and length of hospital stay. Comparison with each of these can lead to different interpretations about the appropriate relationship with research funding levels.

Disability Adjusted Life Years (DALYs) are frequently used as a measure of burden of disease. DALYs are calculated by combining two established metrics; years of life lost from mortality (YLL)[40] and years lost due to disability (YLD)[41]. The former uses incidence of disease and life expectancy at death as a measure of mortality whilst the latter adjusts prevalence for the severity of disease as a measure for morbidity. The resulting figure is the total number of years lost (i.e. 1 DALY = one lost year of 'healthy' life). The DALY rate used in this

analysis is the proportion of DALY for a particular health category relative to the DALY total for the UK.

Figure 10 presents a comparison of the proportion of research funding in 2014 across the health categories (all 64 funders) against the latest UK DALY rates (2012) from the WHO Global Burden of Disease Project[42]. The Health Categories have been combined as necessary to allow appropriate comparison with the WHO Global Health Estimates (GHE) disease coding system used for DALY data. Details of this disease mapping process are available in Appendix 7. However it is important to note that three health categories, *Inflammatory and Immune System, Generic Health Relevance* and *Other*, have no equivalent GHE codes and are

omitted from this comparison. Therefore only 71 per cent (£1.4bn) of spend is represented here.

Correlation analysis shows relatively poor matching of the UK's burden of disease in DALY rates and the research funding available (Spearman's coefficient 0.56). *Cancer* received both the highest proportion of 2014 spend and highest DALY rate, with comparable proportions. However *Infection, Neurological and Reproductive Health* and *Childbirth* all show a higher proportion of research funding than the corresponding UK DALY ranking. In contrast comparisons in *Mental Health, Musculoskeletal, Oral and Gastrointestinal, Respiratory, Renal and Urogenital* and combined group *Blood / Cardiovascular / Stroke* show research funding is lower than the comparative burden of disease.
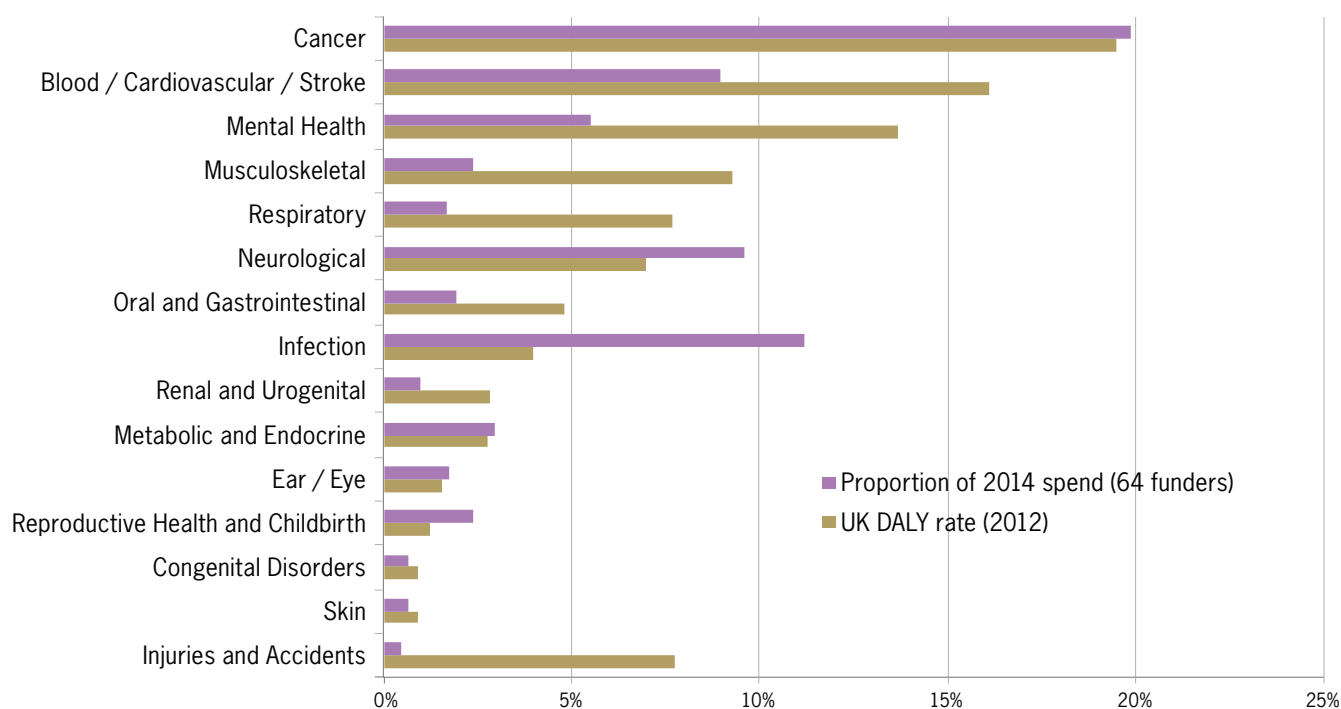
Figure 10 – *Comparison of Disability Adjusted Life Years (DALY) rates for the UK in 2012 and proportion of UK health research analysis 2014 combined spend by health category in 2014*

While comparisons with such data are interesting, there are some important caveats which should be considered. Firstly the burden of a disease is dependent on disease severity, duration and risk of premature mortality but this will not automatically correlate with the research costs involved. For example, research into *Injuries and Accidents* is part of HRCS coding and includes external injuries (fractures, burns and poisons) and intervention studies to prevent future accidents. This represents a very small proportion of research funding,

but the loss of life or quality of life through disability is considerable (7.8%).

Secondly while both HRCS and GHE disease classifications show similarities, the mapping is imperfect. In particular there is no suitable GHE classification for funding assigned to HRCS's *Inflammatory and Immune System, Generic Health Relevance* and *Other*, so 29% (£587m) of research funding is not included in comparison with DALY rates. There is also

no method to determine GHE classification for the £984m in indirect funding listed in this analysis. This report has clearly shown that the majority of health research funding is still focused on basic science and the infrastructure to support it. Therefore while the ultimate aim that drives health research is to solve societal health problems, the focus of funding towards developing the capacity/capability to perform research is as important as the burden a specific disease may have on the UK population.

Thirdly, the outcomes resulting from research are often unexpected, particularly so for basic/fundamental or discovery science. Experience shows that research has wider spill-over benefits to areas beyond that originally envisaged. Recent examples include advances in cancer therapy that have substantially benefitted from research in immunology and infections. Analysis of the MRC portfolio of neurodegenerative disease-relevant research projects has suggested that approximately half of all MRC publications with relevance to neurodegenerative disease research may arise from this portfolio of projects, with the remaining half being produced from the wider MRC portfolio. These results highlight the importance of tracking the progress, productivity and quality of research, not only focussing on the details of applications funded. Managing the composition of research portfolios at the outset (inputs) as well as better understanding how this work translates into impact (by examining outputs and indicators of progress) are both important aspects of co-ordinating health research.

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39. Examples of disputed aetiology include myalgic encephalomyelitis (ME) and Post Traumatic Stress Disorder. The Other category is also used for other social service research for at risk groups, such as young people at risk of domestic violence, and studies of animal welfare.
40. YLL = Number of Deaths x Life Expectancy at age of death.
41. YLD = Prevalence x Disability Weighting (a measure of disease severity).
42. WHO Global Burden of Disease Project – Estimates for 2000-2012 – DALY by country 2012 (all ages). **http:// www.who.int/healthinfo/global_burden_disease/estimates/en/index2.html**

GEOGRAPHICAL DISTRIBUTION

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Geographical Distribution

The compilation of portfolio data centrally provides an opportunity to map the directly funded research of participating organisations by geographical location within the United Kingdom. The data from all 64 funders for 2014 is shown in Figure 11 below.

Glasgow **3.5%**
Belfast **0.7%**
Manchester **3.9%**
Liverpool **1.9%**
Birmingham **2.3%**
Cardiff **1.7%**
Bristol **2.7%**

Dundee **2.3%**
Edinburgh **4.5%**
Newcastle Upon Tyne **2.4%**
Leeds **1.9%**
Sheffield **1.6%**
Nottingham **2.3%**
Leicester **1.2%**
Cambridge **12.1%**
London **32.1%**
Oxford **10.7%**
Southampton **0.7%**
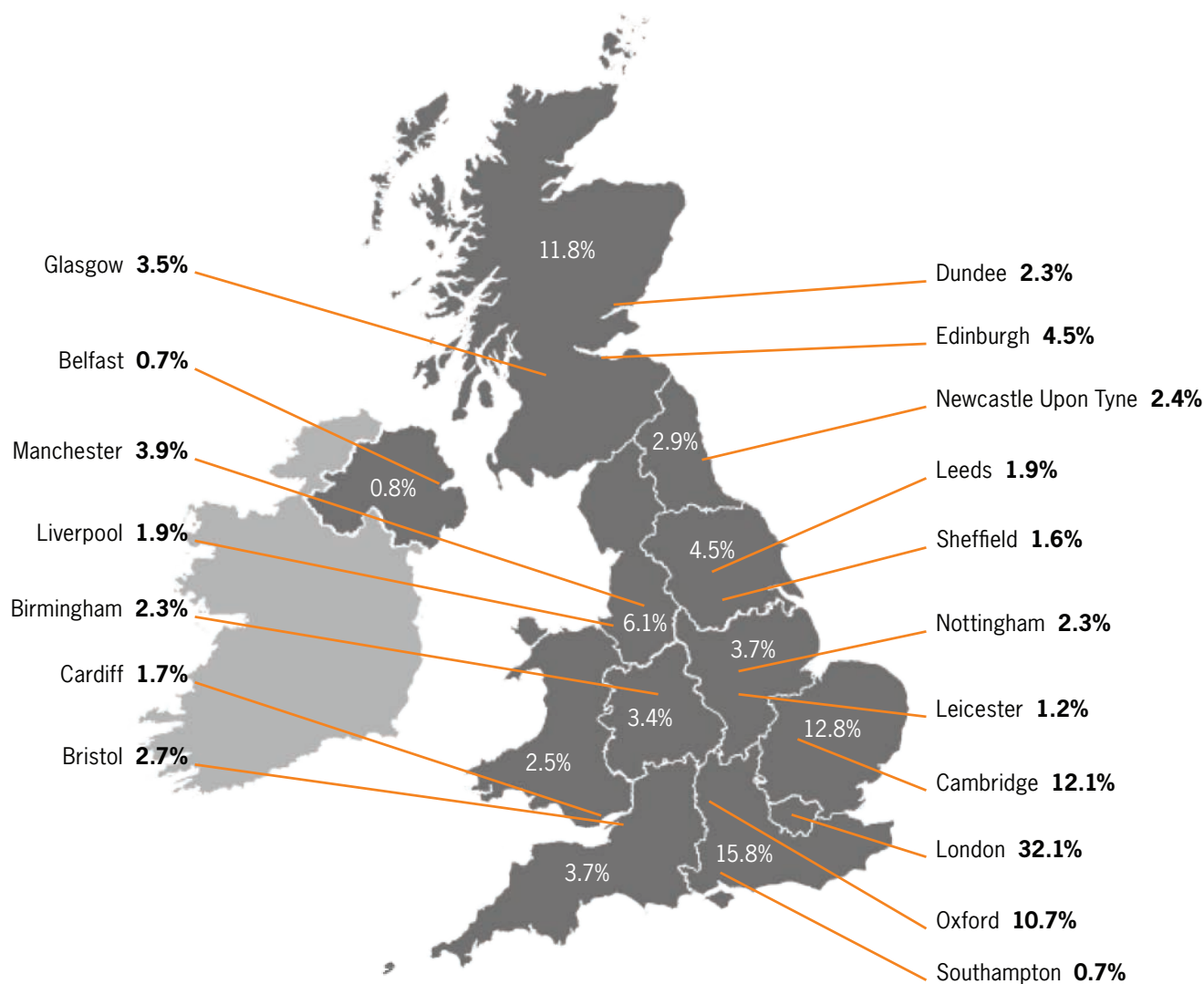
Figure 11 – *Geographical distribution of combined research funding in the UK (64 Funders)*

Again, to allow comparison with previous analysis data, data from 2014 was split by HRAF funders (12 organisations) and All Funders (64 organisations). However the addition of the 52 new funders has only a minor impact (<±0.4%) on the geographical distribution of research funding. The UK distribution of combined research spend by region is shown in Figure 12, and a complete breakdown of this regional data, including by city (>0.1%) can be found in Appendix 8.
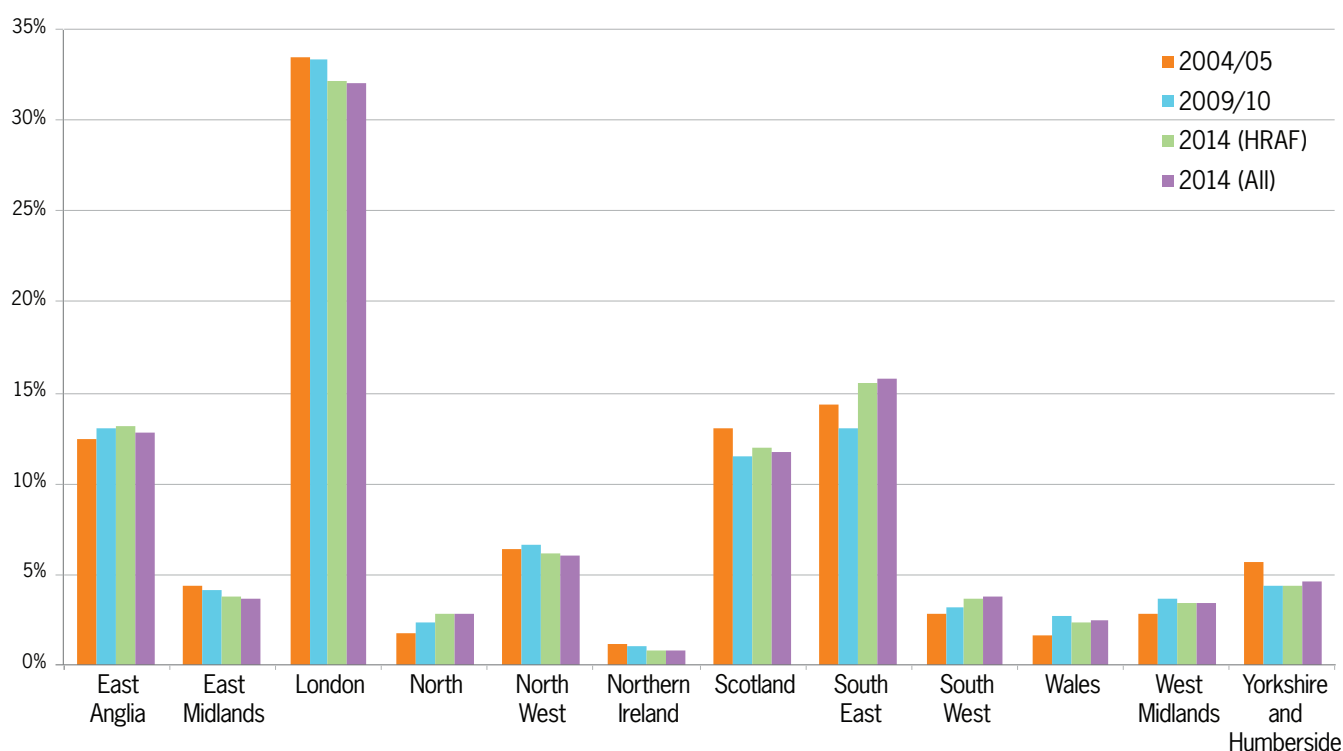
Figure 12 – Proportion of combined spend by geographical distribution (2004/05, 2009/10 and 2014).

