

<b>Institution: University of Bristol</b>
<b>Unit of Assessment: 2: Public Health, Health Services and Primary Care</b>
<b>1. Unit context and structure, research and impact strategy</b>

## Overview

We are international leaders in population health science research. As the largest research grouping within the University of Bristol (UoB), we are one of UoB's leading drivers of research output, impact, capacity-building, training and income. In the Shanghai GRAS Ranking for Public Health UoB was 2<sup>nd</sup> and 3<sup>rd</sup> in the UK in 2019 and 2020 respectively, and 8th globally.

Our research spans discovery science based on large-scale 'omics, through translational research and pilot and feasibility trials, to large Phase III randomized trials, evidence synthesis, evaluation and implementation science. Strong links between our major externally-funded research centres facilitate this translational pathway. The Medical Research Council (MRC) Integrative Epidemiology Unit (IEU) directed by **Davey Smith** (Fellow of the Royal Society (FRS)) is internationally renowned for developing and applying research methods, including Mendelian randomization, that have transformed epidemiology and are increasingly applied to discovery science. We host and co-fund The Avon Longitudinal Study of Parents and Children (ALSPAC – also known as “Children of the 90s”), which is one of the world's most richly phenotyped birth cohorts. Translational research conducted by our National Institute for Health Research (NIHR) Bristol Biomedical Research Centre (BRC) has a strong population science focus. Public health, health services and primary care research is conducted by our two NIHR Schools of Research (Public Health and Primary Care) and NIHR Health Protection Research Unit (HPRU). Our highly regarded UK Clinical Research Collaboration (UKCRC)-registered Clinical Trials Unit has delivered major randomized trials with immediate implications for practice. Our Applied Research Collaboration (ARC West) helps bring research evidence into practice and provides training for the local health workforce. This linked research infrastructure – along with major grant funding (Section 3) – has led to creation of new University-funded posts (Section 2).

We pride ourselves on developing and supporting inter- and multi-disciplinarity across our research teams, with disciplines ranging from anthropology to statistics (Section 2). The NIHR Bristol BRC (**Iredale** (UoA1) Director; **Sterne** Deputy Director; **Davey Smith** Scientific Director) provides an important route to clinical and public health impact, with cross-cutting themes on Translational Population Science, Biostatistics and Evidence Synthesis, and Qualitative Research. Four of the five research themes are led from UoA2: Mental Health (**Gunnell/Zammit**); Nutrition (**Ness**); Perinatal and Reproductive Health (**Lawlor**); and Surgical Innovation (**Blazeby/Blom**). NIHR ARC West also builds on our strength in population health, with three of four research themes and all cross-cutting themes led from UoA2: Mental Health (**Moran**); Behavioural and Qualitative Science (**Yardley**); Applied Data Science (**Ben-Shlomo**); Integrated and Optimal Care (**Salisbury**); Healthier Childhoods (**Crawley**); Evidence (**Higgins**); Health Economics (**Hollingworth**); Implementation (**Feder**).

We seek impact at all stages of the translational pipeline, consistent with our mission to drive novel methodology-driven research, developing and evaluating interventions and preventative strategies from concept to implementation. Our Impact Case Studies exemplify how our world-leading research, underpinned by methodological development, has led directly to patient and population

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benefit across a wide range of disease areas (surgery, reproductive health, suicide and self-harm, cancer, infectious disease) and patient groups, including marginal and hard-to-reach populations such as people who inject drugs and victims of domestic violence. The underpinning research included observational studies, modelling, novel methods of evidence synthesis and health technology appraisal, and large innovative randomized controlled trials.

We prioritise support for the career development of researchers at all career stages, as individuals and teams. We strongly promote patient and public involvement, science communication and knowledge mobilisation to translate excellence in research into impact on clinical practice, public health and public policies.

Our new research strategy is to capitalise upon and expand our existing research excellence, develop new research and training in global health, digital health, and data science, advance early and mid-career researchers as our next generation of research leaders, work to remove gender and other inequalities, and promote greater diversity in our research community.

### 1.1 Research structure within UoA2

Research in Public Health, Health Services and Primary Care at UoB is delivered primarily through the Bristol Population Health Science (Specialist) Research Institute (Bristol-PHSI) led by **Relton**. This is the largest of UoB's seven such Institutes. Bristol-PHSI is cross-Faculty, with the majority of contributors within Population Health Sciences (PHS), led by **Hickman**, the largest of two sections of Bristol Medical School (BMS) led by **Blom**. The Faculty of Health Sciences is led by **Norman** (UoA1) and overseen by the Pro Vice-Chancellor (Health) (**Iredale** (UoA1)), with **Peters** as Faculty Research Director and **Relton** as Faculty Enterprise and Innovation Director. Our Bristol-PHSI research strategy identified areas of excellence and potential for growth, which here we group into four themes: **Translational Epidemiology; Public Health; Primary Care** and **Applied Health Research**.

We have doubled the number of researchers submitted in UoA2 from 84 in 2014 to 168 in 2021 (Section 2).

In 2014 UoB conducted a review of its biomedical research and education, aiming to build on the earlier success of research in population health, encourage interdisciplinary and translational research, and enhance training and teaching. This led to major restructuring of our research compared with REF2014 (Institutional Environment Statement: REF5a). The key changes were:

- Creation of Bristol Medical School (BMS) from the School of Social and Community Medicine (SSCM) and School of Clinical Sciences (SOCS) in August 2017, with SSCM changing to Population Health Sciences (PHS) contributing primarily to this UoA, and SOCS to Translational Health Sciences (THS) contributing primarily to UoA1 and UoA4. BMS successfully modernised the undergraduate medical programme around case-based learning and increased early exposure of medical students to primary care.
- The Faculty of Health Sciences was created from BMS, Bristol Veterinary School and Bristol Dental School and a new Pro Vice-Chancellor (Health), **Iredale** (UoA1), was appointed.
- Bristol-PHSI was created in 2017, in recognition of our potential to sustain world-leading research of scale (REF5a). Bristol-PHSI draws together researchers from across the Faculty of Health Sciences, as well as the Faculties of Engineering, Life Sciences, Science,

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and Social Sciences and Law. Most PHSI researchers are submitted in UoA2 but members of Bristol-PHSI have been submitted to ten other UoAs across all Main Panels.

- Bristol Health Partners (BHP), a partnership between acute and mental health NHS Trusts, the Clinical Commissioning Group and local government, was designated as an Academic Health Sciences Centre (AHSC) in 2020, one of 8 nationally.

### 1.2 Research themes and highlights

Our four themes are made up of multiple interdisciplinary research groups and teams, encouraging flexibility; our researchers can be members of several groupings. We have an exemplary track record in leveraging our core infrastructure and programme funding to generate additional University-funded posts (Section 2) and research investment (Section 3).

#### A. Translational Epidemiology

##### 33 Researchers; 1 Impact Case Study (ICS) – Lawlor

We are a centre of excellence for development and application of causal analysis methods that transform epidemiology into a core discovery science, testing effects of potentially modifiable exposures on health outcomes to guide public health policy and, increasingly, support drug development. Our outstanding longitudinal cohort resources are internationally renowned.

##### Core infrastructure and research groups

The MRC IEU, directed by **Davey Smith**, is a major focus of UoB's research activities in population health science (MRC/UoB £23M per quinquennium). It hosts six substantive research programmes: Mendelian Randomization (**Davey Smith**); Statistical Methods for Improving Causal Analyses (**Tilling**); Data Mining Epidemiological Relationships (**Gaunt**); Epigenetic Epidemiology (**Relton**); Reproductive and Cardiometabolic Health (**Lawlor**); Modification of Health Behaviour (**Munafò**, UoA4). The IEU (2013-18) successfully secured its second quinquennial funding (2018-23).

The internationally-renowned Avon Longitudinal Study of Parents and Children (ALSPAC), directed by **Timpson**, is the most widely used prospective, multi-generation birth cohort of its kind (>800 registered users across >20 countries, 18 requests for data/samples per month). Core support (MRC/Wellcome/UoB) was renewed for 2019-24 (£8M). During the REF2021 period 1272 published papers used ALSPAC data. By end 2020 ALSPAC had a study h-index of 145.

The Cancer Research UK (CRUK)-funded Integrative Cancer Epidemiology Programme (ICEP), co-directed by **Martin** and **Relton** (2015-20, £4.15M, and renewed for 2020-25, £7.7M), applies 'omic approaches and causal analysis methods to find better evidence for cancer prediction, prevention and treatment. During 2014-19 ICEP created multiple databases and analytical platforms that are openly accessible and widely used around the world. The recent renewal expands translational aspects of the programme.

Our strength in Translational Population Science (TPS) underpinned creation of our NIHR Bristol BRC (cross-cutting TPS theme led by **Davey Smith**, contributions to the Perinatal and Reproductive Health theme led by **Lawlor**).

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### Research and impact highlights

Our research made a major contribution to advancing the integration of genomic data into epidemiological enquiry through genome-wide association studies (GWAS) and large-scale sequencing efforts [Timpson, *Nature*, 2015], including those studying intergenerational effects. For example, novel variants associated with atopic dermatitis were found to be shared across other atopic disorders [Wyss, *Nat Commun*, 2018; Ferreira, *Nat Genet*, 2017].

We pioneered methodological advances, notably development and application of the causal inference method of Mendelian randomization (MR), utilized in >2000 publications since REF2014. We developed analytical tools and made widely available open-access data resources to undertake MR analysis with our MR-Base platform [Hemani, *eLife*, 2018], OpenGWAS database, LD Hub [Zheng, *Bioinformatics*, 2017] and EpiGraphDB.

In collaboration with GlaxoSmithKline (GSK) and Biogen we systematically applied these tools and platforms to prioritise drug targets [Zheng, *Nat Genet*, 2020].

We successfully and rapidly applied new methods to clinically driven research questions. MR studies showed that cholesterol-lowering statins could reduce risk of ovarian cancer, both among women with no clear family history and in women with mutations in *BRCA1* or *BRCA2* who have an elevated lifetime risk of this disease [Yarmolinsky, *JAMA*, 2020], motivating future randomized controlled trials (RCTs) of statin therapy for cancer prevention. MR demonstrated that increasing levels of physical activity reduce risks of prostate, breast and colorectal cancer by about 50% [Kazmi, *IJE*, 2019; Papadimitriou, *Nat Commun*, 2020], that obesity causes people to smoke and smoke more heavily [Carreras-Torres, *BMJ*, 2018] and is the most common cause of multiple cancers after tobacco [Lauby-Secretan, *NEJM*, 2016].