As with previous analyses, London still accounts for approximately one third of UK health research spend, with the South East (including Oxford), East Anglia (including Cambridge) and Scotland (including Edinburgh) sharing approximately 40 per cent of UK funding (between 11% and 16% each). Comparison between 2004/05, 2009/10 and 2014 data shows relatively little change in UK distribution. Funding to the South East appears to have increased slightly (14.3% to 15.8%, +1.5%), with Oxford receiving an increase of £112m in real terms (1.9%) more in proportional funding since 2004/05. In the same ten year period, London showed a decrease in proportional funding (33.5% to 32.1%, -1.4%) although funding has increased by £249m in real terms.

Scotland has seen a decrease in the proportion of total UK funding (13.0% to 11.8%, -1.2%), although the amount spent in Scotland still increased by £83m in real terms since 2004/05 and has increased proportionally since 2009/10 (11.5% to 11.8%). Due to the overall increase in total funding, no UK region has seen a real terms decrease in funding between 2004/05 and 2014.

The full data from this analysis, including a breakdown of the combined funding by institution, is available via the 2014 report pages on the HRCS website[43].

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43. **http://www.hrcsonline.net/pages/uk-health-research-analysis-2014**

DISTRIBUTION OF FUNDING BETWEEN CHARITY AND PUBLIC SECTOR

Distribution of Funding between Charity and Public Sector

The current analysis increased participation from 12 funders in 2009/10 to 64 funders in 2014, with the majority of new funders consisting of medium to smaller medical research charities (48 total). Combined with the original 4 charitable funders that are HRAF members (i.e. 52 charities), this analysis now covers 94.9 per cent of AMRC's funding.

The comparison of charity and public funding is much discussed, but has not been previously assessed as part of the UK Health Research Analysis. Charitable funding of direct research in the 2014 analysis totalled £793m (39.1%) from the 52 charity funders whereas combined public funders (12 total) contributed £1.23bn (60.9%). For the purposes of this analysis, public funding was split into Research Council (6 funders; MRC, BBSRC, EPSRC, ESRC, NERC & AHRC) and Other Government (6 funders; DH, CSO, DSCHR, HSCNI, NC3Rs and IUK) sub groups, with totals of £857m (42.4%) and £375m (18.5%) respectively.

Distribution of research activity funding by charity or public funder

The distribution of combined total funding by research activity is shown in Figure 13 below. A full breakdown of the data can be found in Appendix 9.
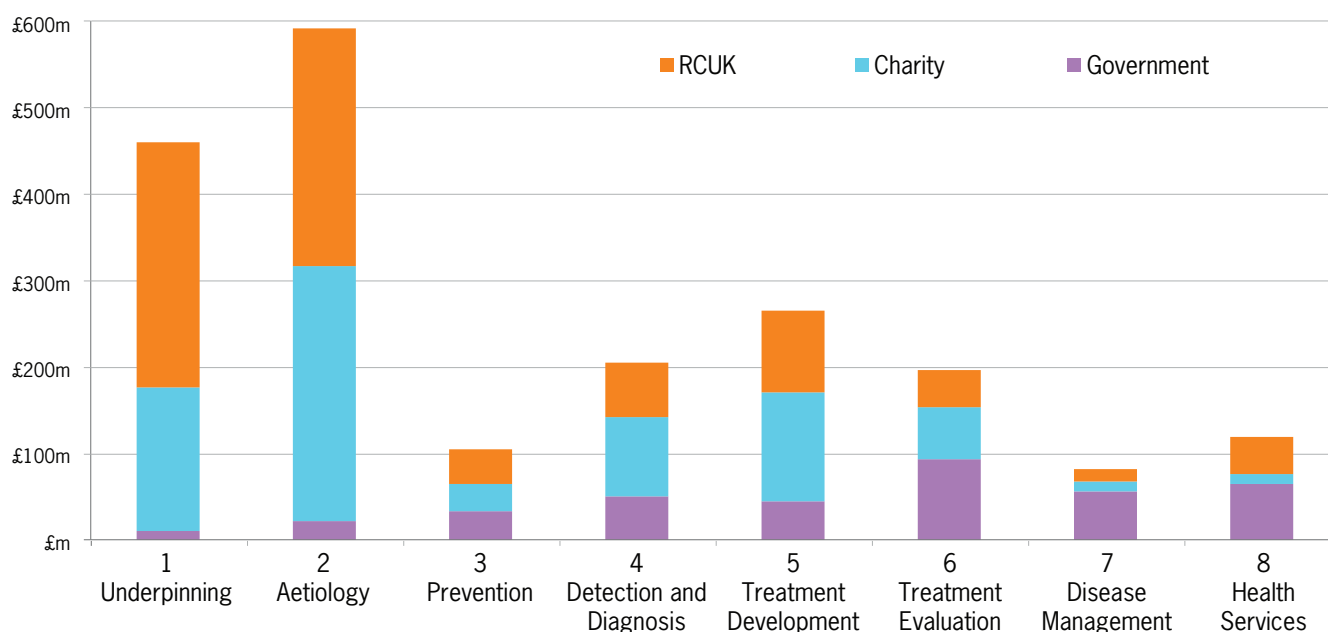

Figure 13 – Distribution of combined spend by research activity by charity, research council and other Government funders

Charitable funders provide nearly half of all funding in *Aetiology, Detection and Diagnosis* and *Treatment Development* (49, 44 and 47% respectively) which is consistent with their focus in determining the causes of disease and developing new strategies for both early diagnosis and novel treatments. Research Council funding supports *Aetiology* (49%) but also contributes over half of the basic research within *Underpinning* (62%), consistent with research council focus on discovery science. Rank correlation analysis shows that both charities and research councils share priorities in research activity funding (Spearman's coefficient = 0.97). In contrast, the other

Government funders have a more patient/treatment focused portfolio, with a relatively small proportion (<4%) of research in *Underpinning* or *Aetiology*, and therefore provide the majority of funding in *Treatment Evaluation, Disease Management* and *Health Services* (47, 70, 54% respectively). Rank correlation analysis also shows that Government research activity priorities are different to both charitable and research council funding (Spearman's coefficient = -0.71 to -0.69). Finally, all three funding groups have an interest in *Prevention* research, with each providing approximately one third of the total funding.

Distribution of health category funding by charity or public funder

The distribution of combined total funding by health category is shown in Figure 14 below. A full breakdown of the data can be found in Appendix 9.

Research Councils support the majority of *Generic Health Research* (64%), which is often used in conjunction with *Underpinning* in studies of basic biological processes. Charities support the majority of funding for *Cancer* (£299m, 74%), primarily by Cancer Research UK (84%, £252m) although 12 of the 48 medium to smaller charities also have an exclusively cancer-based portfolio. Similarly 60 per cent (£82.5m) of all *Cardiovascular* funding is by charities, primarily by the British Heart Foundation (86%, £70.8m).

While specific categories may be favoured by one funder type, in general all three groups distribute their funding in a similar way. Correlation analysis shows that when funding for health categories are ranked by amount funded, charities, research councils and Government funders all prioritise in similar ways (Spearman's coefficients 0.91 to 0.97). The reasons for this correlation are unclear but may relate to similar strategic priorities in public funding and the capacity for funding in certain areas. A recent report from the Office for Health Economics on interdependencies in cancer research suggests that public, charity and private sector funding of medical research is complementary, not duplicative, with two thirds of projects supported by funding from multiple sources[44].

DISTRIBUTION OF FUNDING BETWEEN CHARITY AND PUBLIC SECTOR
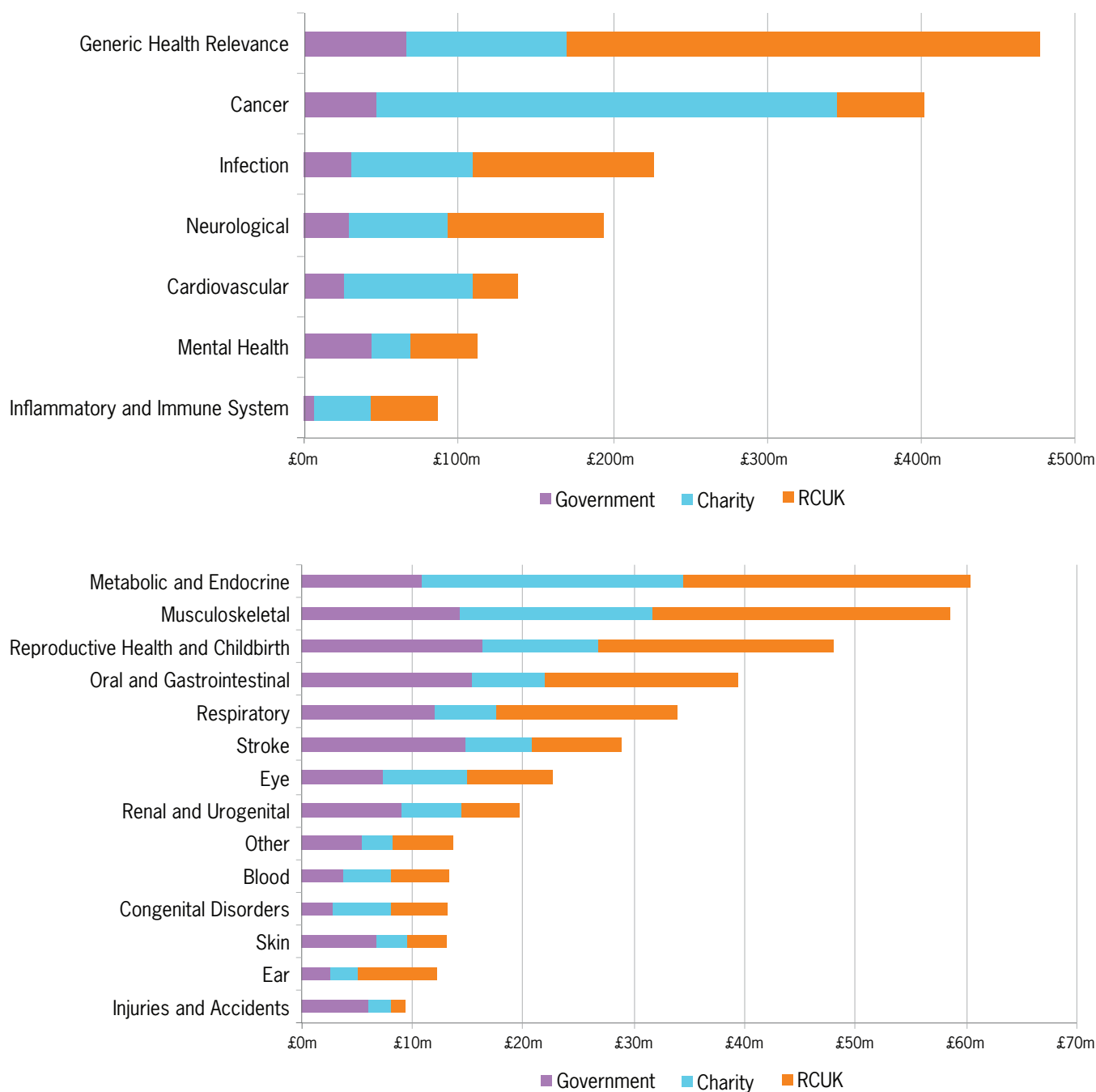
Figure 14 – Distribution of combined spend by health category by charity, research council and other Government funders, split by >£70m (upper panel) and <£70m (lower panel)

44. Office of Health Economics / Science and Technology Policy Research Report for Cancer Research UK (March 2014) *Exploring the interdependencies of research funders in the UK.* https://www.ohe.org/publications/exploring-interdependencies-research-funders-uk

NEXT STEPS

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Next Steps

The 2014 UK Health Research Analysis had two primary aims:

- To increase participation and thereby coverage of health research analysis within the UK

- To provide a ten year view of the UK's health research funding landscape

Widening Participation

This analysis now includes over £3bn in research spend from a total of 64 public and charitable funding organisations. Taken together with the £1bn public funding estimated to flow via the CSRF etc., this report now covers 47 per cent of all UK health research funding and approximately 91 per cent of all public/charitable health research funding in the UK. The assessment of infrastructure and other supportive funding has undergone considerable revision since the 2009/10 report, but there are several areas that would benefit from inclusion. The use of large facilities for health-related research, such as those maintained and managed by the Science and Technology Facilities Council, is one such example of this.

Improved Identification of Research Shortfalls

As the third in a series of quinquennial analyses, this report has shown how health research funding has grown since 2004 and how changes in policy have caused a shift away from basic, aetiological projects towards a more translational focus for research. Continuing this report series will allow consistent monitoring of the UK funding landscape, and identify when efforts are needed to co-ordinate funding in particular areas. The provisions made since 2004 to increase Prevention research have already shown improvement in funding and it is important that these analyses continue to be used in this manner.