Our work improved outcomes and minimised harm with in-vitro fertilization (IVF), prompting an increase in single embryo transfers (45% to 60% from 2013 to 2016) and associated decreases in multiple pregnancies and preterm births (ICS **Lawlor**) [Smith, *JAMA*, 2015].

## B. Public Health

### 31 Researchers; 2 ICSs – Christensen & Hickman; Vickerman & Hickman

We are a centre of excellence for research and training in all aspects of Public Health. We host key NIHR infrastructure programmes covering the three pillars of Public Health: Health Promotion and Behaviour Change; Health Protection; and Health Services Research. We introduced two new MSc programmes in Public Health (2018) and Epidemiology (2019). Our Public Health training was rated top in the UK based on the 2019 National Training Survey.

### Core infrastructure and research groups

We were a founder member of the NIHR School of Public Health Research (SPHR) with infrastructure income of £3M per five years (2012-17 and 2017-22) and have played a key role in helping the SPHR achieve its objectives nationally. **Campbell** is director of SPHR at UoB and national SPHR Deputy Director and Training Lead. She led a successful bid for an additional £3.9M nationally for research capacity development in the current quinquennium.

We host the NIHR Health Protection Research Unit (HPRU) in Evaluation of Interventions, co-led by **Hickman** (UoB) and Oliver (Public Health England (PHE)) from 2014-20 (£4.6M), recently renewed as an HPRU in Behavioural Science and Evaluation co-led by **Hickman** (UoB), Oliver and

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Amlot (PHE) for 2020-25 (£4M). Our HPRU is a partnership between UoB, PHE and other universities (University of the West of England (UWE) Bristol, University of Cambridge, UCL). In its first 5 years it contributed to >350 publications and 40 research studies with PHE.

The Bristol Nutrition Biomedical Research Unit led by **Ness** (2012-17; £4.5M) was renewed (2017-22) as the Bristol BRC Nutrition Diet and Lifestyle theme (£5M).

Public Health and Prevention is one of the four core themes of NIHR ARC West (2019-25), as in the previous (2014-19) Collaboration for Leadership in Applied Health Research and Care West (CLAHRC West).

Our NIHR Public Health Research Programme – Public Health Intervention Responsive Studies Teams (PHIRST) led by **Campbell** and **Kidger** (£1.5M 2020-25) builds on success in producing methodologically rigorous, impactful and policy-relevant research with partners in local government and the NHS.

The UKRI (UK Research and Innovation) UKPRP (Prevention Research Partnership) Consortium led by **Hickman** on Tackling Root Causes Upstream of Unhealthy Urban Development (TRUUD) 2019-24 (£6.5M) is a partnership between UoB, Bristol City Council, Greater Manchester Combined Authority, UWE Bristol and the Universities of Bath, Manchester and Reading. One of four consortia funded in the first round, TRUUD created a trans-disciplinary team including engineering, economics, politics, social policy, law, urban planning, finance, and public health.

## Research and impact highlights

Our work was crucial to the Joint Committee on Vaccination and Immunisation (JCVI) recommending the introduction of the ‘MenB’ vaccine (Bexsero) in infants and was used by HM Treasury to inform vaccine procurement [Christensen, BMJ, 2014] (ICS **Christensen & Hickman**).

We showed that protein antigen vaccines for Meningitis B do not impact on carriage and transmission of meningococcus in the way that conjugate polysaccharide vaccines for Meningitis C do, so young children cannot be protected indirectly by immunising teenagers for Meningitis B [Read, Lancet, 2014; Marshall, NEJM, 2020] but can be for Meningitis C [Pace, BMJ, 2015]. We supported efficient mobilisation and enrolment to permit rapid demonstration of efficacy of a novel SARS-CoV-2 vaccine against symptomatic COVID-19 [Voysey, Lancet, 2020].

Our research strengthened global evidence on the impact and prevention of drug-related harm among people who inject drugs (PWID) [Degenhardt, Lancet Glob Health, 2017; Trickey, Lancet Gastro, 2019; Lim, Lancet Glob Health, 2020], in particular on prevention of Hepatitis C Virus (HCV) [Martin, J Hep, 2016] (ICS **Vickerman & Hickman**). We showed that prison exposure is an important driver of increased risk of HIV and HCV transmission [Stone, Lancet ID, 2018] and that HCV case-finding in primary care can be highly cost-effective [Roberts, BMJ, 2020].

We strengthened public health evidence on adverse mental health risks and social outcomes of adolescent self-harm [Mars, BMJ, 2014] and on the safety profile of varenicline, a smoking cessation therapy [Thomask, BMJ 2015].

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### C. Primary Care

#### 42 researchers; 2 ICSs – Feder; Gunnell & Biddle

As one of the largest UK centres for primary care research we are a centre of excellence for development and evaluation of interventions to improve primary care nationally and globally. We conduct research to optimise health care in the community for mental health and child health. We are at the forefront of health informatics, developing scalable methods and secure infrastructure to maximise the value that routine health and social data can add to health research.

#### Core infrastructure and research groups

UoB is a founder member of the NIHR School for Primary Care Research (NIHR SPCR) and one of only three members reselected through all three renewal exercises (most recently in 2020-25). Led by **Salisbury** (2010-17) then **Macleod** and **Turner** (from 2017), this provided research funding of ~£2.2M per five years, along with £1.5M for capacity building.

Primary care makes a major contribution to the NIHR ARC West, including the Director (**Macleod**) and four ARC themes (**Moran, Crawley, Feder, Yardley**).

We established key infrastructure through development of a 'One in a Million' NIHR-funded archive of video recordings of GP consultations for future research, used in 16 research studies in different universities on a wide range of topics.

#### Research and impact highlights

We undertook the landmark IRIS trial through a social enterprise (IRISi), which has trained >1,000 general practices. More than 20,500 women have been referred from these practices to domestic violence services (ICS **Feder**).

**Wiles, Kessler** and **Peters** conducted large multicentre trials on the management of anxiety and depression in primary care demonstrating the effectiveness of psychological therapy and optimal use of antidepressants [Gilbody, BMJ, 2015; Kuyken, Lancet, 2015; Wiles, Lancet Psychiatry, 2016; Kessler, BMJ, 2018].

Our self-harm research influenced suicide prevention globally and in the UK. The World Health Organization (WHO) and World Bank recommend restricting access to pesticides as a key contributor to suicide prevention strategies, and our research motivated changes in online safety regarding suicide content [Biddle, J Affect Disord, 2016; ICS **Gunnell & Biddle**].

**Yardley** pioneered the 'Person-Based Approach', developing digital tools to support self-management for health problems in primary care [Yardley J Med Internet Res 2015] that underpinned RCT designs [Little, Lancet Diabetes Endocrinol, 2016; Little, Lancet, 2015; Salisbury, BMJ, 2016].

We led the most influential trial of an intervention to improve management of patients with multimorbidity in primary care [Salisbury, Lancet, 2018].

Our research provides evidence cited by the National Institute for Health and Care Excellence (NICE) and antimicrobial stewardship polices internationally, regarding the effectiveness of antibiotics [Little, Lancet Infect Dis 2014], their alternatives [Hay JAMA 2017, Hayward JAMA 2017]

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and harms [Gulliford BMJ 2016, Bryce BMJ 2016] when used by primary care clinicians for common diseases.

### D. Applied Health Research

#### 62 researchers; 4 ICSs – Blom & Whitehouse; Donovan; Martin; Welton

We have changed the culture and practice of applied health research in the evaluation of surgery and invasive procedures, generating high-quality evidence to inform practice and measurement of patient outcomes. We have optimised recruitment and participation in trials previously deemed too difficult to conduct. We are internationally renowned for developing tools to assess risk of bias in research studies and for developing novel statistical methods, such as network meta-analysis, that are central to decision making by NICE, industry and other bodies evaluating new interventions.

#### Core infrastructure and research groups

Bristol Trials Centre (BTC) (**Rogers, Lane**) is a UKCRC-registered Clinical Trials Unit, combining two NIHR-funded trials centres, with a portfolio of >40 ongoing multicentre trials (spanning UoA2 and UoA1). In 2019/20 BTC (both UoAs) received £1.8M from the NIHR, compared with £0.84M in 2013/14.

Central to our success in applied health research was NIHR CLAHRC West led by **Donovan** and **Redwood** (2014-19, £10.4M grant funding and over £14M matched funding from 24 partner organisations including NHS acute and mental health Trusts, primary care, local government, other universities, industry, and third sector organisations). It was refunded as NIHR Applied Research Collaboration (ARC) West led by **Macleod** and **Redwood** (2019-24, £9M grant funding and >£8M co-funding committed to date from 25 partner organisations).

The MRC ConDuCT-II Hub (Collaboration and innovation in Difficult and Complex randomized controlled Trials In Invasive procedures) for trials methodology research (**Blazeby**) (2014-19) (£1.9M) supported cutting-edge methodological research relevant to pragmatic RCTs, with a particular focus on surgical RCTs.

Our strength in surgical research from MRC ConDuCT-II and the Musculoskeletal Research Unit (MRU) led by **Blom** and **Tobias** was taken forward by the Bristol BRC Surgical Innovation Theme (2017-22, £2.7M).

The Bristol BRC Biostatistics, Evidence Synthesis and Informatics cross-cutting theme (**Sterne, Macleod, Higgins**) supported clinically-facing research and developed health informatics in close collaboration with local NHS organisations, leading to establishment of the Health Data Research (HDR) UK South West Better Care Partnership (2020-23, £1.2M, Director **Sterne**).

Our NICE Technical Support Unit led by **Welton** (2011-22) (£2M) developed methods and guidance on conducting Technology Appraisals for NICE Clinical Guidelines.

#### Research and impact highlights

We fundamentally changed the practice of arthroplasty worldwide, with adoption of our research in NICE, US FDA and EU commission guidelines (ICS **Blom & Whitehouse**). Our research highlighted greater risks of revision surgery following newer metal-on-metal hip replacement and hip resurfacing approaches compared with long-standing metal-on-polyethylene implants [Lopez-Lopez, BMJ, 2017]. We developed a tool to guide referrals for hip surgery [Price, Health

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Technology Assessment (HTA), 2019] and provided robust evidence on rates of revision surgery in younger patients [Bayliss, Lancet, 2017].