Continue to improve the sharing of data for further analysis

The data collected for this report now includes more detail than previous analyses and will allow a wider set of assessments to be carried out. This is in part due to changes in how participating organisations organise their data but also how attitudes have shifted toward greater transparency of funding and sharing of data. HRAF members agreed to make all the data compiled in this exercise available via the HRCS website[45]. The UKCRC encourages the analysis of this data, but also efforts to routinely make research portfolio information openly accessible.

Review the Health Research Classification System to further the aim of creating an internationally recognised coding/analysis system

No system can remain static, particularly in a sector well known for innovation. In the ten years since its inception, the HRCS has continued to be widely used within the UK and elsewhere. However to ensure the system remains relevant to new developments, regular reviews should be undertaken. These can be relatively minor changes to guidelines or training methods, but may lead to new categories should changes in the research landscape require it. To follow up the publication of this report will be an editorial review of the HRCS and its application in the UK, which has been accepted for submission to BMC Health Policy Research and Systems, part of the WHO's Global Observatory journal series.

Progress the development of automated coding

The main limiting factor to more regular application of the HRCS for portfolio analysis is the time and cost of manual coding. Training of individual coders and the time required to read, interpret and apply HRCS coding means any analysis requires either continual investment in on-going coding or a regular large investment for specific reports. Furthermore the potential for individual interpretation of coding guidelines can lead to inconsistencies.

Automated coding could provide a solution to both these issues, and would also allow any future modifications to the system to be applied retrospectively. To progress this requires cooperation between funders and companies that can provide such automation, but the benefits would be considerable. The HRAF members have collaborated with UberResearch Ltd. regarding piloting automated approaches to coding[46]. While promising results were obtained with assignment of health category codes automation of coding for research activities remained problematic. The data generated from this analysis will be utilised to further test and improve automated approaches, in the hope that future UK Health Research Analyses could be entirely automatically coded, or at least coders could be supported by computer generated suggestions for codes.

45. **http://www.hrcsonline.net/pages/data**
46. UberResearch Ltd. have provided some explanatory information and an exemplar analyses for this project, which can be found on the HRCS website: **http://www.hrcsonline.net/pages/uk-health-research-analysis-2014**

NEXT STEPS

APPENDICES

UK CLINICAL RESEARCH COLLABORATION

igniting our potential

Appendix 1 – Coding Approaches

Arthritis Research UK

All grants active over this period were included. Every grant in the analysis worth over £25,000 per annum was awarded following peer-review (external, committee, or both) of a specific research project or projects that comprised all or part of the application for funding. This included Project and Programme grants, all Fellowship schemes, PhD studentships, Clinical Studies, and Academic Posts. 'Centre Initiatives' – core funding to establish Arthritis Research UK Centres of Excellence - were also included in this analysis. Additionally, we included grants categorised as indirect awards, including grants related to infrastructure (e.g.

Equipment grants and Experimental Arthritis Treatment Centres) as well as personal awards (e.g. Nurse and Allied Health Professional training fellowships and travel awards, and GP training bursaries).

The majority of grants were coded externally by either a freelance coder or a coder from the Association of Medical Research Charities using the UKCRC Health Research Classification System. The remaining grants were coded internally. Just over 50% of all awards were coded by a second coder.

Arts and Humanities Research Council (AHRC)

AHRC funds research which looks to enhance health and wellbeing, as well as address specific medical, therapeutic and demographic challenges, through ethical, cultural and creative insights and interventions involving the arts and humanities. AHRC research also plays an important role in improving understanding of changes in health and wellbeing over time, of the impact of the wider cultural and historic environment and of cultural differences in beliefs and cultural inequalities in public health within diverse societies.

The grants submitted to the analysis were collected based on keyword searches across the AHRC's research grants and fellowships portfolio. The data does not include details on postgraduate training grants. The list was then condensed to grants active during the 2013/14 financial year. AHRC submitted details of 39 grants for this exercise totalling an award value of £10.3m, of which 31 grants were included in this analysis. A further 8 grants were included which had been co-funded by EPSRC.

Association of Medical Research Charities (AMRC)

48 medium to smaller AMRC member charities agreed to submit data on grants active in 2014 according to criteria set by UKCRC. Grants were coded either by AMRC or by the charity and 37% were secondary coded for quality control purposes.

More information on individual charity data will be made available via the HRCS website[47].

Biotechnology and Biological Science Research Council (BBSRC)

The BBSRC defines health-related research as: research on i) ageing, lifelong health and wellbeing, ii) regenerative biology and tissue engineering, iii) **nutrition and health**, iv) **"one health"** (to combat infectious diseases of zoonotic origin), v) pharmaceuticals (**excluding work on bioprocessing**) and vi) **"personal care"** (relevant to fast moving customer goods/healthcare products). This aligns with the BBSRC

Strategic Plan grand challenge "Bioscience for Health" as detailed in its publication in January 2014[48]. This differs from earlier definitions and is somewhat broader; the changes since the last submission to the HRAF are highlighted in bold text. Research falling within Bioscience for Health is identified as such during routine BBSRC classification procedures.

British Heart Foundation (BHF)

The British Heart Foundation ensured that all grants, excluding infrastructure awards (funding for buildings and equipment), strategic awards and other awards that could not be linked to a Research Activity Code, were included in the analysis. The BHF used the same coding criteria as the 2009/10 portfolio except for research into genetic biomarkers of cardiovascular risk or disease, which were

coded as Research Activity Code 4.2 in the 2014/15 portfolio compared with Research Activity Code 2.1 in the 2009/10 portfolio. Coding was carried out internally by a small team. All awards were designated as 100% relevant to the cardiovascular disease category. The total number of submitted awards was 776.

Cancer Research UK (CRUK)

Cancer Research UK included all active research except the following:

- Awards which cannot be submitted to NCRI (awards without publishable abstracts, capital spend or research infrastructure not linked to a specific research code)
- Funding for Cancer Research Technology projects
- Cancer information, policy and advocacy funding

The total amount not submitted from the annual research portfolio is approximately £98m. This is the same approach as that taken for compiling the 2004/05 and 2009/10 portfolios. In general, indirect or infrastructural funding (such as capital contributions to the Crick Institute) is not included in CRUK's submission.

Cancer Research UK codes its research to the Common Scientific Outline (CSO). For this analysis, as in previous years, awards were not coded directly to the CSO, but were translated to the HRCS using a semi-automated approach and validated by a research manager.

Chief Scientist Office, Scotland (CSO)

The CSO have included all directly funded awards that could be attributed to a set of defined research objectives. The data includes:

- Research Grants
- Personal research awards (pre and post-doctoral)

- Funding to research units
- Contributions to national initiatives

In previous reports the CSO included Clinical Research Networks (CRN's) in the coded analysis, in this report

by agreement all CRN's have been included in the infrastructure funding.

We have submitted data on 319 individual awards around half of these were coded by a professional coder experienced in the use of HRCS and the rest were coded in house. A QC check of the data was organised by the Project Manager.

Scotland contributes to the overall budget for NIHR research programmes managed by NETSCC on behalf of the UK. NIHR have coded all their projects and those projects led from Scotland have been included in the CSO funding breakdown in Appendix 2.

The significant balance of CSO funding is allocated as infrastructure funding to support research in the NHS, including that funded by other partners in the analysis.

Department of Health, England (DH)

HRCS coded spend includes:
- All NIHR research programmes and Department of Health Policy Research Programme Units and projects (non-NIHR)
- All fellowships EXCEPT those that are part of the Integrated Academic Training stream
- All direct research spend (i.e. non-core support costs) at the NIHR Biomedical Research Centres, Biomedical Research Units, Collaborations for Leadership in Applied Health Research and Care, Patient Safety Translational Research Centres, Healthcare Technology Cooperatives, Health Protection Research Units, School of Primary Care Research, School of Public Health Research, Diagnostic Evidence Co-operatives, Health Informatics Collaborative and Translational Research Centres.

The NIHR Infrastructure spend includes:
Clinical Research Network costs and other types of research infrastructure and core support at the NIHR Biomedical Research Centres, Biomedical Research Units, Collaborations for Leadership in Applied Health Research and Care, Patient Safety Translational Research Centres, Healthcare Technology Cooperatives, Health Protection Research Units, School of Primary Care Research, School of Public Health Research, Diagnostic Evidence Co-operatives, Health Informatics Collaborative Translational Research Centres and Senior Investigator awards.

Data coding and verification:
NIHR research and training programmes are co-ordinated and managed by the NIHR Central Commissioning Facility (CCF), the NIHR Evaluation, Trials and Studies Coordinating Centre (NETSCC) and the NIHR Trainees Coordinating Centre (TCC). At NETSCC, research programmes were coded by trained programme managers and 40% then checked by different internal coders, with up to 20% sent out to external coders. At CCF, all programmes were externally coded (by Anna Smith) and then checked by trained internal coders. Coding at CCF and NETSCC was done on project abstracts. At TCC, Fellowships were initially coded by award applicants and 40% then checked by trained internal coders. Coding was done on project abstracts or descriptions.

CCF also manages the NIHR Infrastructure (out with the Clinical Research Networks) and was coded by CCF programme managers with 100% then checked by a trained internal coder. The coding was based on detailed research theme descriptions for each award.

NETSCC also manages Technology Assessment Reports (TAR) that are commonly produced to inform NICE Appraisal Committee guidance on the use of new and existing medicines, treatments and procedures within the NHS in England and Wales. They are funded through an overarching agreement, therefore no funding is directly associated with an individual TAR. Therefore, these were not included in this report.

Division for Social Care and Health Research, Welsh Government (DSCHR)

HRCS coded spend includes all active research grants awarded through open, peer reviewed competition. In 2014 DSCHR was funding 91 awards at a cost of £3.88m. DSCHR contributes to the overall budget for agreed NIHR research programmes managed by NETSCC. NIHR have coded all their projects and those projects led from Wales have been included in the DSCHR spend profile.

Changes in the methods by which infrastructure and other supportive funding has been classified has reduced DSCHR's 'direct spend', though the 'indirect spend' captured has increased. Infrastructure spending now includes: clinical research support; funding for biomedical, clinical, public health and social care research units; and contributions to UK research initiatives. Additional 'Indirect' support for health research is provided through NHS R&D funding streams. This funding has been reported as 'Other' indirect spend in Appendix 2, Part Two.

Economic and Social Research Council (ESRC)

The ESRC took a download of its entire award data which incurred spend in the 2014 calendar year. This was then manually sifted to identify health relevant awards. A broad interpretation of health relevance was used which reflects the contribution that the social sciences make to the health research landscape. The analysis picked up all research awards, including large scale data resources but not studentships.

Engineering and Physical Sciences Research Council (EPSRC)

The number and value of EPSRC awards has continued to increase since 2009/10, with £16m real terms increase in health-relevant spend on direct awards and a total of £36m on research infrastructure. The majority of EPSRC's spend (92%) is shared between four research activities. Funding for Underpinning research has increased consistently since 2004/05; funding for Detection and Diagnosis also shows a net increase over the same period, whereas for Treatment Development there has been a smaller net decrease. The reduced value and share of funding for Health Services since 2009/10 is due to a re-focussing of EPSRC support for manufacturing research.

EPSRC continues to support multidisciplinary collaborations, such as the UK Regenerative Medicine Platform, in addition to its own calls. Such awards support researchers to develop innovative technologies, arising from research in engineering and the physical sciences, that will help to prevent, diagnose, and treat disease in a more effective, personalised, and collaborative way.

Health and Social Care Research and Development Division of the Public Health Agency, Northern Ireland (HSCNI)

The HSC R&D Division, Public Health Agency, Northern Ireland (NI) has made every effort to maximise reporting on the use of all funds. It is important to note that the HSC R&D Division Budget is small relative to other UK Health Departments. Developments in the UK R&D landscape over the time period covered by this report (2006; 2009/2010 and 2014) have naturally driven funding allocation decisions. This has resulted in a change in the distribution and proportion of funding between direct and indirect awards with indirect R&D support proportionately increasing in order that R&D in Northern Ireland can strive for parity with other regions of the UK which receive larger per capita R&D budgets. Consequently this has increased the emphasis for Northern

Ireland researchers to seek direct R&D funding from national funding sources.

The indirect awards included under infrastructure encompass the clinical research networks and centres providing specialist research services and support. Some examples of the latter include: HSC Innovations, The NI Clinical Trials Unit and The NI Biobank. Those awards included under the 'Other' category have been omitted due to various reasons such as non-coding.

In 2014 there were a total of 162 active awards in our portfolio across the various categories in the report. Direct awards were coded using the HRCS by a freelance coder.

Innovate UK

Innovate UK provided a portfolio of projects relating to all aspects of Health and Care, including areas of strategic importance such as Stratified Medicine, Regenerative Medicine and Independent Living. This portfolio is predominantly focused on projects awarded through specific Health and Care interventions. It does not include:

- Infrastructure awards, such as funding for Catapult Centres
- Awards for projects without a public abstract
- Awards of less than £5,000

- Awards for projects with potential healthcare applications from the Enabling Technology, Emerging Industry, High Value Manufacturing, Nutrition for Life, Agrifood or Digital portfolios.

All grants included in the analysis were active in 2014 and were coded by a freelance coder. Every grant in the analysis was awarded following expert review. This included Biomedical Catalyst, Collaborative Research and Development, Smart and Small Business Research Initiative funding. The number of submitted awards was 209, with a total 2014 value of £42.4m and total commitment from Innovate UK of £124m.

Medical Research Council (MRC)

Data Collection

The 2014 data includes all MRC grants, studentships, fellowships and programmes.

The MRC financial year runs from 1 April to 31 March. Figures for grants, studentships and fellowships have been calculated based on their durations during the 12 months of 2014. If a grant was running from January to December in the

year 12 months of funding has been allocated to the record if a record started or finished during the year a prorated approach has been used.

MRC Programmes have been presented as the figures attributed to each programme during the 2013/14 financial year. The annual programme spend include the salaries of research and technical staff included in the project,

consumables and use of research facilities, together with capital equipment and depreciation. Programme costs also include elements for overheads supported through regional centres and MRC Corporate sections. These types of awards meet criteria for both direct awards (directly funding research) and indirect awards (infrastructure) but are fully coded and included within the main analysis.

Studentships and Infrastructure

Funding for MRC studentships is awarded to research organisations, including universities, MRC units, institutes and centres who select outstanding candidates for projects across MRC's remit and strategic priority areas. Funds support postgraduate students aligned to the RO's scientific strategy and strengths. Details of the students are inputted by the ROs in to the Je-S administration portal where we extract the information and send to an external verifier to complete HRCS coding.