We contributed to the transformation, nationally and globally, of the management of localised prostate cancer (ICS **Donovan**) and decision-making about prostate cancer screening (ICS **Martin**). Findings from the ProtecT Trial (Prostate testing for cancer and Treatment) [Hamdy, NEJM, 2016; Donovan, NEJM, 2016] underpinned changes of practice from routine radical (surgery or radiotherapy) treatment of low-risk prostate cancer to widespread use of active monitoring, with substantial reductions in harm. The Cluster Randomized Trial of Prostate-Specific Antigen (PSA) Testing for Prostate Cancer (CAP) RCT (>400,000 men randomized) confirmed that population-based PSA screening should not be introduced because harms were likely to outweigh benefits [Martin, JAMA, 2018].

Our globally-used tools for assessing risk of bias include: RoB2 for randomized trials [Sterne, BMJ, 2019]; ROBINS-I for non-randomized studies of interventions [Sterne, BMJ, 2016]; PROBAST for prediction modelling studies [Wolff, Ann Int Med, 2019]; and ROBIS for systematic reviews [Whiting, JCE, 2016]. Other key developments in evidence synthesis include meta-epidemiological studies to provide empirical evidence about bias and heterogeneity in randomized trials [Savović, AJE, 2018; Turner, Stat Med, 2015], ‘living’ systematic reviews to keep abreast of evidence as it accumulates [Elliott, PLoS Med, 2014], and methodological advances in network meta-analysis, health technology appraisal and population-adjusted indirect comparisons (ICS **Welton**).

We developed novel capability measures for use in economic evaluation to aid decision-making: adding approaches for end-of-life and children to the ICECAP measures [Huynh, Soc Sci Med, 2017] and methods for measuring and reporting patient-reported outcomes in cancer trials [McNair, PLoS Med, 2016; McNair, BMJ, 2019]. The innovative QuinteT Recruitment Intervention, which aims to optimise patient participation and improve recruitment to complete challenging pragmatic RCTs [Donovan, Trials, 2014; Rooshenas, PLoS Med, 2016], is being used in >25 RCTs.

### 1.3 Research and Impact strategy

Our impact strategy seeks to support the growth of, and give greater visibility to, a world-leading population health research programme that aligns with the aspirations of the Academy of Medical Sciences Report (2016) for ‘Improving the Health of the Public by 2040’. Specifically, it takes “a broader view of the drivers of health and the types of evidence we need to intervene – now and in the future – for the promotion of health and the prevention of disease”.

### Research objectives during the assessment period

We achieved all our core strategic research aims listed in REF2014, including:

- Renewal and expansion of the MRC IEU (from 34 to 134 research active members).
- Renewal and increase in research capacity of ALSPAC including successful linkage of ALSPAC to multiple (>8) health and social administrative databases.
- Membership renewal of NIHR Schools for Primary Care Research and Public Health Research.
- Expansion of our RCT portfolio, with BTC (in UoA1 and UoA2) increasing the number of trials from 29 in 2013/14 to >40 in 2019/20.
- Widespread dissemination and knowledge mobilisation of key findings from the NIHR ProtecT RCT and linked CRUK/Department of Health CAP trial of prostate cancer screening highlighted in two ICSs (**Donovan; Martin**).



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- Expansion of patient and public involvement in our research (described below).
- Expansion of postgraduate and doctoral training programmes (Section 2).
- Athena SWAN Silver Award for the newly formed BMS, building on previous Silver Awards for SSCM and SOCS.
- Renewal of NIHR CLAHRC West (as ARC West) and securing infrastructure grants that recognise our strong strategic and effective working relationships with partners in local NHS organisations, local government and other universities regionally and nationally.

## Future strategic aims and goals

We have five key priorities over the next 5 years:

**Nurture interdisciplinary and multidisciplinary research capacity and research that crosses sectoral programmes:** We are already highly multidisciplinary, with clinical and methodological experts from various disciplines working together (Section 2). We will support our research teams in developing and applying research methods and increase support for evaluating and optimising new interventions and conducting population-based trials. **We will seek renewal of MRC IEU, renewed membership of the NIHR SPHR, and renewal and expansion of the NIHR Bristol BRC.** We will focus our effort and resources on continued capacity-building, especially by supporting and **increasing opportunities for early and mid-career researchers to secure academic posts at UoB and other Higher Education Institutions (HEIs)** and increasing the diversity of our research teams and senior staff so that we better represent the population we serve. We will support and encourage stronger links between clinical and life sciences, and of our researchers with laboratory-based science, computer science, engineering, mathematics, law, economics, and political, social and behavioural sciences. We will **develop and apply for research programmes that cross Faculties and disciplines, extending beyond “health sciences” and attracting more cross-sectoral funding.**

**Expand research that harnesses new data science and digital health technologies:** We will encourage and support the integration of technologies such as novel sensor technologies and app-based interventions and methods such as causal inference, machine learning and artificial intelligence. We will establish new health record linkages with our NHS and local government partners, and work within the population-level data resources established during the pandemic. We will **increase research capacity, training opportunities, and research programmes in data science**, contributing to the national need for skills development in this area. We will **extend partnerships with external stakeholders and agencies such as Health Data Research UK, the Alan Turing Institute, NHS Digital and NHSX.**

**Develop non-academic partnerships and accelerate impact:** We will **expand and develop more partnerships with non-academic entities**, including the commercial sector, NHS, funders, policymakers, civic and government organisations (local and national), NGOs, patients and the public at all stages of the research lifecycle. We will explore a wide range of translational pathways, including conventional routes to commercialisation, policy and practice impact as well as develop strategies to enhance research uptake and implementation.

**Transform models of discovery and implementation science:** We will promote translational epidemiology as a discovery science, forming a firm foundation at the early stages of the translational pipeline to **enhance and inform drug discovery.** We will promote our model of optimising interventions and **increase the number of studies evaluating the implementation of interventions into the NHS** and other health systems. We will continue to prioritise and nurture

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our positive, equitable and intellectually open research culture, embedding principles of research improvement and responsible research and innovation across all activities (Section 1.8).

**Enhance our global profile:** We will ensure our research has international impact and seek additional opportunities to address issues of global and climate health relevance. We will **extend strategic alliances with partners in Africa and Asia and expand programmes of research including trials aligned with global and climate health priorities**, building on initiatives such as our NIHR Global Health Group on Health Systems Responses to Domestic Violence (**Feder**) and Newton UK-China AMR Partnership Hub (**Lambert**). Our Global Public Health Research Strand led by **Lambert** within UoB's Elizabeth Blackwell Institute (EBI) has identified research priorities including: multimorbidity in low and middle-income countries, for example the intersection of musculoskeletal conditions, ageing and HIV in sub-Saharan Africa (**Gregson**); and prevention of infection, for example using digital behaviour modification interventions in China (**Yardley**). We will build on recently-funded studies on the global health consequences of COVID-19 to support future pandemic recovery in low and middle-income countries, such as rapid-impact research on provision of COVID-19 care in India and self-harm in Sri Lanka.

### Achieving impact

There are several components of our impact strategy:

**Research translation through influencing clinical and public health guidelines and policies**, shown in Section 4 and exemplified by our ICSs. For example, UoA2 research has underpinned: NICE Technology Appraisal Guidance [TA304] Total hip replacement and resurfacing arthroplasty for end-stage arthritis of the hip (ICS **Blom & Whitehouse**); NICE (NG131) Prostate cancer: diagnosis and management (ICS **Donovan**); NICE [QS116] Domestic violence and abuse: quality standard (ICS **Feder**); WHO World Suicide Report (ICS **Gunnell & Biddle**); NICE [PHG 43] Hepatitis B and C testing (ICS **Vickerman & Hickman**); NICE [CG156] Fertility Problems: Assessment and Treatment (ICS **Lawlor**); US Preventative Services Task Force (USPST) recommendations on prostate-cancer-screening (ICS **Martin**); JCVI recommendations on Men B Vaccine (ICS **Christensen & Hickman**); NICE Guidelines Manual (ICS **Welton**).

**Knowledge mobilisation and impact training:** We are **innovators in knowledge mobilisation (KM) and effective involvement of patients and public** in health research. This has largely been led by our NIHR infrastructure (especially NIHR ARC West, SPCR, BRC and HPRU) with future developments underpinned by renewals in these grants and our UKPRP consortium (TRUUD). These provide the core funding for People in Health West of England (PHWE), led by colleagues at UWE Bristol, a nationally recognised collaborative network that has established and driven meaningful Patient and Public Involvement and Engagement (PPIE) for this UoA. Through PHWE we provide training and resources to support both public contributors and PPIE leads within our research teams. This includes payment policies, draft role descriptions, a newsletter, a regional PPIE network and digital tools to support on-line involvement. The Learning and Development programme covers a wide range of topics including an introduction to PPIE, co-production, digital health and evaluating public involvement.

With support from UoB's Research and Enterprise Development (RED) Division (REF5a), Bristol-PHSI maps enterprise and innovation activities to identify opportunities for focused support and impact acceleration. Several core infrastructure and programme grants also include KM fellows who work with an expanded team on communications and PPIE. For example, KM fellows

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supported optimisation and implementation of IRIS (ICS **Feder**), and won support from the Economic and Social Research Council (ESRC) to co-produce innovative health promotion materials for service users and services to switch people to low-dead space syringes, contributing to UK policies to reduce HCV transmission. Our Palliative and End-of-Life Care Research Group, with funding from the Wellcome Trust (WT) and UoB, curated and produced the Good Grief Festival, a three-day online public engagement event on grief and bereavement (Section 4).

We have embedded an Impact and Policy Engagement Manager in our local research environment who has been instrumental in catalysing policy engagement training and involvement across the career spectrum. Policy engagement champions spread expertise and experience and resulted in outputs such as policy briefing notes and internships with the Parliamentary Office for Science and Technology.

**Translation and industry support:** RED's support, including its Impact Development Team, enables initiatives such as commercialisation feasibility plans for novel epigenetic biomarkers via MRC Confidence in Concept funding (**Relton**) and spin-out company development, for example the not-for-profit smoking prevention programme ASSIST (**Campbell**). The UoB EBI Advisor on Business Development provides guidance on and facilitates commercialisation, for example establishment of an Industry Club of potential stakeholders in the MRC IEU data analytics platform MR-Base [Hemani, eLife 2018] (Section 4).