In 2013/14 1690 students were active with an estimated spend of £31m, based on MRCs minimum stipend values, adjusted accordingly for inside/outside London weighting and fees. Of these students 80.9% were coded on the information provided by the ROs. Those studentships without sufficient detail to code are included as part of MRC's infrastructure submission.

MRC provided approximately £115m in infrastructure support in 2014. The majority of this funding was provided to support the construction of the new Francis Crick Institute.

Coding

The MRC routinely codes all awards using the HRCS. This work is carried out by staff in the research programmes group at MRC Head office. Periodic peer review between the internal coders is carried out to ensure a consistent approach from the coding community. In addition, 30 per cent of MRC's award portfolio submitted was QC coded via the processes outlined in this report's Methods chapter.

National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs)

The NC3Rs funds research and early career awards that are directly aligned to its mission to replace, refine and reduce the use of animals in research (the 3Rs). Awards can be in any area of science, engineering and mathematics related to this mission. A significant proportion of the portfolio aims to apply the 3Rs to models of disease and the safety assessment of pharmaceuticals and chemicals. Much of the NC3Rs research funding therefore has the potential to impact on medicine and human health.

This is the first time that NC3Rs has taken part in the HRCS data analysis exercise. All Project Grants, Pilot Study Grants, Strategic Awards, Studentships and Fellowships that were active in the calendar year 2014 were submitted. Infrastructure grants that fund resources and equipment, and CRACK IT awards for commercialisation of technologies

with 3Rs potential, were not submitted. Of the 123 awards (total commitment of £24.1m), three awards (totalling £0.9m) were excluded with no HRCS codes and four awards (£1.3m) were classified as infrastructure under the data submission guidelines, and are therefore included in the indirect assessment (£0.4m annualised value for 2014 - see Appendix 2, part 2). This left 116 awards with a total commitment value of £21.9m, and annualised value for 2014 of £5.9m. Note that some of these 116 awards are specifically aimed at improving animal health and welfare, but with sufficient relevance to human health to code under HRCS.

All data for the coding was taken from the Siebel system and JeS application forms. Coding was completed by the MRC on behalf of the NC3Rs.

Natural Environment Research Council (NERC)

This is the first submission by the NERC and is based upon active grants during 2014 associated with NERC's Environment & Health science topic classification. These grants are worth £4.2m in terms of annualised spend, calculated assuming a flat spending profile across the life of the grants. Note, two of these grants are held by the NERC Centre for Ecology and Hydrology (CEH) and one by the NERC British Geological Survey (BGS).

However, because much of the metadata was only available in NERC's grants system, health research embedded within

NERC's national capability funding was not covered – national capability being a large component of the funding for NERC's six established Centres: The British Antarctic Survey (BAS), the British Geological Survey (BGS), the Centre for Ecology and Hydrology (CEH), the National Centre for Atmospheric Sciences (NCAS), the National Oceanography Centre (NOC) and the National Centre for Earth Observation (NCEO). An example of such national capability is the Air Pollution Information Service (**www.apis.ac.uk**) operated by CEH that provides a long-term environmental monitoring service that underpins health research.

Wellcome Trust

The data provided by the Wellcome Trust contains the annualised commitment for all UK funded Wellcome Trust grants active at any time in 2014. As the Wellcome Trust does not currently classify grants according to the UKCRC Health Research Classification System all grants were coded by a small team of freelance coders. Grants awarded to support non-research activities (e.g. travel grants, publishing costs, some equipment grants, etc.) were included in the main analysis as 'infrastructure' rather than assigned an HRCS code.

The data provided by the Wellcome Trust is the annualised commitment for active grants in 2014. The period 2014 is defined as 1 January 2014 to 31 December 2014. The interpretation of "annualised commitment for active grants" is as follows:

(A) The report includes all grants which were active for any time period during 2014 ("A"). The number of months that each grant was active for in 2014 ("B") was calculated, using the start and end dates of the grant. The proportion of each

grant that relates to 2014 ("C") was calculated, by taking "B" as a proportion of the total length of the grant in months. The annualised commitment for each grant in 2014 ("D") was calculated, by taking "C" multiplied by the total commitment value of the grant.

This process was necessary because the Wellcome Trust accounts for grant activity on a full commitment basis.

The calculation above converts full commitment basis to "annualised commitment for active grants". The data for 2014 was prepared on the same basis as the data previously provided for the 2009/10 report.

Exclusions
The following grants and all programme related investments were excluded from the main analysis. These awards constitute the Wellcome Trust's annual commitments in support of large facilities/programmes and as such are not suitable for coding using the HRCS.

Institution	Amount Awarded (£m)	Notes
Wellcome Trust Sanger Institute	£74,320,548.00	Sanger Core Envelope- Operating Revenue: Researchers use genome sequences to advance understanding of the biology of humans and pathogens in order to improve human health.
Diamond Light Source Ltd	£5,294,079.00	Diamond - Operating Revenue
Stevenage Bioscience Catalyst	£2,000,000.00	Stevenage Bioscience Catalyst
Francis Crick Institute	£780,000.00	Francis Crick Institute - Public Art: This initiative is for the development of a major new institute for basic and translational research excellence at a site near St Pancras.
Wellcome Trust Sanger Institute	£14,901,146.00	Sanger Building Capital: Researchers use genome sequences to advance understanding of the biology of humans and pathogens in order to improve human health.
Wellcome Trust Sanger Institute	£14,253,598.00	Sanger Core Envelope - Operating Capital: Researchers use genome sequences to advance understanding of the biology of humans and pathogens in order to improve human health.
Diamond Light Source Ltd	£2,847,000.00	Diamond - Phase III

47. http://www.hrcsonline.net/pages/uk-health-research-analysis-2014
48. http://www.bbsrc.ac.uk/news/planning/strategy/priority-three.aspx

Appendix 2 – Combined Spend Breakdown by Funding Organisation

Part One – Direct Awards

Funding Organisation	2004/05		2009/10		2014			
	# Awards	Spend (£m)	# Awards	Spend (£m)	# Awards	Spend (£m)	Indirect (£m)	Total (£m)
Action Medical Research†	69	2.41	-	-	62	2.69	<0.01	2.70
Action on Hearing Loss	-	-	-	-	73	1.04	0.05	1.10
Alcohol Research UK	-	-	-	-	26	0.52	0.01	0.53
Alzheimer's Research UK†	54	1.73	-	-	108	4.14	1.27	5.41
Alzheimer's Society†	24	1.20	-	-	49	2.66	0.01	2.67
Arthritis Research UK*†	286	17.26	304	28.41	273	21.14	0.9	22.04
Arts and Humanities Research Council#	-	-	-	-	39	3.00	-	3.00
Asthma UK†	-	-	-	-	22	0.81	0.27	1.07
Ataxia UK	-	-	-	-	9	0.11	-	0.11
BACP Research Foundation	-	-	-	-	1	0.13	-	0.13
Biotechnology and Biological Sciences Research Council*	249	15.11	279	30.40	471	60.6	0.46	61.05
Breakthrough Breast Cancer†	48	1.66	-	-	10	2.23	6.81[49]	9.04
Breast Cancer Campaign†	36	4.66	-	-	111	3.74	-	3.74
British Heart Foundation*	1,038	46.27	912	64.81	726	70.76	13.22	83.98
British Lung Foundation	-	-	-	-	20	0.63	-	0.63
Cancer Research UK*	1,001	175.29	1,476	249.89	1,223	252.39	93.48	345.87
Chest, Heart & Stroke Scotland	-	-	-	-	21	0.57	-	0.57
Chief Scientist Office (Scotland)*	311	13.62	277	24.15	319	27.67	42.45	70.12
Children with Cancer UK	-	-	-	-	30	1.30	0.01	1.31
CORE	-	-	-	-	13	0.32	-	0.32
Department of Health (England)*	1,040	£96.88	1,574	217.72	1,983	285.87	358.49	644.36
Diabetes UK†	169	5.55	-	-	116	6.09	0.05	6.15
Division for Social Care and Health Research (Wales)*	43	1.84	163	17.47	116	9.02	28.31	37.34
Economic and Social Research Council*	116	9.68	250	28.36	326	36.23	40.54	76.77

Funding Organisation	2004/05		2009/10		2014			
	# Awards	Spend (£m)	# Awards	Spend (£m)	# Awards	Spend (£m)	Indirect (£m)	Total (£m)
Engineering and Physical Sciences Research Council*	407	26.30	572	96.40	591	112.38	36.3	148.68
Epilepsy Research UK†	9	0.22	-	-	21	0.73	-	0.73
Fight for Sight	-	-	-	-	141	3.11	0.08	3.19
Great Ormond Street Hospital Children's Charity	-	-	-	-	95	4.37	0.22	4.59
Guy's & St Thomas' Charity†	51	2.05	-	-	44	1.6	2.78	4.38
Health and Social Care Research and Development Division (HSC R&D) of Public Health Agency, Northern Ireland*	180	8.49	126	10.31	89	4.45	5.28	9.73
Innovate UK#	-	-	-	-	209	41.95	0.51	42.45
Juvenile Diabetes Research Foundation	-	-	-	-	28	2.55	0.61	3.16
Kidney Research UK†	63	1.79	-	-	69	2.61	0.31	2.92
Kids Kidney Research	-	-	-	-	18	0.52	-	0.52
Macular Society	-	-	-	-	10	0.20	-	0.20
Marie Curie†	16	2.23	-	-	21	1.37	0.93	2.29
Medical Research Council*	2,927	335.27	3,236	634.26	3,674	641.06	121.52	762.58
Medical Research Scotland	28	0.90	-	-	60	0.78	<0.01	0.78
Meningitis Now	-	-	-	-	10	0.41	-	0.41
Meningitis Research Foundation	-	-	-	-	4	0.19	-	0.19
Motor Neurone Disease Association†	18	0.82	-	-	49	1.38	<0.01	1.38
MQ: Transforming Mental Health	-	-	-	-	3	0.04	<0.01	0.04
Multiple Sclerosis Society†	-	-	-	-	59	2.26	0.48	2.74
National Centre for the Replacement, Refinement and Reduction of Animals in Research#	-	-	-	-	116	5.92	0.37	6.29
Natural Environment Research Council#	-	-	-	-	58	4.28	-	4.28
Northern Ireland Chest, Heart & Stroke	-	-	-	-	8	0.20	-	0.20
Orthopaedic Research UK	-	-	-	-	25	0.55	0.02	0.56
Pancreatic Cancer UK	-	-	-	-	15	0.52	-	0.52
Parkinson's UK†	45	1.66	-	-	74	5.10	0.11	5.20
Pharmacy Research UK	-	-	-	-	11	0.20	<0.01	0.20
Prostate Cancer UK	-	-	-	-	78	4.08	-	4.08
Royal Hospital for Neuro-disability	-	-	-	-	2	0.13	0.12	0.25
Sarcoma UK	-	-	-	-	11	0.12	-	0.12

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Funding Organisation	2004/05		2009/10		2014			
	# Awards	Spend (£m)	# Awards	Spend (£m)	# Awards	Spend (£m)	Indirect (£m)	Total (£m)
SPARKS†	17	0.70	-	-	31	1.20	0.02	1.22
Stroke Association†	55	2.19	-	-	37	1.87	0.13	2.00
Tenovus Cancer Care†	27	2.45	-	-	22	0.36	-	0.36
The Brain Tumour Charity	-	-	-	-	19	0.90	0.03	0.94
The British Pain Society	-	-	-	-	2	0.04	<0.01	0.04
The Dunhill Medical Trust	-	-	-	-	65	2.15	-	2.15
The Lullaby Trust	-	-	-	-	1	0.02	-	0.02
Wellcome Trust*	2,303	218.96	2,313	370.08	2,910	375.74	203.46	579.19
World Cancer Research Fund	-	-	-	-	13	0.55	-	0.55
Worldwide Cancer Research†	161	£6.96	-	-	58	3.35	-	3.35
Yorkshire Cancer Research†	47	2.72	-	-	36	2.15	0.07	2.21
All Funders							17.17	17.17
GRAND TOTALS	**10,889**	**£1.01bn**	**11,482**	**£1.77bn**	**14,934**	**£2.03bn**	**£984.2m**	**£3.01bn**

Key:

*   Funding Organisation is a member of the Health Research Analysis Forum and participated in both 2004/05 and 2009/10 analyses. In this 2014 report, data from these 12 funders is presented separately as 'HRAF Funders' and also in 'All Funders' groups.

\#   Funding organisation is new to the analysis in 2014 but is not a member of AMRC. In this 2014 report, data from these four funders are included in the 'All Funders' group.

†   Funding organisation is AMRC member that participated in the UKCRC Donation to Innovation report (2007), and data from this report is displayed under 2004/05 columns. In this 2014 report, these 21 organisation's data are included in the 'All Funders' group, but are occasionally referenced separately.

<none> Funding organisation is AMRC member and new to analysis in 2014. In this 2014 report, these organisations data are included in the 'All Funders' group.

Note: All tables in this report may contain small rounding errors. Number of Awards are direct awards only.

Part Two – Indirect Awards

Funder	Indirect Spend by Category (£m)				
	Infrastructure	Personal	Studentships	Other	TOTAL
AMRC[50]	13.3	1.1	-	-	14.4
Arthritis Research UK	0.8	0.1	-	-	0.9
BBSRC	0.5	-	-	-	0.5
BHF	8.7	-	4.5	-	13.2
CRUK	97.6	-	-	-	97.6
CSO	42.5	-	-	-	42.5
DH	358.5	-	-	-	358.5
DSCHR	10.4	-	-	17.9	28.3
ESRC	40.5	-	-	-	40.5
EPSRC	14.3	-	-	22.0	36.3
HSCNI	8.2	<0.1	-	0.4	8.6
Innovate UK	0.5	-	-	-	0.5
MRC	115.0	-	6.5	-	121.5
NC3Rs	0.4	-	-	-	0.4
Wellcome Trust	174.5	0.7	7.0	21.2	203.5
All Funders	-	-	-	17.2	17.2
TOTAL	**885.6**	**1.8**	**18.0**	**78.8**	**984.2**

The definitions of *Infrastructure, Personal*, and *Studentships* can be found in the *Changes to Data Collection* section of the main report, page 19. Any addition indirect funding is classified as 'Other' and is either described on page 19 or in the funding organisation's coding approach description in Appendix 1.

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49. Please note that this figure includes funding for our Breakthrough Breast Cancer Toby Robins Research Centre, which was incorrectly assigned to indirect costs. Breakthrough Breast Cancer has funded £8.84m directly on research, and £0.2m on indirect costs. This means that for this UKCRC analysis it does not represent the correct spend for Breakthrough Breast Cancer in all of the analyses included in this report. For accurate data please do contact the charity directly.
50. This represents the combined Indirect spend from all medium to smaller AMRC members (48 charities).

Appendix 3 – Additional Funding Sources for UK Health R&D Expenditure

The data submitted by participating organisations for this analysis does not constitute the sum total of health-relevant funding in the UK. There are many other additional funding sources outside of the scope of this analysis that can nevertheless be identified as support UK health research.

Full economic costing (fEC)

The previous analysis required both comment and uplift calculation to accommodate changes in how full economic costing (fEC) of awards changed between 2004/05 and 2009/10. This was due principally to changes in UK Government policy targeting funding to support and grow infrastructure and sustainability in the HEI sector. The changes seen in 04/05 to 09/10 were significant (e.g. Research Council funding shifted from 46% overhead on direct costing to 80% fEC) however since 2009/10 the changes have been less extreme. A full review of fEC funding impacts (RCUK/ UUK Review, April 2009[51]) and subsequent assessment of financial sustainability (Wakeham Report, June 2010[52]) has led to implementation of a range of efficiency initiatives to reduce the burden of indirect costs. For example, RCUK initiated efficiency groupings for funded research organisations in 2011, consisting of savings of 0-5% dependent on the organisations level of efficiency. Thus although the level of fEC support has remained stable between 2009 to 2014, incentives like efficiency grouping and other initiatives may have reduced funding allocation slightly.

Support for charity-funded research

Charity grants cover the direct cost of research. Based on data from Cancer Research UK and the Wellcome Trust, charity grants meet an average of 58.5% of fEC. The Government and devolved administrations make additional funding available to support indirect costs via the devolved HEFCs. In England, HEFCE established the Charity Research Support Fund (CRSF) as a specific stream of quality-related (QR) funding. Since 2010, the CRSF has stood at £198m per year[53]. The devolved HEFCs have each provided their own CRSF equivalent schemes:

- The Scottish Funding Council allocates a charity stream of funding within its main QR grant, equivalent to the HEFCE value (i.e. ~20% of FEC) in proportion to the level of charity income received in Scotland. This QR funding was £23.8m in 2013[54].
- The Welsh National Assembly provided charity support via £3.1m from HEFC Wales (HEFCW) QR funding stream in 2013/14[55].
- In Northern Ireland, the Charities Support Element is funded via the Department for Employment and Learning (DELNI) QR research funding stream. A total of £3.7m was allocated in 2013/14[56].

Therefore the combined total available charity support funding in the UK is £228m.

Quality-related (QR) and other support funding from HEFCs

Quality-related funding supports research infrastructure necessary for universities to conduct research, including permanent academic staff salaries, premises, libraries, central computing costs and a contribution to postgraduate training. In 2013/14, HEFCE allocated £1.018bn of QR funding and a further £342m in smaller support funding[57], from which a total of £370.7m (27.2%) was coded to units of assessment relevant to biomedicine[58].

The devolved HEFCs provide similar funding:

- SFC allocated a total of £230.7m in 2015/16, without unit of assessment classification[59].
- HEFCW allocated £71m in 2013/14 academic year, without unit of assessment classification[60].
- DELNI allocated £30.6m in 2013/14, with £14.5m (47.4%) classified as health relevant[61].

NHS funding of Health R&D

The funding of health-related R&D within the NHS is primarily derived from within the Department of Health (England) and the National Institute for Health Research (NIHR). This includes, among other streams, funding for Clinical Research Networks (CRNs), Biomedical Research Centres (BRCs) and Biomedical Research Units (BRUs). The funding for these elements of research infrastructure were recorded separately in the 2009/10 analysis, but are incorporated into the revised Infrastructure assessment of this report.

Devolved Government Funding (NIHR Contributions)

The devolved funding administrations for Scotland, Wales and Northern Ireland also provide core support for NHS research funding through some of the above mechanisms, principally the CRNs, and this is included under the assessment of indirect funding. In addition, the devolved nations make contributions to the Department of Health in order to gain access to specific NIHR research programmes[62]. These contributions allow their researchers to apply to these funding streams, but as these awards are not made on any geographical criteria, the amount in contributions and value of awards funded may not correlate. All grants in these communal research programmes awarded to Scotland, Wales or Northern Ireland are included in the analysis and are attributed to the devolved funders. The amounts paid in the 2013/14 financial year are in the table below:

Funding Programme	Contributors	Funding
NIHR	CSO	£7.96m
	DSCHR	£5.15m
	HSCNI	£2.88m

Table 6 – *Devolved Government Funding for NHS Programmes*

NHS support for clinical academics

In 2013 there were 3,132 clinical academics employed across 36 UK Institutions[63]. Funding from NHS constitutes 1,376 (43.9%) of clinical academic posts, the remainder split between Funding Council (43.2%) and other sources (12.9%). These 1,376 NHS-supported posts consisted of

432 Professors, 572 Readers/Senior Lecturers and 372 Lecturers. Based on current average clinical academic salaries[64], this constitutes a further ~£88m in salary alone and will be considerably more when accounting for full economic costings for staffing.

Total for Additional Funding Sources

The combined spending for health-related R&D outside of the scope of this analysis is £1.06bn (see Table 7 below):

Funding Source	Detail	Value(£m)
Charity Support Funding	Estimation of FEC support for health-relevant research from the HEFC charity support funding streams	228
Higher Education Funding Council Allocations	QR funding and additional support element funding for from HEFCs: England £370m, Scotland £230m, Wales £71m, N. Ireland £14.5m	685
Devolved Government funding for NHS programmes (inc. NIHR)	All funding from CSO, DSCHR and HSCNI are included in the main indirect assessment. NIHR contributions are recorded above, but awards are already included in the main analysis.	n/a
NHS Support for Clinical Academics	Based on 3,132 clinical academics supported in 2013.	88
Additional Sources of Funding Total		**£1.06bn**
Main Analysis (Direct and Indirect Awards) Total		£3.01bn
Combined Total 2014 (Main analysis + Additional Funding)		**£4.07bn**

Table 7 – *Final Combined Analysis Totals*

51. Research Council UK & Universities UK Report, *RCUK/UUK Review of the Impact of Full Economic Costing on the UK Higher Education Sector*, April 2006. **http://www.rcuk.ac.uk/RCUK-prod/assets/documents/reviews/fec/fecexecsum.pdf**
52. Sir William Wakeham (chair), RCUK/UUK Task Group Report, Financial Sustainability and Efficiency in Full Economic Costing of Research I UK Higher Education Institutions, June 2006. **http://www.rcuk.ac.uk/RCUK-prod/assets/documents/reviews/fec/fECReviewReport.pdf**
53. HEFCE QR business and charity support funding 2013/14, by institution: **http://www.hefce.ac.uk/media/hefce/content/What,we,do/Funding,and,investment/Funding,institutions/Annual,funding,allocations/201314/march/research/businesscharity1314.xls**
54. From internal communications. **No public reference at time of press.**
55. From HEFCW Allocations 2015/16, adjusted to 2014 prices using GDP modifiers: **https://www.hefcw.ac.uk/documents/working_with_he_providers/data_collection/QR%20model%20201516.pdf**
56. From DELNI University Recurrent Research Grant Summary for FY 2013/14: **http://www.delni.gov.uk/index/further-and-higher-education/higher-education/role-structure-he-division/he-research-policy/recurrent-research-funding/quality-related-research-funding.htm**
57. Includes London weighting on mainstream QR (£32m), research degree programme (RDP) supervision fund (£240m), business research element (£64m) and research libraries (£6m): **http://www.hefce.ac.uk/funding/annallocns/1314/research/**
58. Unit of Assessment (UoA) classifies research by area and QR funding is rated on quality of research based on Research Assessment Exercise (RAE 2008) assessment. UoAs 1-15 are relevant to biomedicine. In total, £290m of QR funding (28% of £1.018bn total) and £80.7m of other support funding (24% of £342m total) was coded UoA1-15.
59. Scottish Funding Council (SFC) Research Excellence Grant Announcement for 2015/16: **http://www.sfc.ac.uk/web/FILES/Announcements_SFCAN062015/Outcome_Agreements_for_universities_indicative_research_funding_decisions.pdf**
60. HEFCW Press Release 10th of April 2013. *Funding for Higher Education in 2013/14.* **https://www.hefcw.ac.uk/documents/news/press_releases/2013%20Press%20Releases/10.04.13%20Funding%20for%20higher%20education%20in%202013_14%20English.pdf**
61. DELNI University Recurrent Research Grant QR Allocations 2013/14: **http://www.delni.gov.uk/university_recurrent_research_grant_summary_tables_2013_14.xls**
62. These include HTA, PHR, HS&DR and EME.
63. Medical Schools Council Report, *A Survey of Staffing Levels of Medical Clinical Academics in UK Medical Schools as at July 2013*, published May 2014: **http://www.medschools.ac.uk/AboutUs/Projects/Documents/2014-Clinical-Academic-Survey-Medicine-July-2013-data.pdf**
64. Based on Threshold 6 salaries for Clinical Lecturer, Senior Lecturer and Consultants from the British Medical Association Pay Scales for 2014/15: **http://bma.org.uk/-/media/files/pdfs/practical%20advice%20at%20work/pay/clinicalacademicpayscalesengland2014.pdf**

Appendix 4 – Total UK Health R&D Expenditure

Previous UK Health R&D Estimation

In the previous HRCS Analysis (2009/10) we reported total health R&D expenditure in the UK of £8.1bn (£8.8bn at 2014 prices). Approximately 30 per cent (2.4bn) was captured as part of the 2009/10 analysis. The majority of total UK health R&D funding (60%) came from the business sector and was outside of the scope of the analysis.

In this report, a similar process has been used to provide an estimate for total UK health R&D expenditure for 2014. Due to changes in reporting over time, some methods for data gathering have been altered so direct comparisons with the 2009/10 data may not be valid. We therefore present a revised, comparable total for 2009/10 UK health R&D expenditure of £9.28bn to allow for more accurate comparison between 2009/10 estimates and the 2014 values.

Total UK R&D Expenditure

The UK Gross Domestic Expenditure on Research and Development (GERD) is issued annually by the Office for National Statistics (ONS) and the latest data for 2013 was released on the 20th of March 2015[65]. The total GERD for 2013 was £28.9bn. In current prices, the GERD was £25.054bn in 2004 and £26.796bn in 2009. This indicates on-going growth in total R&D expenditure, increasing by 7.3% in the last five years and an increase of 13.3 per cent in the last 10 years. By compound annual growth rate (CAGR), this represents a year-on-year growth of 1.44 per cent over ten years (1.35% between 2004 and 2009, 1.91% between 2009 and 2014).

To assess the proportion of the GERD that is of health relevance requires separate assessment of the Business, Private Non-Profit, University and Public Research Institute expenditures to obtain appropriate estimations. A breakdown of the funding flows between these different sectors can be seen in Figure 15 below. These combined will form the total UK health relevant R&D expenditure.
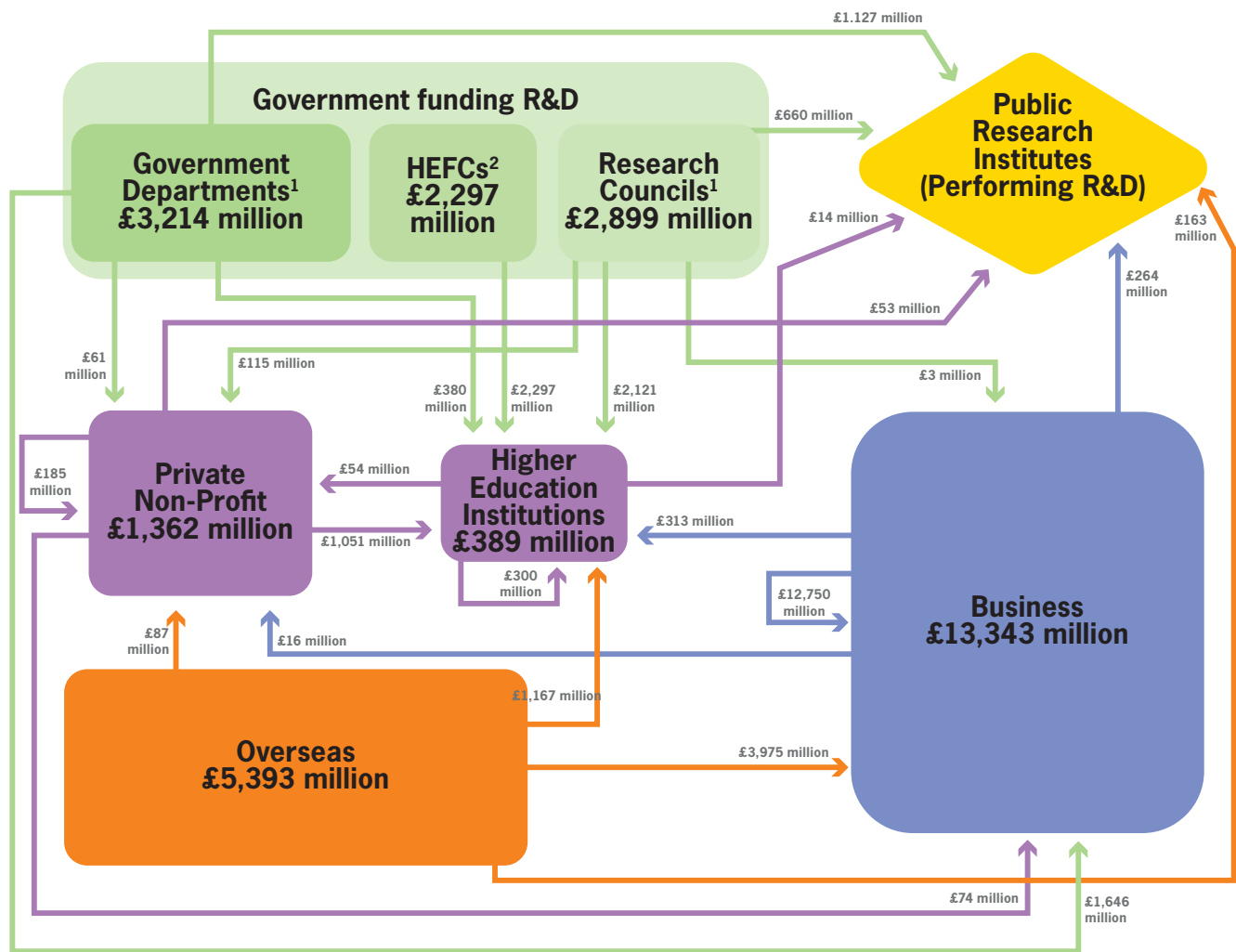
Figure 15 – *Flows of R&D funding in the UK, 2013. From the Gross Domestic Expenditure on Research and Development (GERD) issued by the Office for National Statistics (Figure 7, page 10, released 20th of March 2015).*

Research and Development in the Private Sector

Business

The Business Enterprise Research and Development (BERD), also reported annually by the ONS, gives a total expenditure within the business sector in 2013[66] of £18.4bn, of which £4.1bn (22%) is categorised as 'pharmaceuticals'. While a significant health relevant area, using data purely on pharmaceuticals will provide an underestimation of true private sector funding with health research relevance.