With financial support from and in scientific collaboration with Pfizer, and in partnership with both Bristol NHS Trusts, UoB has established a Centre of Excellence led by **Finn** to gather detailed epidemiological information on vaccine-preventable infectious diseases (£5M).

### 1.4 Research culture and integrity

We provide training in research governance, and engagement with public and stakeholders, through our short course programme and mandatory staff training modules. Bioethics colleagues provide training in clinical and research ethics and bioethics methodologies (supported by Bristol BRC Surgical Innovation theme and other major awards from WT and Engineering and Physical Sciences Research Council (EPSRC)/UKRI (UoAs 18 and 30). They have been recognised for their engagement with the public and professionals (UoB 2016 Engagement Award).

We endorse and support the development of the **UK Reproducibility Network** and UoB **Statement on Research Integrity**, which sets out our commitment to the highest standards of integrity in all aspects of research (REF5a). We aim for information to be shared in the public domain (including research articles and data used in research papers) with hypotheses and protocols pre-specified, and when data cannot be shared then that is clearly stated together with the reason. We have a dedicated researcher to promote and support transparency in research to augment our policies. As far as is possible and appropriate, we expect our researchers to: make their research methods, software, outputs and data open, and available at the earliest possible time, according to statements such as the Berlin Declaration; describe their data according to FAIR (Findable, Accessible, Interoperable and Reusable) Data Principles; deposit their outputs in open access (OA) repositories such as preprint servers and UoB's institutional repository for OA; and house research data in repositories such as UoB's resource data.bris.

Our commitment to open research led us to develop custom software to monitor OA to our publications, thereby ensuring that details and manuscripts are uploaded promptly to UoB's

## Unit-level environment statement (REF5b)

research repository. The system searches weekly for newly-published research articles and cross-checks them with the repository. It is monitored by dedicated administrative staff who, where necessary, contact authors to ensure the repository is current.

We actively promote the sharing of our data and being open about the uses to which they are put. We explicitly welcome requests to access ALSPAC data and samples, including a high proportion of independent projects (with no UoB collaborators involved) and we publish details of all research proposals ALSPAC approves (currently >2,500). Our MR-Base analytics platform (**Hemani, Gaunt**) catalogues >11 billion single nucleotide polymorphism-trait associations from >1600 GWAS and is updated regularly. It is openly available to anyone who wishes to register.

## 2. People

### 2.1 Staffing strategy

UoA2 research at UoB (in large part from PHS) has a longstanding and highly-regarded reputation for collegiality and intellectual openness. We provide a vibrant and supportive environment for researchers at all levels within a diverse ecosystem that encompasses team scientists, group leaders, professional services staff and early and mid-career researchers.

In PHS in 2020 there were 794 staff comprising 473 academic and technical research staff, 159 postgraduate students and 162 professional service staff. Our UoA2 submission includes 140 (83%) PHS staff, 16 from other BMS research units, 11 from Bristol Dental School, and 1 from the School of Psychological Science.

The number of researchers submitted to UoA2 in REF2021 is 168 (153 FTE, 35 Early Career Researchers (ECRs)), which has doubled compared with 84 staff (75 FTE, 21 ECRs) in REF2014. The number of UoA2 staff in senior academic roles has increased from 13 to 32 and the number of clinical academic staff from 26 to 56.

We aim to attract, support, retain and promote outstanding research active staff who conduct internationally excellent research at all stages of the translational pipeline. Our substantial expansion during the current REF period has been achieved through a combination of attracting exceptional leaders and nurturing ECRs and Mid-Career Researchers (MCRs). We work with our Faculty leadership, UoB Finance Services and UoB senior academic leadership to develop and implement business cases that create new University-funded academic appointments and doctoral studentships linked to successful major grant and infrastructure awards. All new appointments are aligned with strategic research priorities. For example, during REF2021 we:

- Funded five new research-active Lectureships and Senior Lectureships during REF20201 through our new MSc and intercalated BSc programmes, and will create further university appointments linked to iBSc and MSc programmes over the next 3-5 years.
- Created two new posts for Lecturers in qualitative methods supporting recruitment to trials (QuinteT group).
- Created a new Senior Lecturer (SL) and two Professor posts linked to the MRC ConDuCT Hub and Surgical Innovation BRC theme.
- Strengthened our evidence synthesis and health economics teams through new SL and Professor posts.
- Made strategic appointments of talented researchers from other institutions.

**Unit-level environment statement (REF5b)**

We also made a number of 'proleptic' appointments under which staff awarded externally-funded senior Fellowships, or workstream leads within major programmes, are appointed to University-funded posts after their Fellowship or programme grant finishes (Section 2.3).

Since 2014 we have appointed the following 35 new Associate Professors (AP) and Professors through promotion (29) and external recruitment (6), enhancing our research strength across UoA2:

**Translational Epidemiology:** **Davis**, Statistical Genetics; **Egger**, Clinical Epidemiology; **Fraser**, Epidemiology; **Gaunt**, Health and Biomedical Informatics; **Howe**, Epidemiology and Medical Statistics; **LewisS**, Molecular Epidemiology; **Northstone**, Medical Statistics; **Timpson**, Genetic Epidemiology.

**Public Health:** **De Vocht**, Epidemiology and Public Health; **Horner**, Sexually Transmitted Infections; **Kipping**, Public Health; **Leary**, Statistics.

**Primary Care:** **Crawley**, Child Health; **Horwood**, Social Sciences and Health; **Joinson**, Developmental Psychology; **Kessler**, Primary Care; **Moran**, Psychiatry; **Ridd**, Primary Health Care; **Turner**, Primary Care Research; **Wiles**, Epidemiology; **Williams**, Paediatric Ophthalmology; **Yardley**, Behavioural Science.

**Applied Health Research:** **Blair**, Epidemiology and Statistics; **Coast**, Economics of Health and Care; **Gregson**, Musculoskeletal Medicine; **Hinchliffe**, Vascular Surgery; **Lambert**, Medical Anthropology; **Lane**, Trials Research; **May**, Medical Statistics; **Potter**, Oncoplastic Breast Surgery; **Rogers**, Medical Statistics and Clinical Trials; **Welton**, Statistical and Health Economic Modelling; **Whitehouse**, Trauma and Orthopaedics; **Whiting**, Clinical Epidemiology; **Wyld**, Musculoskeletal Health Services Research.

We have established a multi-faceted approach to career progression and succession planning over and above new and proleptic staff appointments. In our planning process, which determines recruitment priorities, we identify strategically important areas for growth (currently translational epidemiology, primary care, economic modelling, evidence synthesis, and medical statistics/data science), over a three-year cycle. We encourage and support our senior professors to identify successors and create succession, business, and strategic plans for our major research groups. The Faculty of Health Sciences has established a pathway to substantive academic posts that will be in place for the next REF period for research staff with a track record of successful income generation and contribution to education and research training.

We recognise the vital contribution of team scientists to our research ecosystem, including the important contribution of professional service and technical colleagues (programme and project managers, administrative and technical support staff) and are actively developing career pathways for these staff. We advocated successfully for the inclusion of criteria in the revised UoB framework for progression (to grades up to Senior Research Fellow or Senior Lecturer) and promotion (to AP or Professor) that better capture collective efforts to building our research capability and generate research outputs and impact. New financial systems are in place across UoB that better recognise team science contributions to research and income generation. Faculty targets for research income are contextualised by discipline and expressed for research teams as well as individual PIs so that we can support the career progression of team scientists and provide a path to UoB-funded posts.

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### 2.2 Staff development

We are extremely proud of our inclusive research culture and subscribe fully to the Concordat to Support the Career Development of Researchers. In addition to our formal mentorship and development programmes (REF5a), we expect senior staff to offer a comprehensive range of informal support to their more junior colleagues in areas such as grant-writing, supervised reviewing of grants and manuscripts, support for new supervisors on thesis review committees and nominations to external roles. We aim to support researchers in all disciplines to maximise the impact of their research, for example through a range of training offerings and support provided by an Impact and Policy Engagement Manager.

All staff receive annual reviews, and we provide training and advice to line managers to ensure that career development, citizenship, research leadership, training and teaching contribution are discussed, and career progression planned. We encourage all staff across all levels and roles to make the most of the extensive staff development opportunities available. These include UoB courses (REF5a), NIHR leadership courses for our NIHR academy researchers, mentoring and leadership courses run by the Royal Society and Academy of Medical Sciences and the WT Research Leadership Development Programme. Sabbatical opportunities and study leave are available and considered following a transparent application process.

Staff development and training includes free access for all academic staff to our comprehensive programme of 35+ high-quality intensive short courses in research methods, covering randomized trials, epidemiology, medical statistics and data science (including genetics and epigenetics and causal inference), qualitative research, health economics, evidence synthesis, and health protection. These courses range from one to five days duration and are aimed at doctoral students, postgraduate researchers, public health specialists, health care professionals and the pharmaceutical and medical device industries. During the REF2021 period we increased the number of places to ~1000 annually, from 850 in 2013/14. Each year we collect extensive feedback on each course from attendees and organisers, review the course programme, and pilot new courses. This ensures the programme evolves to meet current and future training needs of our staff and PhD students.

We support researchers to collaborate with other research groups nationally and internationally (Section 4). We have created honorary positions for staff from, and joint appointments with, NHS, local government, PHE, UK industry and third sector, and several international universities. Such links enhance our research environment and provide opportunities for intellectual engagement and collaboration for ECRs.

### 2.3 Support for Early Career Researchers

An important strategic priority over this REF period was to create career development opportunities and secure University academic posts for talented ECRs. This was achieved both by growing research income and through income generated by provision of new taught postgraduate programmes. Most of the appointments to new University-funded posts described in Section 2.1 were to our ECRs and MCRs. We also secured a substantial increase in proleptic appointments that guarantee future academic posts, from 4 during REF2014 to 18 during REF2021. These were supported and achieved as follows:

**Unit-level environment statement (REF5b)**

**UoB contributions to major competitive funding applications:** MRC IEU future programme lead (3); NIHR ARC West team lead (4); NIHR SPHR (1); ALSPAC (1); CRUK Integrative Cancer Epidemiology Programme (1).

**Other strategic support:** Joint post in Public Health in local government (1).

**Advanced fellowships:** NIHR (2); Wellcome Sir Henry Dale Postdoctoral Fellowship (2); MRC Clinician Scientist (1); UKRI Future Leaders Fellowship (2).

Many of our ECRs secure research and academic roles in other HEIs, as well as other professional roles in a diversity of career paths. We actively support career advancement whether internal or external to UoB.