Interestingly, the expenditure in pharmaceutical has decreased by more than £700m since the last analysis; £4.434bn reported (£4.8bn in real terms) with a total decrease of 14.6 per cent. In the BERD, it was noted that the rate of decrease has slowed, from 15 per cent decrease

between the period of 2011 to 2012 to just 3 per cent in the period 2012 to 2013.

As there are no further public records of business expenditure, it is impossible to estimate where within the flow of funding health-relevant expenditure is occurring. Therefore the total of £4.1bn is separated from the breakdown in subsequent sector assessment.

Overseas funding for health research

This analysis focuses primarily on UK derived health expenditure, thus overseas expenditure in UK health research is excluded from this assessment.

However the contribution of overseas investment in UK R&D is substantial. Data of R&D expenditure from the GERD 2013 estimates a total of £5.4bn enters the UK from overseas. The majority (~£4.0bn) goes to industry, but £1,417m is invested in charity, university and public research institutes (PRIs). The previous report estimated 20 per cent of this funding would support health research, giving a total of £283.4m based on current data.

Private Non-Profit (Charities)

Total Private Non-Profit (PNP) expenditure in the UK GERD for 2013 was £1.362bn. The majority of PNP expenditure (£1.051bn) is within the University sector (which is assessed separately, below), whilst a further £53m goes to public research institutions and £74m to Business.

Expenditure **within** the PNP sector is £518m, with the largest contribution of £185m from re-investment within PNP sector, which would include non-profit, charity funded research institutes (e.g. CRUK's London Research Institute).

AMRC members' (137 total) UK research expenditure is reported as £1.286bn in 2014. In direct comparison with the GERD data, we estimate 93.9 per cent of PNP R&D expenditure is relevant to health[67]. Therefore the health relevant re-invested expenditure within the PNP sector is £173m (93.9% of £185m re-investment).

Of the remaining intra-PNP expenditure, Overseas (£87m) is excluded and Business (£16m) is accounted for elsewhere in this assessment, leaving £230m from Government, Research Councils and Higher Education Institutions. Using the same proportion as above (93.9%) would provide an estimate of £216m health-relevant expenditure from these funding sources. Thus the estimated total expenditure within the PNP sector relevant to health would be £389m. This is appears to be comparable with the 2009/10 estimation, which calculated PNP contribution to be approximately £350m (£379m in real terms)[68].

Research performed in the University Sector

The UK University Higher Education Institution (HEI) sector is primarily supported by government funding via the Higher Education Funding Councils (HEFCs) and the Research Councils. In the GERD 2013, the HEFCs expenditure in the HEI sector was £2.297bn, while Research Council expenditure was £2.121bn. A further £1.051bn comes from PNPs, £1.167bn from Overseas, £380m from Government Departments, £313m from businesses and £300m internal investment directly from the HEIs gives a total of £7.629bn expenditure in the University Sector.

Data on HEIs in the GERD comes from the Higher Education Research and Development (HERD) data provided to the ONS by the Higher Education Funding Councils (HEFCs). This data in turn is monitored by the Higher Education Statistics Agency (HESA). In the 2009/10 analysis, this value was estimated as £1.758bn (£1.90bn in real terms) based on HESA financial return expenditure of research grants and contracts data separated by cost centre. However the methods by which these data are collated by HESA have been revised and no directly comparable data is available. There have also been modifications to cost centre classifications which further impedes comparison.

Therefore to estimate HEI health-relevant spend, research income data is used. This is not ideal, as expenditure and income do not necessarily correlate, but does allow a breakdown of biomedically relevant funding. Table 8 (below) shows the health-relevant cost centre breakdown for research grant and contract for the 204 participatory UK HEIs. The total health-relevant income for 2013/14 is £2.7bn, constituting more than half of total research income (£5.1bn).

Given the disparate methods by which this value is calculated, it is improper to directly compare the previous HEI expenditure estimates from 2009/10 and the 2014 analysis. Instead, the same income data used in the 2014 estimate is available for 2009/10, allowing for a revision of the previous 2009/10 HEI estimation. This data is also shown in Table 8, and provides a revised figure of £2.5bn in 2014 prices, an increase of £600m from the previous metric estimate. This would increase the real terms total for the 2009/10 estimate from £8.8bn to £9.28bn.

Cost Centre	Income 2009/10		Income 2013/14	
	Real Terms (£m)	% of Total	(£m)	% of Total
101 Clinical Medicine	1,570.	62.0	1,728.9	63.7
102 Clinic Dentistry	19.1	0.8	21.4	0.8
103 Nursing & Allied Health Professionals	49.5	2.0	51.2	1.9
104 Psychology & Behavioural Science	85.8	3.4	81.1	3.0
105 Health and Community Studies	58.2	2.3	62.5	2.3
106 Anatomy & Physiology	57.3	2.3	58.6	2.2
107 Pharmacy & Pharmacology	63.9	2.5	64.9	2.4
112 Biosciences	628.	24.8	645.3	23.8
Selected Cost Centre Total (101-107,112)	2,531.8	54.1	2,713.8	53.6
TOTAL (all cost centres)	**4,680.8**	**100%**	**5,060.9**	**100%**

Table 8 – *Breakdown of income by cost centre (academic departments), for all UK Institutions available (n=204). Adapted from HESA Finance Returns (Table 5b: Research grants and contracts).*

Using these new metric values, we estimate the HEI sector expenditure has grown by £200m in real terms since 2009/10. Approximately £65m of this (35%) relates to the transfer of MRC Units to University Units would constitute a significant shift in classification of resources from Public Research Institutes (PRIs, see section below) to HEIs.

Public Sector Research Institutes

The GERD 2013 gives a total funding to public research institutes of £2.2bn, the majority coming from Government Departments (£1.127bn) and Research Councils (£660m). There are no figures available for health relevant research in this sector, thus the calculation of this value requires some additional data for various sources:

Governmental Department Contributions
The primary civil department for health relevant contributions is the Department of Health, with an estimated contribution for 2013 of £904m[69]. This includes funding to NIHR institutes and NHS Trusts.

Research Council Contributions
The primary research council for health relevant contribution is MRC, with an estimated spend within the GERD 2013 reporting period of £672m[70]. A total of £281m can be directly attributed to research institutes[71].

Additional Contributions
This includes any non-MRC and non-Health Department spend on health research within the public sector. As the GERD 2013 total of Government spend on R&D within government departments is £1.787bn, with MRC/DH accounting

for £1.185bn leaves a total of £602m. With estimated governmental R&D spend on health research at 18.6 per cent[72]; an approximate figure for additional public sector spend on health research is £112m.

Overseas funding also contributes to non-MRC research organisations. From the GERD figure this should be less than £163m in 2013. There are no further sources of data to estimate a health relevant proportion of this spending but, as overseas spend, this is excluded from this estimation.

Finally, PNP spend in non-MRC research organisations is valued at £53m in the GERD 2013, which based on a 93.9 per cent contribution from AMRC funders would make approximately £49.8m of this funding health related.

Estimated total health-relevant expenditure for Public Research Institutes
This provides an estimated total of £1.35bn for health-related public sector research institute spend, suggesting approximately 60 per cent of total expenditure in PRIs has biomedical relevance. The first estimate of this funding, presented in the HRCS analysis 2009/10, valued public

sector research institute spending at £1.55bn in real terms, thus this 2014 data suggests a five year decrease in funding of approximately £200m in real terms (-3.46% CAGR).

Total UK health-relevant R&D expenditure

The combined total estimation of health-relevant R&D expenditure of all four research sectors was £8.5bn. This estimate shows a £780m decrease (8.4%) in comparison with the revised real terms 2009/10 total of £9.28bn.Please refer to the main report on page 22 for further assessment of this figure and its implications.

65. Office for National Statistics (2015). *Gross Domestic Expenditure on Research and Development (GERD), 2013*. **http://www.ons. gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2013/index.html**
66. Office for National Statistics (2014) *Business Enterprise Research and Development 2013*, released 20th of November 2014. **http://www.ons.gov.uk/ons/dcp171778_385959.pdf**
67. NOTE: The data used to calculate the PNP estimation comes from a biennial survey of PNP organisations of which a relatively few conduct research and development, whereas AMRC expenditure comes directly from financial return data, making this comparison problematic. However the GERD report acknowledges the majority of PNP organisations performing R&D specialise in mainly health and medical research.
68. PNP expenditure in 2009/10 was estimated between £200m and £500m, with the middle range figure (£350m) used in the total UK expenditure calculation.
69. Based on Science Engineering & Technology (SET) data (2013) from BIS/ONS with most recent data from 2011/12; **https://www. gov.uk/government/uploads/system/uploads/attachment_data/file/246227/13-499-set-statistics-2013A.xls**
70. Also from the BIS/ONS SET data.
71. From MRC Annual Report (2011/12) intramural total expenditure; **http://www.mrc.ac.uk/news-events/publications/annual-report-and-accounts-201112/**
72. Using the Organisation for Economic Co-operation and Development (OECD) Gross Domestic Expenditure on R&D for the UK by sector of performance and field of science 2011 data, Medical and Health Sciences was £436.4m (18.6%) of a total science expenditure of £2.349bn; **http://stats.oecd.org/Index.aspx?DataSetCode=GERD_SCIENCE**

Appendix 5 – Table of Total Funding Distribution by Research Activity Sub Groups

Research Activity Group	Research Activity Code	2004/05 (%)	2009/10 (%)	vs. 04/05	2014 (HRAF) (%)	vs. 04/05	2014 (All) (%)	vs. 04/05
Underpinning	1.1 Normal biological development and functioning	28.28	22.14	-6.14	18.01	-10.27	17.03	-11.25
	1.2 Psychological and socioeconomic processes	1.27	0.94	-0.33	1.23	-0.04	1.17	-0.10
	1.3 Chemical and physical sciences	1.50	1.77	0.27	1.51	0.00	1.46	-0.05
	1.4 Methodologies and measurements	0.12	0.76	0.63	0.58	0.45	0.57	0.44
	1.5 Resources and infrastructure (underpinning)	2.45	1.96	-0.49	2.59	0.14	2.47	0.02
Underpinning Total		**33.63**	**27.57**	**-6.06**	**23.91**	**-9.72**	**22.69**	**-10.94**
Aetiology	2.1 Biological and endogenous factors	22.50	20.24	-2.26	18.46	-4.04	18.58	-3.92
	2.2 Factors relating to physical environment	5.42	3.30	-2.12	3.75	-1.68	3.68	-1.75
	2.3 Psychological, social and economic factors	1.60	1.31	-0.28	1.15	-0.45	1.10	-0.49
	2.4 Surveillance and distribution	1.84	2.42	0.58	1.77	-0.06	1.76	-0.08
	2.5 Research design and methodologies (aetiology)	0.22	1.16	0.93	0.75	0.53	0.75	0.52
	2.6 Resources and infrastructure (aetiology)	3.11	3.34	0.23	3.56	0.45	3.46	0.34
Aetiology Total		**34.69**	**31.77**	**-2.92**	**29.44**	**-5.25**	**29.32**	**-5.37**
Prevention	3.1 Primary prevention interventions to modify behaviours or promote well-being	0.52	1.33	0.81	2.05	1.53	1.94	1.42
	3.2 Interventions to alter physical and biological environmental risks	0.20	0.40	0.20	0.90	0.70	0.91	0.71
	3.3 Nutrition and chemoprevention	0.82	0.63	-0.20	0.94	0.11	0.91	0.09
	3.4 Vaccines	0.91	1.03	0.12	0.88	-0.03	0.91	0.00
	3.5 Resources and infrastructure (prevention)	0.03	0.36	0.33	0.58	0.55	0.55	0.52
Prevention Total		**2.48**	**3.75**	**1.27**	**5.35**	**2.87**	**5.22**	**2.74**

Research Activity Group	Research Activity Code	2004/05 (%)	2009/10 (%)	vs. 04/05	2014 (HRAF) (%)	vs. 04/05	2014 (All) (%)	vs. 04/05
Detection and Diagnosis	4.1 Discovery and preclinical testing of markers and technologies	1.88	2.57	0.70	4.10	2.22	4.35	2.48
	4.2 Evaluation of markers and technologies	2.17	1.84	-0.32	2.90	0.74	3.00	0.84%
	4.3 Influences and impact	0.14	0.12	-0.02	0.18	0.04	0.17	0.04%
	4.4 Population screening	0.52	0.76	0.24	0.76	0.25	0.73	0.21%
	4.5 Resources and infrastructure (detection)	0.57	2.04	1.47	2.03	1.46	1.95	1.38%
Detection and Diagnosis Total		**5.27**	**7.33**	**2.07**	**9.97**	**4.70**	**10.20**	**4.94**
Treatment Development	5.1 Pharmaceuticals	3.85	4.95	1.10	5.14	1.30	6.01	2.16
	5.2 Cellular and gene therapies	2.24	1.46	-0.79	2.08	-0.16	2.23	-0.01
	5.3 Medical devices	0.73	0.50	-0.23	0.88	0.15	0.91	0.18
	5.4 Surgery	0.57	0.35	-0.22	0.45	-0.12	0.44	-0.13
	5.5 Radiotherapy	0.28	0.39	0.11	0.40	0.12	0.40	0.11
	5.6 Psychological and behavioural	0.14	0.25	0.11	0.20	0.06	0.19	0.05
	5.7 Physical	0.03	0.14	0.12	0.15	0.12	0.14	0.12
	5.8 Complementary	0.01	0.00	-0.01	0.01	0.00	0.01	0.00
	5.9 Resources and infrastructure (development of treatments)	0.77	2.64	1.87	2.75	1.98	2.71	1.94
Treatment Development Total		**8.61**	**10.68**	**2.07**	**12.07**	**3.45**	**13.04**	**4.43**
Treatment Evaluation	6.1 Pharmaceuticals	3.11	3.82	0.70	4.02	0.91	4.22	1.11
	6.2 Cellular and gene therapies	0.25	0.16	-0.08	0.46	0.21	0.56	0.31
	6.3 Medical devices	0.41	0.35	-0.06	0.64	0.23	0.71	0.30
	6.4 Surgery	0.70	0.97	0.27	1.11	0.41	1.07	0.37
	6.5 Radiotherapy	0.42	0.43	0.01	0.28	-0.14	0.28	-0.14
	6.6.Psychological and behavioural	0.41	0.63	0.23	0.85	0.45	0.83	0.42
	6.7 Physical	0.40	0.56	0.16	0.58	0.18	0.58	0.18
	6.8 Complementary	0.12	0.05	-0.07	0.06	-0.06	0.06	-0.06
	6.9 Resources and infrastructure (evaluation of treatments)	2.46	1.57	-0.90	1.44	-1.03	1.37	-1.09
Treatment Evaluation Total		**8.29**	**8.55**	**0.25**	**9.44**	**1.14**	**9.69**	**1.40**

Research Activity Group	Research Activity Code	2004/05 (%)	2009/10 (%)	vs. 04/05	2014 (HRAF) (%)	vs. 04/05	2014 (All) (%)	vs. 04/05
Disease Management	7.1 Individual care needs	1.11	1.41	0.30	1.93	0.82	2.15	1.04
	7.2 End of life care	0.08	0.10	0.02	0.13	0.05	0.16	0.08
	7.3 Management and decision making	0.97	1.24	0.27	1.43	0.46	1.42	0.45
	7.4 Resources and infrastructure (disease management)	0.16	0.49	0.33	0.27	0.11	0.26	0.11
Disease Management Total		**2.32**	**3.23**	**0.91**	**3.76**	**1.44**	**4.00**	**1.68**
Health Services	8.1 Organisation and delivery of services	2.52	3.43	0.90	2.83	0.31	2.77	0.24%
	8.2 Health and welfare economics	0.62	0.56	-0.06	0.56	-0.05	0.54	-0.07%
	8.3 Policy, ethics and research governance	0.60	0.68	0.08	0.86	0.26	0.82	0.21%
	8.4 Research design and methodologies	0.59	1.15	0.57	1.06	0.47	1.00	0.42%
	8.5 Resources and infrastructure (health services)	0.38	1.30	0.93	0.75	0.37	0.71	0.33%
Health Services Total		**4.70**	**7.12**	**2.41**	**6.06**	**1.36**	**5.84**	**1.14**

Appendix 6 – Table of Total Funding Distribution by Health Category (HRAF vs. All Funders)

Health Category	2014 (HRAF)			2014 (All)			Differences		
	#	Spend (£m)	%	#	Spend (£m)	%	#	Spend (£m)	%
Blood	77	12.7	0.67	85	13.4	0.66	8	0.7	-0.01
Cancer	2085	370.4	19.53	2610	402.2	19.86	526	31.8	0.33
Cardiovascular	1227	133.2	7.02	1298	138.5	6.84	71	5.4	-0.18
Congenital Disorders	77	12.4	0.65	93	13.2	0.65	16	0.8	0.00
Ear	62	10.6	0.56	133	12.3	0.61	71	1.7	0.05
Eye	143	17.7	0.93	298	22.7	1.12	155	5.0	0.19
Generic Health Relevance	2547	467.1	24.63	2686	477.9	23.60	138	10.8	-1.03
Infection	1517	216.3	11.41	1638	226.9	11.21	121	10.6	-0.20
Inflammatory and Immune System	616	82.9	4.37	667	85.7	4.23	51	2.8	-0.14
Injuries and Accidents	75	9.0	0.47	86	9.4	0.47	11	0.4	-0.01
Mental Health	888	109.4	5.77	941	112.3	5.54	53	2.9	-0.22
Metabolic and Endocrine	310	50.9	2.68	472	60.4	2.98	162	9.5	0.30
Musculoskeletal	472	53.5	2.82	527	58.7	2.90	55	5.2	0.08
Neurological	1216	171.4	9.04	1694	194.3	9.60	478	23.0	0.56
Oral and Gastrointestinal	300	36.0	1.90	345	39.4	1.95	46	3.4	0.05
Other	93	12.4	0.66	115	13.6	0.67	22	1.2	0.02
Renal and Urogenital	125	16.4	0.86	215	19.8	0.98	90	3.4	0.11
Reproductive Health and Childbirth	329	47.0	2.48	357	48.0	2.37	28	1.0	-0.11
Respiratory	261	31.0	1.64	323	34.1	1.68	62	3.1	0.05
Skin	85	11.5	0.60	96	13.2	0.65	11	1.7	0.05
Stroke	189	24.8	1.31	253	29.0	1.43	64	4.2	0.12
GRAND TOTAL	**12696**	**£1.90bn**	**100%**	**14934**	**£2.03bn**	**100%**			

Appendix 7 – Details of Mapping between WHO DALY rates and HRCS codes

GHE #	GHE Cause ID	Mapping to HRCS Health Categories	2002		2004		2012		% Difference	
			DALY	%	DALY	%	DALY	%	vs. '02	vs. '04
2	I-A. Infectious and parasitic diseases	Infection	105.1	1.39	108.3	1.40	246.6	1.38	-0.01	-0.02
38	I-B. Respiratory infections	Infection	234.6	3.11	129.6	1.68	464.7	2.60	-0.51	0.92
42	I-C. Maternal conditions	Reproductive Health	24.3	0.32	33.3	0.43	5.5	0.03	-0.29	-0.40
49	I-D. Neonatal conditions	Reproductive Health	99.1	1.31	103.8	1.35	214.8	1.20	-0.11	-0.15
54	I-E. Nutritional deficiencies	Metabolic and Endocrine	41.5	0.55	29.2	0.38	81.5	0.46	-0.09	0.08
61	II-A. Malignant neoplasms	Cancer	1167.9	15.46	1203.5	15.59	3418	19.14	3.68	3.55
79	II-B. Other neoplasms	Cancer	18.3	0.24	20.5	0.27	61.6	0.34	0.10	0.07
80	II-C. Diabetes mellitus	Metabolic and Endocrine	99.7	1.32	139.1	1.80	230.8	1.29	-0.03	-0.51
81	II-D. Endocrine, Blood, Immune Disorders	Metabolic and Endocrine	94.6	1.25	98.4	1.28	183	1.02	-0.23	-0.26
82	II-E. Mental and Behavioural Disorders	Mental Health	1970.5*	26.08*	2057.7*	26.66*	2440	13.66	-5.45*	-6.03*
94	II-F. Neurological conditions	Neurological	-*	-*	-*	-*	1245	6.97	n/a*	n/a*
102	II-G. Sense organ diseases	Ear / Eye	334.0	4.42	543.1	7.04	274.3	1.54	-2.88	-5.50
110	II-H. Cardiovascular diseases	Blood / Cardiovascular / Stroke	1297.3	17.17	1248.8	16.18	2875	16.10	-1.07	-0.08
117	II-I. Respiratory diseases	Respiratory	690.5	9.14	638.1	8.27	1376	7.70	-1.44	-0.57
121	II-J. Digestive diseases	Oral and Gastrointestinal	383.6	5.08	392.7	5.09	713.7	4.00	-1.08	-1.09
126	II-K. Genitourinary diseases	Renal and Urogenital	92.2	1.22	71.6	0.93	501.4	2.81	1.59	1.88
133	II-L. Skin diseases	Skin	14.4	0.19	16.0	0.21	163.4	0.92	0.73	0.71
134	II-M. Musculoskeletal diseases	Musculoskeletal	306.3	4.06	316.8	4.11	1662	9.31	5.25	5.20
140	II-N. Congenital anomalies	Congenital	87.2	1.16	94.0	1.22	169.4	0.95	-0.21	-0.27
147	II-O. Oral conditions	Oral and Gastrointestinal	53.4	0.71	48.3	0.63	142.8	0.80	0.09	0.17

GHE #	GHE Cause ID	Mapping to HRCS Health Categories	2002		2004		2012		% Difference	
			DALY	%	DALY	%	DALY	%	vs. '02	vs. '04
152	III-A. Unintentional injuries	Injuries and Accidents	307.4	4.07	289.1	3.75	1152	6.45	2.38	2.70
160	III-B. Intentional injuries	Injuries and Accidents	132.0	1.75	135.3	1.75	236.1	1.32	-0.43	-0.43
0	ALL CAUSES	-	7555.0	100	7718.3	100	17856.0	100	-	-

* Previously (2002, 2004) a single category, Neuropsychiatric Conditions, therefore percentage changes are assessed comparing both Neurological and Mental Health.

Note: The previous analyses also used DALY comparison data; 2002 figures for 2004/05 and 2004 for 2009/10. Since that time there has been some minor modification to the GHE disease classifications, the most notable being the segregation of *Neuropsychiatric Conditions* to N*eurological Conditions* and *Mental and Behavioural Disorders*. These changes allows for better comparison with the HRCS *Neurological* and *Mental Health* categories, which were previously assessed together. In general the UK's burden of disease remains static for most disease classifications (<±1.5% differences) but with some notable exceptions; decreases in DALY rates are seen for *Neuropsychiatric* (HRCS *Neurological & Mental Health*) and *Sense Organs (Ear & Eye)*, but increases in *Malignant Neoplasms (Cancer), Genitourinary (Renal), Musculoskeletal* and *Injuries*. Please note there are no GHE equivalent codes for three HRCS health categories; *Inflammatory and Immune System, Generic Health Relevance* and *Other*.

Appendix 8 – Table of Total Funding Distribution by Geographical Region (2004/05, 2009/10 and 2014 All Funders)

UK Region	2004/05			2009/10		
	# Awards	Spend (£m) (real terms)	%	# Awards	Spend (£m) (real terms)	%
East Anglia	1065	148.3	12.4	1075	231.1	13.0
Cambridge	1013	145.4	12.2	998	223.6	12.6
Norwich	50	2.8	0.2	77	7.6	0.4
East Midlands	410	52.7	4.4	503	72.6	4.1
Leicester	201	24.6	2.1	175	32.2	1.8
Nottingham	190	27.2	2.3	300	33.5	1.9
North	245	20.3	1.7	350	42.0	2.4
Durham	27	1.4	0.1	43	2.6	0.1
Newcastle-upon-Tyne	205	18.1	1.5	298	38.7	2.2
North West	665	76.6	6.4	802	116.9	6.6
Liverpool	139	8.9	0.7	230	25.3	1.4
Manchester	492	63.9	5.3	540	89.2	5.0
Northern Ireland	230	14.2	1.2	190	18.8	1.1
Belfast	199	12.4	1.0	165	17.4	1.0
Coleraine	17	0.9	0.1	18	0.8	0.0
Scotland	1513	155.2	13.0	1429	204.3	11.5
Aberdeen	160	10.4	0.9	170	15.1	0.9
Dundee	252	26.1	2.2	227	37.3	2.1
Edinburgh	562	66.0	5.5	587	91.2	5.1
Glasgow	479	48.6	4.1	380	53.6	3.0
South East	1217	171.1	14.3	1406	231.7	13.1
Oxford	752	105.1	8.8	926	172.2	9.7
Southampton	194	18.2	1.5	205	21.2	1.2
Brighton	77	9.0	0.8	105	11.0	0.6

| | 2014 (All) | | | Difference vs. 04/05 | | Difference vs. 09/10 | |
# Awards	Spend (£m)	%	%	Spend	%	Spend
1,565	259.8	12.8	0.40	111.6	-0.17	28.7
1,402	244.8	12.1	-0.10	99.3	-0.51	21.2
150	13.7	0.7	0.48	10.9	0.28	6.2
563	74.9	3.7	-0.70	22.2	-0.40	2.4
214	24.4	1.2	-0.90	-0.3	-0.60	-7.8
305	45.9	2.3	-0.03	18.7	0.37	12.5
485	57.8	2.9	1.15	37.5	0.45	15.8
28	2.5	0.1	0.02	1.1	0.02	-0.1
431	49.6	2.4	0.95	31.5	0.25	10.9
1,020	122.8	6.1	-0.34	46.2	-0.54	5.9
338	37.5	1.9	1.15	28.6	0.45	12.2
603	78.5	3.9	-1.42	14.7	-1.12	-10.7
224	17.2	0.8	-0.35	2.9	-0.25	-1.7
182	14.5	0.7	-0.28	2.1	-0.28	-2.9
11	0.5	0.0	-0.07	-0.3	-0.01	-0.2
1,846	238.2	11.8	-1.24	83.0	0.26	34.0
151	14.4	0.7	-0.19	4.0	-0.19	-0.7
303	46.1	2.3	0.08	20.0	0.18	8.8
670	91.7	4.5	-0.97	25.7	-0.57	0.5
589	71.4	3.5	-0.57	22.8	0.53	17.8
2,155	319.9	15.8	1.49	148.8	2.69	88.2
1,367	217.2	10.7	1.93	112.1	1.03	45.0
124	14.3	0.7	-0.79	-3.9	-0.49	-6.9
288	33.7	1.7	0.87	24.7	1.07	22.7

UK Region	2004/05			2009/10		
	# Awards	Spend (£m) (real terms)	%	# Awards	Spend (£m) (real terms)	%
South West	445	33.9	2.8	546	55.5	3.1
Bath	78	4.8	0.4	69	4.9	0.3
Bristol	301	24.0	2.0	367	36.6	2.1
Exeter	24	1.9	0.2	51	5.4	0.3
Wales	255	19.9	1.7	434	48.2	2.7
Cardiff	220	17.7	1.5	315	37.6	2.1
Swansea	15	1.0	0.1	68	6.3	0.4
Bangor	15	1.0	0.1	35	2.9	0.2
West Midlands	399	33.0	2.8	626	63.6	3.6
Birmingham	313	27.6	2.3	459	43.5	2.5
Coventry	47	3.0	0.2	106	14.3	0.8
Yorkshire & Humberside	631	68.1	5.7	721	76.5	4.3
Leeds	258	35.0	2.9	284	31.6	1.8
Sheffield	221	20.8	1.7	255	28.3	1.6
York	104	7.4	0.6	133	11.6	0.7
London	2812	399.5	33.5	3347	591.3	33.4
All Regions	**9885**	**1192.9**	**99.9**	**11429**	**1752.6**	**98.9**
No Location Info	16	1.4	0.1	46	19.7	1.1