As well as the staff development opportunities described in the previous section, our ECRs are well-supported in developing a wider range of skills such as PPIE, impact development and data management, with regular opportunities to contribute through representing their peers or local research groupings in these activities. We aim to develop rounded academics with an excellent understanding of all aspects of the research environment. We have created multiple opportunities for bridging funding for ECRs through the EBI, NHS Research Capability Funding (RCF), infrastructure grants and a newly established BMS Bridging Funding Scheme, which we are piloting for UoB, for ECRs with future funding opportunities identified who cannot access other funding to secure their salary between roles. Senior staff actively encourage inclusion and development of less experienced researchers as co-investigators and workstream leads in research grants, as well as supporting them to develop and lead their own funding submissions.

**2.4 Fellowships**

We provide comprehensive support for ECRs to make fellowship applications to develop their intellectual niche, broader skills and consolidate their research independence. During the REF2021 period 124 researchers secured competitive fellowships including 33 doctoral awards (15 NIHR, 9 WT, 8 MRC, 1 Other Health Charity) and 62 postdoctoral awards (20 NIHR, 15 MRC/UKRI, 9 WT, 6 UoB Vice-Chancellor's (VC) Fellows, 10 Other Health Charities, 2 ESRC). There were 6 NIHR pre-doctoral awards for places on our MSc programme and 29 1-3 year launching fellowships that provide valuable research experience and time with our research teams for clinical and non-clinical ECRs. A key opportunity provided by UoB is the VC Fellowship Scheme (~£200k each over an average of 3 years) (REF5a). To date UoB has appointed 41 VC Fellowships across all Faculties, of which 6 are hosted in UoA2.

The Elizabeth Blackwell Institute (EBI) for interdisciplinary health research, led by **Gooberman-Hill**, manages matched UoB and WT Institutional Strategic Support Funding (£1.5M annually) that funded 38 Clinical Primers in UoA1 and UoA2. These provide early career clinicians with research experience and time to prepare for an Academic Clinical Fellowship or doctoral application.

Support continues beyond the application and interview, with ongoing training and mentorship throughout each Fellowship. Of 49 researchers who completed their fellowship since REF2014: 5 obtained another fellowship; 7 returned to clinical training; 24 moved into UoB research positions; three obtained academic positions elsewhere; and 1 is on secondment.

## Unit-level environment statement (REF5b)

During REF2021 two staff (**Lawlor, Pearson**) received European Research Council (ERC) awards and three obtained MRC New Investigator Research Grants with 50% funding from UoB (**Jones, SharpG**, now UoB-funded SLs; **Dias** now AP elsewhere).

### 2.5 Research students

We train a large multidisciplinary community of postgraduate research (PGR) students, registering 178 new students during REF2021 (an 85% increase on REF2014 UoA2), including 162 PhD students. We have developed a diverse and vibrant doctoral training environment with students from a wide array of academic and professional backgrounds, including public health, medicine, biomedical and biological sciences, mathematics and statistics, computer science, econometrics, social sciences, engineering and chemistry. Our PhD cohort are 76% female, 24% from BAME groups. Studentships are advertised internationally, with 19% of registered students from outside the EU. We offer a small number of international fee waivers (6 since 2014) for exceptional overseas candidates. We include positive action statements and ensure diversity in recruitment materials and on interview panels, and review our intake profile against all applications. Selection involves a formal interview and project presentation involving at least one member of the PGR team to ensure transparency and consistency. The BMS PGR team includes two co-Directors, six postgraduate tutors, two postgraduate administrators and five PGR student representatives.

We have attracted or retained several doctoral programmes, leveraged UoB investment in new studentships, supported applicants to secure funding through clinical and non-clinical doctoral fellowships and secured several studentship cohorts as part of major competitive grants such as the NIHR ARC West, Bristol BRC, MRC IEU and CRUK ICEP. Our funders include: Research Councils UK (RCUK, 16%), Department of Health and Social Care and NIHR (20%), WT (16%), other charities (11%) and self-funded (including overseas scholarships) (12%). Funding sources include several doctoral training programmes, notably continued WT funding for a 4-year PhD Programme in Molecular Genetic and Lifecourse Epidemiology (lead, **Relton**) since 2008; the WT GW4 (REF5Aa) Clinical Academic Training Programme (lead, **Iredale**, UoA1) since 2015; an MRC GW4-BIOMED DTP since 2015, with Population Health as one of the three themes; a cross-Faculty British Heart Foundation (BHF) PhD Programme in Integrative Cardiovascular Science (leads, **Poole, George**, UoA1, **Gaunt**) since 2017; and the cross-institutional MRC Addiction Research Clinical Training programme (lead, **Hickman**) since 2015.

Most (94%) PhD students complete their studies successfully and within their maximum study period (93% of those who complete). We offer a flexible approach to suspensions and extensions of study to meet the diverse needs of our students, with the majority being for parental leave (16 suspensions), ill health (23 suspensions, 4 extensions), or clinical work in response to the COVID-19 pandemic (11 suspensions). We provide access to low-cost childcare and a University Financial Assistance Fund for students in financial need. Based on survey data we estimate at least 50% of graduating students took up positions in research and 20% continued in clinical posts. Other career destinations include Public Health England, industry, science communication and science policy.

The 2019 postgraduate research experience survey (PRES) results reflect our high-quality PGR training environment, with 92% satisfied with their research degree experience (UK average 81%), 96% reporting receiving training in research skills (UK 76%), 96% reporting supervisors have the skills and subject knowledge to support their research (UK 92%) and all measures of wellbeing exceeding the UK average.



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Our PhD experience is enhanced by a strong training programme. A comprehensive induction programme covers what to expect from supervision, support services, training opportunities, PGR policy and University services. Our monthly graduate studies programme provides generic and core skills training, delivered by both internal and external experts. All PhD students have access to our internationally-recognised programme of 35+ short courses covering an array of research topics (Section 2.2; 192 places/year for PhD students). These are supplemented by training courses and workshops from Bristol Doctoral College (REF5a) and the UoB Advanced Computing Research Centre, with students encouraged to attend training courses throughout their degree. All students are encouraged to attend and present at national and international conferences and undertake public engagement.

We provide a comprehensive support network. All PhD students are allocated at least two supervisors (median 3), a postgraduate tutor, a postgraduate director and a PhD student 'buddy'. We are piloting a new academic mentor scheme to provide independent support for career development. Student progress is reviewed at 6 months, 12 months and annually thereafter, with annual reviews carried out by two independent academic reviewers and documentation reviewed by one postgraduate tutor and one postgraduate director. We aim to improve our PhD experience continually, with an annual programme review (APR) to update our Education Action Plan, input from students through an annual survey and inclusion of PGR student representatives in regular PhD team meetings and the APR. Recent initiatives arising from this process include an academic mentoring scheme, PGR newsletter and PGR 'town hall' meetings to promote regular dialogue between PhD students and the PGR team.

Our PhD supervisors are central to our training environment. We actively encourage training and development of new supervisors, with 40% of supervisors being ECRs or MCRs. To ensure ECRs develop effective supervisory skills, they are mentored by more senior supervisors, provided with supervisor training (run twice per year within BMS) and encouraged to supervise 4-month mini-projects (as part of 4-year PhD programmes). We actively encourage senior supervisors to engage with training to update their skills and share experiences with others. ECRs are supported in developing PGR examination skills through annual training and the support of an independent viva chair during their first examination experience.

The 2019 University Quality Team (UQT) review of our PhD programme commended our supervisor training, comprehensive approach to induction, support network, submission rates and sharing of best practice. We collaborate closely with PGR colleagues across the Faculty to ensure a consistent experience for PGR students and to share training and development opportunities. The annual Faculty PGR showcase provides an opportunity for students to present their work and network with students from other disciplines.

We established two new MSc courses during REF2021 in Public Health (started 2018/19) and Epidemiology (started 2019/20). The number of students who completed the MSc in Public Health were 13 in 2018/19 (11 women and 2 men; 2 international students) and 21 in 2019/20 (19 women and 2 men; 8 international students), increasing to 44 full-time MSc students across the programmes (37 women and 7 men; 19 international students) in 2020/21. All taught postgraduate (PGT) students have ready access to our research active staff, with extended research projects programmed into all courses.

## Unit-level environment statement (REF5b)

### 2.6 Equality, diversity and inclusion (EDI)

EDI is a prominent feature of both the UoB Strategy and Vision and Bristol-PHSI Research Strategy.

The UoA2 gender ratio has remained constant at 60% women since REF2014, although we now have a higher proportion of women in senior academic roles (53% in 2020 vs. 38% in 2014) and a higher proportion of women clinical academics (39% in 2020 vs. 25% in 2014). Between 2014 and 2020 there were increases in the proportion of staff declaring a disability (6.5% vs. 1.2%) and the proportion of BAME academic staff (13.7% vs. 11.0%) as well as BAME groups across all BMS staff (11.5% vs. 8.7%).

Highlights of our promotion of EDI during the REF2021 period include:

**Mentoring:** a variety of schemes have been developed and implemented to ensure mentoring is widely available: Bristol Clear mentoring programme; Bristol Women Mentoring Network; Elevate scheme (for women from BAME backgrounds across academic staff and professional services, run across GW4 universities); Aurora Women's Leadership Scheme; CV surgeries (annual 'single-shot' mentoring sessions with senior staff for focussed support to prioritise actions for personal development).

**Increasing access to opportunities for career development and promotion:** we adopted an annual 'staff review and development checklist' to ensure every staff member discusses criteria for their next stage of progression or promotion in their staff review. This is supplemented by regular workshops involving both academics and HR, ensuring all staff members understand the process, enhanced transparency of criteria and streamlining of promotion process.

**Clinical academic career progression:** consultations determined barriers to and improved recruitment of women clinical academics; women-only workshops for clinical academics are run annually with senior women providing advice on career progression.

**EDI in management roles and beyond:** all committees, discussion panels, recruitment panels, symposia programmes and other such events adhere to gender, and wherever possible ethnic, representation.

**Visibility of role models for staff and students:** diversity is a major priority in refreshing the BMS intranet and public-facing internet pages and communications.

**Intolerance of inappropriate behaviour:** has improved across BMS with 87% (2019 survey) of staff recognising a culture of respect. Initiatives included regular information on this topic at BMS meetings and in newsletters; posters and videos to improve communication; bystander training for staff; raising awareness about recognising and reporting inappropriate behaviour.