	2014 (All)			Difference vs. 04/05		Difference vs. 09/10	
# Awards	Spend (£m)	%	%	Spend	%	Spend
755	75.1	3.7	0.91	41.2	0.61	19.6
73	4.6	0.2	-0.17	-0.2	-0.07	-0.3
535	53.9	2.7	0.66	29.8	0.56	17.2
85	8.9	0.4	0.24	7.0	0.14	3.5
493	49.9	2.5	0.76	29.9	-0.24	1.7
375	34.5	1.7	0.20	16.8	-0.40	-3.1
66	10.0	0.5	0.40	9.1	0.10	3.8
37	4.3	0.2	0.11	3.4	0.01	1.4
640	68.1	3.4	0.56	35.0	-0.24	4.5
445	46.6	2.3	0.00	19.0	-0.20	3.1
112	14.3	0.7	0.51	11.4	-0.09	0.0
829	92.0	4.5	-1.16	24.0	0.24	15.6
353	39.3	1.9	-0.96	4.2	0.14	7.6
298	32.6	1.6	-0.09	11.8	0.01	4.3
117	13.6	0.7	0.07	6.2	-0.03	2.0
4,359	649.4	32.1	-1.43	249.9	-1.33	58.1
14934	**2,025.0**	**1.0**	**-98.90**	**832.2**	**-97.90**	**272.5**
0.0	0.0	0.0				

Appendix 9 – Table of Total Funding Distribution by Charity, Research Council and Government Funders (64 total) in 2014

Charity, RCUK and Government Funding by Research Activity

Research Activity Group	Charity		Government		RCUK		Total
	Spend (£m)	%	Spend (£m)	%	Spend (£m)	%	Spend (£m)
1 Underpinning	168	36.5	9	2.0	283	61.5	460
2 Aetiology	293	49.4	22	3.8	278	46.8	594
3 Prevention	29	27.5	34	32.6	42	39.9	106
4 Detection and Diagnosis	92	44.4	51	24.9	63	30.7	207
5 Treatment Development	124	47.1	45	17.1	94	35.7	264
6 Treatment Evaluation	62	31.5	92	46.8	43	21.7	196
7 Disease Management	11	14.1	56	69.5	13	16.4	81
8 Health Services	13	11.1	64	54.3	41	34.6	118
Grand Total	**793**	**39.1**	**375**	**18.5**	**858**	**42.3**	**£2.03bn**

Charity, RCUK and Government Funding by Health Category

Health Category	Charity		Government		RCUK		Total
	Spend (£m)	%	Spend (£m)	%	Spend (£m)	%	Spend (£m)
Injuries and Accidents	2.1	22.0	6.0	63.9	1.3	14.1	9.4
Ear	2.6	20.8	2.5	20.7	7.2	58.6	12.3
Skin	2.9	21.7	6.7	50.7	3.6	27.6	13.2
Congenital Disorders	5.2	39.6	2.9	21.8	5.1	38.6	13.2
Blood	4.3	32.3	3.7	27.5	5.4	40.3	13.4
Other	2.8	20.3	5.5	40.4	5.4	39.4	13.6
Renal and Urogenital	5.4	27.3	9.0	45.6	5.4	27.1	19.8
Eye	7.6	33.6	7.5	32.8	7.6	33.6	22.7
Stroke	6.0	20.7	15.0	51.6	8.0	27.7	29.0
Respiratory	5.7	16.7	12.0	35.1	16.4	48.2	34.1
Oral and Gastrointestinal	6.6	16.9	15.3	38.8	17.5	44.4	39.4
Reproductive Health and Childbirth	10.5	22.0	16.3	34.0	21.2	44.1	48.0
Musculoskeletal	17.5	29.9	14.3	24.4	26.8	45.8	58.7
Metabolic and Endocrine	23.8	39.3	10.9	18.0	25.8	42.6	60.4
Inflammatory and Immune System	36.8	42.9	6.7	7.8	42.2	49.3	85.7
Mental Health	25.1	22.4	42.8	38.1	44.3	39.5	112.2
Cardiovascular	82.5	59.5	26.8	19.3	29.2	21.1	138.5
Neurological	63.4	32.6	29.0	14.9	102.0	52.5	194.4
Infection	78.4	34.5	30.7	13.5	117.9	51.9	227.0
Cancer	299.2	74.4	45.7	11.4	57.3	14.3	402.2
Generic Health Relevance	104.3	21.8	65.8	13.8	307.9	64.4	478.0
Grand Total	**792.6**	**39.1**	**374.9**	**18.5**	**857.5**	**42.3**	**£2.03bn**

Appendix 10 – Additional Methods

Data Analysis

Annualised Values

The analysis used annualised values for each award, dependent on the award's total value ("commitment"), duration and period of activity in the reporting period (i.e. 1/1/2014 – 31/12/2014)[73]. Using actual 'live' spend would provide a more accurate snapshot of activity in 2014 however actual spend data for the period would only be available some months after the end of 2014 whereas commitment and duration information is available from the outset for awards. Previous analyses had used the annualised approach and we wished to be consistent with this to be able to draw comparisons over time.

Conversion of Data

Following final coding and de-duplication/data cleaning processes, the complete analysis data set was converted from single award lines to multiple lines dependent on the number of both Health Category and Research Activity codes. For example, an award of £10,000 coded with two health categories and two research activities is converted from single line:

| Award001 | £10,000 | HC1 | HC2 | RA1 | RA2 |

To multiple lines:

Award001	HC1	RA1	0.25	£2,500
Award001	HC1	RA2	0.25	£2,500
Award001	HC2	RA1	0.25	£2,500
Award001	HC2	RA2	0.25	£2,500

This conversion places all Health Categories and all Research Activities, regardless of number applied to the award in a single column. The number of new lines is show the proportions allocated to each category (4th column) and the original award value is also proportionally distributed. This allows the generation of pivot table summary data from which any required analysis can be performed.

Comparison Analysis and Calculation of Percentage Changes

To compare nominal funding values between 2004/05 and 2009/10 analyses and the current 2014 data required an inflation adjustment to generate real terms values (i.e. at current 2014 market prices). To achieve this we used the Gross Domestic Product (GDP) deflators calculated by the ONS and issued by HM Treasury[74], with 2013/14 financial year as the baseline (100). The GDP deflator values for 2004/05 and 2009/10 were 80.792 and 92.327 respectively. Therefore to calculate the 2014 values of funding from previous analyses requires the original values to be converted by a factor of 1.238 for 2004/05 (=100/80.792) and 1.083 for 2009/10 (=100/92.327). These values are referred to as "real terms" in the text and tables.

Differences between current data and previous data, adjusted to current 2014 values, are presented in three main formats:

- Difference: $= V_2 - V_1$
  Used for showing differences from the original value (V1) to the comparison value (V2) in funding totals (i.e. raw difference in Pounds Sterling) or differences in the percentage of funding allocated to an area.

- Proportional Changes: $= (V_2 - V_1)/V_1 \times 100$
  This shows percentage changes over time, calculated by comparing the difference in value proportional to the original value. This is used extensively when comparing between 04/05, 09/10 and 2014 data, and the original value is usually referenced as 'proportional to', 'compared to' or 'versus' in the text and tables.

- Compound Annual Growth Rate
  (CAGR): $= (V_2/V_1)^{(1/\#years)} - 1$
  The CAGR is applied to give a value to the year-on-year changes, as it provides an average rate at which funding increases (or decreases) over time. This report uses the CAGR to show the annual rate of change over five years (04/05 to 09/10, or 09/10 to '14) or ten years (04/05 to '14).

Spearman's Rank Correlation Coefficient

To compare similarity in funding priorities, Spearman's Rank Correlation Coefficient is used. This statistical measure is used to compare two sets of nonparametric variables by rank to assess how similar or dissimilar they are. In this context, a perfect positive correlation (r=1) would denote matches in funding priorities, whereas a perfect negative correlation (r=-1) would denote polar opposite funding prioritisation. In general, a coefficient value of $>\pm0.8$ would suggest good correlation between two datasets.

Oversight and Ownership of the Data

The compilation of data was managed via the Health Research Analysis Forum (HRAF). The HRAF includes representatives from the 12 original HRCS participating organisations plus AMRC.

Data collected in the course of this work is owned by the organisations funding the research and held in confidence by the MRC. Details of individual awards will not be circulated or published unless agreement is obtained in advance by participating organisations.

The dataset used in this analysis is available via the HRCS website (**www.hrcsonline.net**) and we encourage other organisations to make use of this data to perform further analysis beyond the scope of this report. This dataset contains all awards used in the analysis although certain modifications have been made to meet each participating organisations requirements for data publication and sharing. Any subsequent use of this data in publications and/or use of the HRCS coding process itself must cite the UKCRC as per the Conditions of Use also on the website[75].

Understanding the Health Research Classification System

The Health Research Classification System (HRCS) is a two dimensional framework for classifying research awards. One dimension of the framework, the Research Activity Codes, classifies awards according to type of research activity. The other dimension, the Health Categories, classifies research according to the area of health and disease being studied. Full details of the HRCS are available to download from **www.hrcsonline.net**.

The Research Activity Codes are modelled on the Common Scientific Outline which is a cancer research specific classification system developed by the International Cancer Research Partners[76]. The Common Scientific Outline has been successfully used by the National Cancer Research Institute (NCRI) Partners for the strategic analysis of cancer research in the UK[77]. The Research Activity Codes describe broad areas of research activity organised into eight overarching categories:

- Underpinning Research (Underpinning) - research that underpins investigations into the cause, development, detection, treatment and management of diseases, conditions and ill health
- Aetiology – identification of determinants that are involved in the cause, risk or development of disease, conditions and ill health
- Prevention of Disease and Conditions, and Promotion of Well-Being (Prevention) – research aimed at the primary prevention of disease, conditions or ill health, or promotion of well-being
- Detection, Screening and Diagnosis (Detection and Diagnosis) – discovery, development and evaluation of diagnostic, prognostic and predictive markers and technologies
- Development of Treatments and Therapeutic Interventions (Treatment Development) – discovery and development of therapeutic interventions and testing in model systems and preclinical settings

- Evaluation of Treatments and Therapeutic Interventions (Treatment Evaluation) – testing and evaluation of therapeutic interventions in clinical, community or applied settings
- Management of Diseases and Conditions (Disease Management) – research into individual care needs and management of diseases, conditions or ill health
- Health and Social Care Services Research (Health Services) – research into the provision of health and social care services, health policy and research methodology

Each of these main categories is further subdivided, to give a total of 48 Research Activity Sub-codes. The main eight Research Activity Codes can be used for a 'top level' analysis, a more detailed examination can be carried out by analysing the sub-codes of each main category, and cross-cutting analyses can be performed by combining sub-codes from across different categories.

The Health Categories are based on the International Classification of Diseases (ICD) codes[78] and contain 21 separate groupings which encompass all diseases, conditions and areas of health. Where possible these Health Categories have been designed to match the ICD codes. However, as the ICD codes only describe diseases and ill health, they are not always adaptable to capture the breadth of research funded by the participating organisations. The key differences between ICD codes and HRCS Health Categories are as follows:

- There is no appropriate ICD code to accurately classify studies of normal development and function of the immune system. Therefore the separate category of Inflammatory and Immune System was created.
- Some categories have been created in areas of specific interest to the UKCRC Partners. For instance the Stroke Research Network, part of the UK Clinical Research Network, required a separate Stroke health category.
- A further difference from the ICD codes is the Infection category, which includes all diseases caused by infectious agents regardless of the type of infection or system affected.
- Additionally a Generic Health Relevance category has been added to the system to classify research that is applicable to all diseases and conditions or general health and well-being.

Understanding the Results of the Analysis

The analysis is designed to show trends in the research activities of the largest government and charity research funders in the UK over the last decade (2004/05 to 2014). There are a number of factors that should be considered when reviewing the results of this analysis. Firstly, analysis of the database can provide valuable information on the relative amounts of directly funded research activity in different areas, but it has not been designed to analyse all spending on biomedical and health research in the UK. Secondly, a research award may have a number of objectives; the Health Research Classification System is designed to capture the central aim of the research taking place rather than every facet or possible outcome of the work. The analysis described here provides an indicator of the 'centre of gravity' of the research awards held on the database.

All participating funding bodies fund research in differing ways. All use the peer review system to ensure the quality of the research they fund. Some funders commission research to answer specific questions, but the majority use 'response mode' to fund the highest quality proposals submitted to them by the research community. In light of this, there are several factors that might influence the amount of activity in any given area of health related research. These include:

- The scientific opportunity in an area
- The size and quality of the research workforce in each area
- The 'researchability' or tractability of an area
- The burden of disease in an area
- The level of charity fundraising conducted in an area

This analysis is primarily on the combined research portfolios of the participating funders and focuses on the Health Categories and the major Research Activity Codes. It is

possible to carry out a more detailed breakdown of the research using the Research Activity Sub-codes, but these analyses are outside the scope of this report.

Finally, as the third in a series of quinquennial reports this is the first analysis to assess potential trends in funding over the 10 year reporting period. However three time points of data is still insufficient for formal trend analysis. Critically, any shift in the coding approach between funders or reports could influence the potential trends observed.

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73. For example an award with a total commitment value of £12,000 active for 12 months, beginning on the 1st of October 2014 would report an annualised spendaward of £3,000 in this analysis.
74. HM Treasury National Statistics Autumn Statement (December 2014). **https://www.gov.uk/government/uploads/system/uploads/ attachment_data/file/383986/GDP_Deflators_Autumn_Statement_December_2014_update.csv/preview**
75. **http://www.hrcsonline.net/pages/data**
76. **https://www.icrpartnership.org/CSO.cfm**
77. **http://www.ncri.org.uk/what-we-do/research-database**
78. International Classification of Diseases (ICD) **http://www.who.int/classifications/icd/en/**