**Training in unconscious bias and fair and effective recruitment:** BMS offers unconscious bias training with plans to make this compulsory. 'Blinding' of protected characteristics to reduce bias in recruitment processes has been introduced, for professional services since November 2019 and for some PhD programmes since 2020.

## Unit-level environment statement (REF5b)

**Parental leave:** a buddy system has been adopted across BMS, including keeping-in-touch days and shared parenting leave. Paternal role models are presented on BMS internet pages to address diversity and will be supplemented with a series of short videos. Awareness of maternity, paternity and adoption leave has more than doubled (29% (2016) to 64% (2019)).

**Flexible working** is supported across BMS, with the implementation of a more transparent application process in 2017/18. Since then, there have been 21 requests for flexible working from academic staff in PHS.

**COVID-19 crisis communication:** during the pandemic key communications were promoted via short videos addressing important points such as staff connectedness, work security, childcare and flexible working.

**Gender pay gap:** the UoB mean gender pay gap (in men's favour) is 12.2% (REF5a). In PHS the overall gender pay gap has fallen from 21.9% in 2013/14 to 11.6% in 2019/20. The gender pay gap for non-clinical professors within PHS has reduced from 13% in 2013/14 to -2.8% (in women's favour) in 2019/20. We expect the overall gender pay gap to fall further, because in the August 2020 promotions round 8/9 people promoted to Professor or AP were women.

The BAME representation in our workplace (11%) accords with the diversity of our city; 9.9% of economically active adults in the Bristol area are from BAME groups. BMS has established an Anti-Racism Task force, inspired by the Black Lives Matter movement. This partnership between students and staff aims to design and implement strategies to identify and eliminate all forms of racism within BMS. The scope encompasses curriculum decolonisation, workforce representation, and improvement of the wellbeing of staff and students who identify as BAME. Research staff in UoA2 are prominent in a pan-UoB initiative to 'decolonise research'. BMS has signed up to the BMA Racial Harassment Charter and NHS England's Workforce Race Equality Standard.

Our academics, supported by EBI, lead on UoB's 'Mental Health in Young People' research initiative, looking at ways to improve mental health and wellbeing for young people, with a particular focus on students including PGR and PGT students.

### 2.7 Supporting interdisciplinarity and clinical researchers

Our research is done by interdisciplinary teams including both clinical academics and non-clinical researchers from a wide range of methodological disciplines. These include: anthropology, behavioural and social science, bioinformatics, computational biology, data science, epidemiology, epigenetics and genetics, ethics, health economics, informatics, mathematical modelling, statistics, trial design, public health. Clinical specialties include: genito-urinary medicine; geriatric medicine; neonatology; neurology; obstetrics and gynaecology; ophthalmology; oral medicine and maxillofacial surgery; paediatrics; palliative medicine; primary care; psychiatry (adult, child and adolescent, learning disability); public health; renal and transplantation medicine; rheumatology; surgery (breast, colorectal, gastro-intestinal, orthopaedic, trauma and vascular).

We have built capacity in clinical academic research by increasing the number of Academic Clinical Fellows (ACFs) and Academic Clinical Lecturers (ACLs), combining specialist methodological training with clinical mentoring within both the NHS and UoB. We have leveraged additional ACFs and ACLs from local NHS Trusts alongside investment from NIHR. Over the REF2021 period in UoA1 and UoA2 we supervised a total of 114 ACFs and 58 ACLs. This

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comprised 'formula' NIHR-funded posts based on past grant income (53 ACFs and 18 ACLs), plus NIHR-funded posts obtained through competition (33 ACFs and 11 ACLs) and leveraged posts funded by our local NHS Trusts and deaneries (28 ACFs and 29 ACLs). Just over half the ACFs and ACLs are in UoA2 (59 and 30 respectively).

We specialise in supporting clinical academics from specialties for which we provide the training base (such as academic primary care, psychiatry, public health, community paediatrics and surgery) as well as ACFs and ACLs who want to develop skills in translational epidemiology and applied health services research (specialties of recent trainees include dermatology, emergency medicine, medical oncology, obstetrics and gynaecology, palliative care and renal medicine). Of 31 ACFs who completed their training during REF2021, 20 started PhD programmes, funded by NIHR, MRC, WT and CRUK.

### 3. Income, infrastructure and facilities

#### 3.1 Research income

Overall UoB research spend from UoA2 researchers increased >2.5-fold from REF2014 (total £73.1M) to REF2021 (total £188.6M). Annual research spend has increased from ~£20M in 2013/14 to approximately ~£30M 2019/20.

We increased our income from all major funders and expanded the range of funding sources. Funding from UK Research Councils (including MRC and ESRC) increased >2-fold (£49M in REF2021 compared with £22.4M in REF2014). Competitive UK-based charity funding including WT, CRUK and BHF increased from £14.6M to £30.8M. UK government funding, largely from NIHR, increased >4 fold from £22M in REF2014 to £92.7M in REF2021. International funding from EU and other funders increased nearly 3-fold from £4.9M to £14.4M, including notable grants from the US National Institutes of Health (NIH) and ERC (see below).

Substantial further grant income was managed by our NHS partners. UoA2 contributes to the success of BMS and UoB, which ranks in the top ten of HEIs receiving awards from MRC and WT (REF5a). For the last six years, Bristol, North Somerset and South Gloucestershire (BNSSG) Clinical Commissioning Group (CCG), which manages our NIHR community-based research, had the highest RCF (based on total NIHR grant income) of any CCG in England. In 2018-19 NHS BNSSG CCG region recruited to the second highest number of clinical research studies nationally (55 studies). Together, our two acute NHS Trusts (University Hospitals Bristol and Weston Trust and North Bristol Hospital Trust) were the fifth-highest patient recruiting centre nationally (2014-17) with a 28% rise in patients enrolled into research trials over that period. These Trusts were the highest-recruiting UK centre for the Oxford-AstraZeneca COVID-19 vaccine trial.

Two key drivers of the success of our research teams and themes (Section 1) are: the renewal and expansion of large research programme and infrastructure grants, some of which are managed by our NHS partners; leveraging of additional research funding. For example, the initial £10.4M investment by the MRC in the first quinquennium (2013-18) of the MRC IEU attracted £11M in UoB support as well as a further £22M in additional grant funding. The strategic grant to ALSPAC from MRC and WT (2014-19) leveraged an additional £30M UoB grant income, and ALSPAC makes a substantial contribution to grants of >£100M across multiple institutions. Our programme and

## Unit-level environment statement (REF5b)

infrastructure grants also generate matched funding for PhD students and lead to creation of new core academic posts (Section 2).

Our key large infrastructure and programme grants include (\* managed in local NHS Trust):

- MRC Integrative Epidemiology Unit (IEU) (2013-18 and 2018-23), £23M per quinquennium.
- NIHR Biomedical Research Centre (BRC) (2017-22) £20.9M with £14M led by researchers within UoA2.
- NIHR Collaboration for Leadership in Applied Health Research and Care West (CLAHRC West) (2014-19); and NIHR Applied Research Collaboration West (ARC West) (2019-24) £8.9M per quinquennium with additional matched funding from local partners.
- MRC and WT: The Avon Longitudinal Study of Parents and Children (ALSPAC) (2014-19 and 2019-24) £8M per quinquennium.
- CRUK: Integrative Cancer Epidemiology Programme (2015-20) £4.15M (2020-25) £7.7M.
- NIHR-funded and UKCRC-registered Bristol Trials Centre for both UoA1 and UoA2 >£1M per year since 2014.
- NIHR School for Primary Care Research (2010-15 and 2015-21), with UoB part of the successful 2020 renewal application to take effect from 2021, £2.2M per quinquennium.
- NIHR School for Public Health Research (2012-17 and 2017-22) £2.5M per quinquennium.
- NIHR Health Protection Research Unit (HPRU) in Evaluation of Interventions (2014-20) and Behavioural Science and Evaluation (2020-25) £4M per quinquennium.
- MRC ConDuCT-II Hub (Collaboration and innovation in Difficult and Complex randomized controlled Trials In Invasive procedures) for Trials Methodology Research (2014-2019) £1.9M.
- NICE Technical Support Unit (2014-2020) >£1M.
- Health and Care Research Wales: UKCRC Public Health Research Centre of Excellence DECIPHer (Centre for the Development and Evaluation of Complex Interventions for Public Health Improvement) co-led by University of Cardiff and UoB (2009-19) £3.3M.
- National Joint Registry statistical support and analysis (2011-16 and 2016-12) >£1M per quinquennium.
- The Scar Free Foundation (originally the Healing Foundation) UK Cleft Gene Bank (2011-21) £2.3M.

New infrastructure established or gained during the REF2021 period include:

- UKRI UKPRP (Prevention Research Partnership) Consortium on Tackling Root Causes Upstream of Unhealthy Urban Development (TRUUD) (2019- 24) £6.4M.
- NIHR Public Health Research Programme – Public Health Intervention Responsive Studies Teams (PHIRST) (2020-25) £1.5M.
- HDR-UK South West Better Care Partnership (2020-23) £1.2M.
- Pfizer Center of Excellence for Epidemiology of Vaccine-Preventable Disease – Avon Community Acquired Pneumonia Study (Avon CAP) (2019-24) £4M.

Other key research grants secured during REF2014 and managed by UoB include:

- NIHR HTA: An RCT to establish the clinical and cost effectiveness of expectant management versus pre-operative imaging with Magnetic resonance cholangiopancreatography (MRCP) in patients with symptomatic gallstones undergoing laparoscopic cholecystectomy at low or moderate risk of common bile duct stones: The Sunflower Study (**Blazeby**) (2018-24) £2.8M.

## Unit-level environment statement (REF5b)

- NIHR HTA Extension: The By-Band Sleeve Study - Gastric bypass, adjustable gastric banding or sleeve gastrectomy surgery to treat severe and complex obesity: a multicentre randomized controlled trial (**Blazeby**) (2020-23) £1.3M.
- NIHR HTA: Investigating the effectiveness and cost effectiveness of using FITNET to treat paediatric Chronic Fatigue Syndrome (CFS/ME) in the UK (**Crawley**) (2016-21) £1M.
- NIHR HTA: The ProtecT Trial - Evaluating the Effectiveness of Treatments for Clinically Localised Prostate Cancer (**Donovan**) (2014-21) £2.3M.
- NIHR: Global Health Research Group on health system responses to violence against women (**Feder**) (2018-21) £2.2M.
- John Templeton Foundation: Non-genetic inheritance in human development (Golding) (2018-20) £0.99M.
- Parkinson's UK: A phase III trial of Rivastigmine to prevent falls in Parkinson's Disease: CHIEF PD (CHolinesterase Inhibitor to prEvent Falls in Parkinson's Disease) (**HendersonE**) (2019-24) £2.5M.
- MRC: Excessive drinking and alcohol related harms in Adulthood: ALSPAC at 24 (**Hickman**) (2015-19) £1.3M.
- Newton Fund (UKRI) MRC: Strategies to reduce the burden of antibiotic resistance in China (**Lambert**) (2019-22) £1.9M.
- ERC Advanced Grant: Effects of maternal gestational adiposity on fetal development and perinatal, postnatal and next generation health (DevelopObese) (**Lawlor**) (2015-21) €1.8M.
- US National Institutes of Health (NIH): Metabolomic and Epigenomic Mechanisms in Developmental Overnutrition (**Lawlor**) (NIH R01) (2014-21) \$US22.3M.
- BHF: Accelerator Award (**Lawlor**) (2019-24) £1M.
- MRC: Cohorts as Platforms for Mental Health research (CaP:MH) (**Macleod**) (2018-21) £1.5M.
- CRUK: Evaluating population-based screening for localised prostate cancer in the United Kingdom: the CAP (Comparison Arm for ProtecT) study (**Martin**) (Project Grant) (2013-17) £1.2M.
- ESRC: Bristol BioResource Laboratories – Genotyping UK Millennium Cohort Study (**Ring**) (2017-18) £1M.
- NIH/National Institute on Alcohol Abuse and Alcoholism (NIAAA): Consortium to improve Outcomes in HIV/Aids, Alcohol, Aging & multi-Substance (COMpAAAS) (**Sterne, May**) US\$2.2M.

We have an extensive portfolio of NIHR grants managed by local NHS partners. Since 2014 UoA2 researchers have been awarded >£22M in funding managed at BNSSG CCG and £21M at our two acute NHS Trusts (excluding the NIHR Bristol BRC and CLAHRC/ARC West). Major NIHR grants (£1M+) include:

- Health Services and Delivery Research (HS&DR): 3D Improving the management of patients with multimorbidity in general practice (**Salisbury**) (2014-17) £1.8M.
- HTA: BEE Best Emollient for Eczema: Pragmatic, primary care, multicentre, individually randomized superiority trial of four emollients in children with eczema, with internal pilot and nested qualitative study (**Ridd**) (2017-20) £1.4M.
- HTA: BIG ROMIO Randomized Oesophagectomy: Minimally Invasive or Open: Definitive Trial (**Metcalfe**, UoA1) (2015-22) £2.1M.
- HTA: CEDAR Children's drops for ear pain in acute otitis media: the CEDAR randomized controlled trial (**Hay**) (2015-18) £1M.

## Unit-level environment statement (REF5b)

- HTA: CHICO A clinical effectiveness investigation of a multi-faceted intervention (incorporating a prognostic algorithm) to improve management of antibiotics for CHildren presenting to primary care with acute COugh and respiratory tract infection: an efficient cluster RCT informed by a feasibility (**Blair**) (2018-22) £1M.
- Programme Grants for Applied Research (PGfAR): EPIToPe Evaluating the Population Impact of Hepatitis C Direct Acting Antiviral Treatment as Prevention for People Who Inject Drugs (**Hickman**) (2018-23) £2.8M.
- HTA: H4RT The High-volume Haemodiafiltration vs. High-flux Haemodialysis Registry Trial (**Caskey**) (2017-24) £1.8M.
- HS&DR: IMPPP Improving Medicines use in People with Polypharmacy in Primary Care (**Payne**) (2018-22) £1.9M.
- HTA: INFORM Infection after total joint replacement (**Blom**) (2014-20) £2.1M.
- PGfAR: INTERACT Integrated therapist and online CBT for depression in primary care (**Wiles, Kessler**) (2016-22) £2.5M.
- HTA: PrepareFKC The Prepare Multi-Morbid Older People for End-stage Kidney Disease Trial (**Caskey**) (2017-23) £2.8M.
- HTA: RADICAL Radiofrequency denervation for chronic and moderate to severe low back pain (**Wylde**) (2020-24) £1.8M.
- PGfAR: REPROVIDE Reaching Everyone Programme of Research On Violence in diverse Domestic Environments (**Feder**) (2016-22) £2.6M.
- HTA: REST Immediate oral, immediate topical or delayed oral antibiotics for acute otitis media with discharge (the Runny Ear Study) (**Hay**) (2018-20) £0.96M.
- PGfAR: RESTORE Improving patients experience and outcome of total joint replacement (**Blom, Wylde**) (2008-14) £2.0M.
- HTA: SISMIC Microstructural scaffold insertion following microfracture for chondral knee defects (**Whitehouse**) (2019-24) £1.3M.
- PGfAR: STAR Chronic pain after total knee replacement: Better post-operative prevention and management (**Goberman-Hill**) (2015-20) £2.0M.
- HTA: STRATAA multicentre double-blind placebo-controlled randomized trial of SerTRaline for AnxieTy in adults with a diagnosis of Autism (**Rai**) (2019-23) £1.2M.

We increased funding from industry 4-fold to £1.8M in the REF2021 period. Partnerships with industry include modelling novel interventions to prevent HCV (Gilead Sciences), network meta-analyses of new interventions (Pfizer), studies of vaccine effectiveness (GSK), developing MR-Base for use by discovery scientists (GSK, Biogen), and establishing a centre of excellence for epidemiological evidence on vaccine-preventable infectious diseases (Pfizer). **Relton** has been appointed to a new role of Faculty Innovation and Enterprise Director to co-produce a strategy for industry research funding and enhance impact through multiple modes of translation in the Faculty of Health Sciences.

### 3.2 Infrastructure and facilities

UoA2 has benefited from UoB investment (REF5a) in High Performance Computing (two new HPC clusters in this UoA; 341x16-core nodes and 120x24+-core nodes), a research data storage facility for bulk data storage, the data.bris repository for data-sharing, a research software engineering team, data science support through the Jean Golding Institute and the provision of secure digital infrastructure to support storage and analysis of confidential data.

## Unit-level environment statement (REF5b)

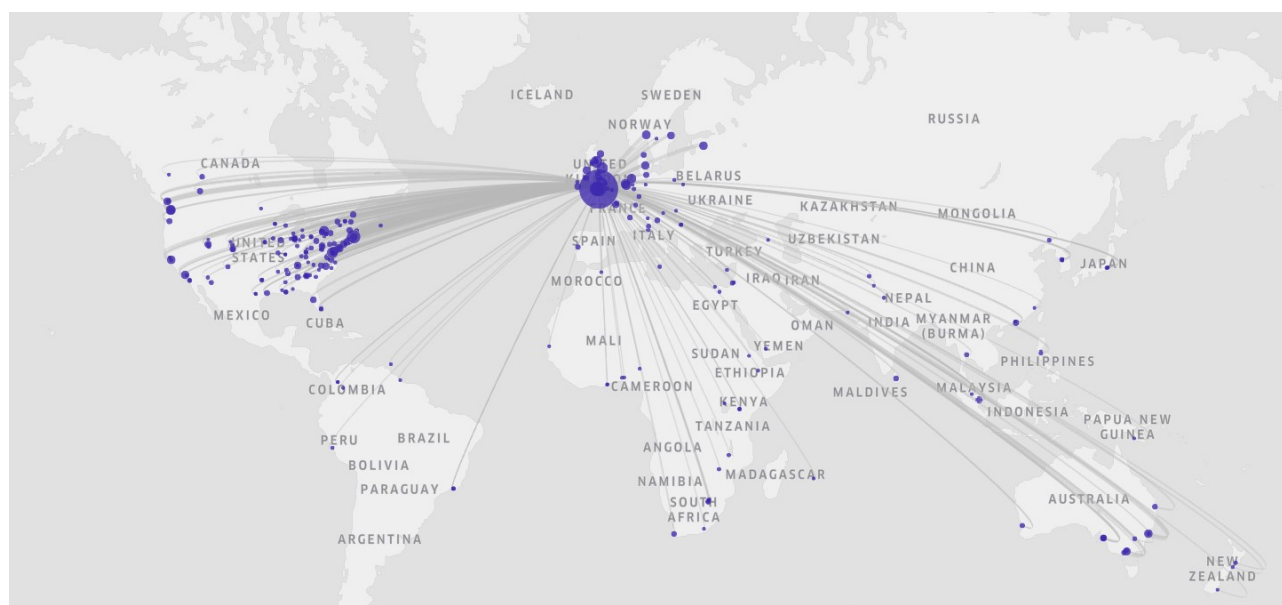
The Bristol Bioresource Laboratories (BBL) provide biological sample processing and storage service, genotyping and functional assay support to UoA2 for the benefit of researchers, other University groups and external parties. BBL is licenced by the Human Tissue Authority and is accredited to the Quality Management System Standard ISO9001. BBL received substantial investment in REF2014; it currently employs 16.6FTE staff with funding drawn from multiple sources. During REF2021 two BBL facilities were established: an Illumina Facility and an NMR Metabolomics Facility (co-located with NMR facilities in Chemistry), both generating data for a wide range of projects. Further investments in BBL included: increased research infrastructure and capacity with investment in a Tecan robot for DNA processing (£194K); upgraded to an NMR Prodigy probe to enhance use of the NMR Facility and allow processing of smaller volume samples (£170K); and purchased Fluidigm Juno System (£80K) with Biomark enhancement (£100K). BBL increased our biobanking facilities managing resources for 18 studies (from 10 in 2014) and now hold >2 million samples that are in active use by scientists in Bristol, nationally and internationally.

Professional services support, from executive assistants (EAs) and programme managers working directly with our research teams as well as central services (REF5a), is a critical infrastructure for UoA2 researchers. Each senior academic receives dedicated part-time support from an EA. We have expanded our office space for PHS researchers during the REF2021 period with an additional building (an extra 1200 sqm) of mixed office, meeting and teaching space.

### 4. Collaboration and contribution to the research base, economy and society

Our open and collaborative research environment, and distinctive contribution to the international research ecosystem, is reflected in our outputs and collaborative grants. Overall, 92% of our submitted outputs involved co-authors from other institutions, and 44% involved international co-authors. Industry co-authors were included on 7% of publications. From 2015-2019 UoA2 researchers contributed to >3,500 publications with an average 27.7 citations per publication and 29% in the top 10% most cited publications worldwide.

The figure shows the location of co-authors on submitted UoA2 outputs.





## Unit-level environment statement (REF5b)

### 4.1 Collaborations, networks and partnerships

#### Academic collaborations

Our major research centres and programmes each have a wide range of national and international collaborations, as illustrated by these examples.

Life course epidemiology: ObesityDevelop (**Lawlor**), an ERC Advanced Grant that combines data from up to 100,000 participants from nine cohorts and two consortia to study effects of maternal adiposity; LifeCycle (**Lawlor**), a Europe-wide network of >40 cohort studies with data from >250,000 European children and their parents; Longitools (**Timpson**), a collaboration of 25 EU cohorts comprising 11 million individuals studying the interactions between the environment, lifestyle and health, and the risks of cardiometabolic diseases.

Genetics: GoDMC, the genetics of DNA methylation consortium (**Relton**) comprising more than 50 academic groups globally; BIOMAP (**Paternoster**), a 12 country EU-funded collaborative network for atopic dermatitis and psoriasis. The Within Families Consortium is an international collaboration of 38 studies with family data comprising of up to 200,000 genotyped siblings, and around 100,000 genotyped parent-offspring trios and involving 116 researchers (**Davies**).

Mental health: An international consortium of cohorts to study the intergenerational transmission of mental health problems (MHINT) supported by an ERC Starter Grant (**Pearson**); membership of the US National Institute of Mental Health (NIMH)-funded Latin America Treatment and Innovation Network in Mental Health (**Peters**).

Infection: the ART Cohort Collaboration (**Sterne**) combines data from 19 HIV cohort studies in Europe and North America and has strong links with other major collaborations in North America, Europe and Southern Africa, by NIH/NIAAA award (**Sterne, May**); the HIV Modelling Consortium (**Vickerman**), which coordinates HIV modelling to inform programmatic policy in the context of sub-Saharan Africa; the International ZIKAction Consortium (**Ades**), which seeks to understand and confront the ZIKA virus epidemic and reinforce regional preparedness for other emerging infectious diseases in South and Central America.

Applied Health: Global INFORM collaboration of centres from 12 countries investigating infected joint replacements, which occur in 1 in 100 of the >160,000 joint replacements in the UK annually (**Blom, Whitehouse**); NIHR Global Health Research Group developing and testing gender-violence interventions in health care settings in Nepal, Sri Lanka, Palestine and Brazil (**Feder**).

COVID-19: ALSPAC is a COVID-19 National Core Study (**Timpson**) and, alongside Generation Scotland, leads the WT Longitudinal Population Studies COVID group, which deployed questionnaires to assess the impact of the pandemic across multiple studies; UoB (**Boyd, Macleod, Sterne, Timpson**) leads the Longitudinal Linkage Collaboration, a key component of the Longitudinal Health and Wellbeing COVID-19 National Core Study (co-lead, **Sterne**). UoB (**Sterne**) led WHO-coordinated meta-analyses establishing clinical benefit of corticosteroids in critically ill COVID-19 patients.

## Unit-level environment statement (REF5b)

### Networks

We are members of the: GW4 Alliance (REF5a), with which we share resources and expertise; HDR-UK, a national network to advance health data science to which we bring extensive data linkage and analytics expertise (**Sterne**, Director of HDR UK South West); Alan Turing Institute, the UK's national institute for data science and artificial intelligence (Fellows **Gaunt, Davis**); UK network of 20 NIHR BRCs; UK network of 15 NIHR ARCs; UK-wide group of MRC Units; NIHR networks including our leadership roles in two NIHR Schools and HPRUs (where we are leading on behavioural science network). We cultivate and maintain extensive internal cross-disciplinary networks within UoB through URIs and SRIs (REF5a).

### Partnerships

We work closely with numerous stakeholder groups to ensure the translation of our research endeavour into impactful gain for society and the economy. These include academic and other research organisations, government agencies, industry, special interest groups, national representative and advisory groups, professional groups and their representative bodies, consumer and patient groups, non-Governmental organisations and community groups.

As illustrative examples, we were instrumental in establishing Bristol Health Partners and since 2020 the Bristol Academic Health Science Centre, a formal academic health sciences partnership between the Universities, NHS Trusts and Bristol City Council providing a collaborative environment for integrating research, innovation, clinical practice and education to improve local public health and healthcare delivery in a population health context. Local academics, commissioners, clinicians, and members of the public have formed 'Health Integration Teams' (HITs) to develop NHS-relevant research programmes and service improvements. HITs led by this UoA include: respiratory tract infections (**Hay**); Bristol bones and joints (**Clark, Blom**); sexual health (**Horner**); improving care in self-harm (**Mars, Biddle**); Drugs and alcohol (**Thomas**); Bristol immunisation group (**Finn**); Supporting Healthy Inclusive Neighbourhood Environments (**Audrey**); perinatal mental health (**Evans**); Avoiding hospital admissions (**Purdy**); Psychosis (**Sullivan**); Adverse childhood experiences (**Macleod**), and Psychological therapies in primary care (**Wiles**).

Our research led to industry partnerships and investment in our informatics and data analytics platforms to enhance causal evidence for drug discovery decision making. The data analysis tools (e.g., MR-Base, OpenGWAS, EpiGRaphDB; **Gaunt, Hemani**) are freely available and openly accessible, allowing scientists all over the world to benefit from our expertise (Section 4). For example, OpenGWAS database (126 billion genetic associations from 34,513 GWAS datasets) attracting international use by a wide range of audiences (~1000 unique users/month from more than 30 different countries). These tools have been developed and tailored in response to industry priorities.

We secured direct investment from GSK, Biogen and a partnership with Oracle to develop and provide cloud-based GWAS data resources and have partnered with Takeda, Pfizer and Sanofi in research projects.

Partnerships with social enterprise include IRISi, established to promote and improve the healthcare response to gender-based violence and Evidence to Impact, a not-for profit University-owned company that aims to maximise the impact of evidence-based public health interventions.

## Unit-level environment statement (REF5b)

### 4.2 Exemplars of interdisciplinary research

Our approach to randomized trials is inherently interdisciplinary: trials often begin with qualitative work to ensure that recruitment targets are feasible. The QuinteT team (**Donovan, Avery, Jepson, Rooshenas, Wade**) has pioneered qualitative approaches to optimise recruitment and participation in RCTs and is currently being used in 25 trials led from UoB and elsewhere. Trials are led by clinicians in conjunction with dedicated trialists and statisticians (**Lane, Metcalfe** (UoA1), **MacNeill, Peters, Rogers**) and including associated economic evaluation (**Hollingworth, Noble, Coast**). For example, the NIHR-funded Prepare for Kidney Care Trial, which includes the QuinteT intervention (**Donovan, Rooshenas**), clinical (**Caskey, Salisbury**), trialist (**Lane**), statistical (**MacNeill**), epidemiological (**Ben-Shlomo**), economic (**Coast**) and ethical (**Huxtable**, UoA18) input as well as PPIE co-investigators. This is the case for all our large trials (Section 3).

Our work on antimicrobial resistance (AMR) involves multiple disciplines in human and veterinary healthcare and engineering including AMR stewardship in Primary Care (**Hay**). **Lambert** has been appointed a Global Health Challenge Leader by UK Research and Innovation (UKRI), leads the MRC National PhD Training Programme in antimicrobial resistance research, and in 2015 was appointed as the ESRC Research Champion for AMR.

Close links with colleagues in the Faculty of Engineering have grown through the SPHERE initiative (a Sensor Platform for Healthcare in a Residential Environment), which has developed technologies for monitoring activities of daily living relevant to health. In addition, >20 UoA2 researchers make a major contribution to EPSRC-funded doctoral training programmes in Digital Health and Care and Statistics, hosting students undertaking interdisciplinary projects.

Our research response to the COVID-19 pandemic exemplifies our interdisciplinary research environment. We supported evaluation of new vaccines (**Finn**), including the Oxford-AstraZeneca COVID-19 vaccine Phase III trial. We have supported treatment trials in UK and internationally (**Blencowe, Sterne**), evaluated new antibody tests in collaboration with PHE (**Jones**), and provided behavioural science expertise to PHE studies on effectiveness of mitigations measures (**Yardley**). We collaborated with WHO and trial investigators around the world to produce a prospective meta-analysis of the effect of corticosteroids on critically ill patients with COVID-19, and are conducting similar work on anti-IL-6 agents and anticoagulants (**Sterne, Higgins, Savović**). Our researchers contributed to the Scientific Advisory Group for Emergencies (SAGE), Scientific Pandemic Insights Group on Behaviours (SPI-B) (**Yardley**) and Scientific Pandemic Influenza Group on Modelling (SPI-M) (**Brooks-Pollock**, UoA6). We developed the first UK-specific model of COVID-19 mitigation in universities and made the code available to other institutions (**Brooks-Pollock**, UoA6). We lead the UoB Scientific Advisory Group for COVID-19 and city-wide UKRI/NIHR-funded Urgent Public Health COVID-19 Mapping and Mitigation in Schools (CoMMinS) study (**Relton**).

### 4.3 Engaging the public and diverse communities

Engagement activities involve a broad array of media including press and broadcast, interactive exhibitions and public lectures and the production of literature and web-based information. Many researchers contribute to TV and radio debate of current research news, give media interviews and public talks and lectures, and press releases result in coverage across the world. Activities to engage general audience include, for example, 'George **Davey Smith**: The Life Scientific', BBC Radio 4. Accolades in public engagement include the "Rising Star in Public Engagement" from CRUK (2017) (**Wade**).

## Unit-level environment statement (REF5b)

We worked closely with Bristol's 'We The Curious' science centre on several projects, including developing a game based on causal networks of human health. ALSPAC has a permanent fixture in We The Curious on the health of the city, representing one of its many strong links with the Bristol public. We have a regular presence at regional and national Science Festivals. For example, we organise a 'Good Grief' festival (**Selman**), co-created with local and national partner organisations, including Cruse Bereavement Care, St Peter's Hospice, Creative Youth Network and Museums and Art Galleries in the city. The event was accessed by >12,000 people (c.25% international audience) and achieved widespread media coverage with a reach of 1.2 billion through >70 news articles across UK and international press and broadcast media.

Supported by the Health Foundation, we assisted Public Health Wales, the Welsh Government and volunteer organisations to understand community-level response to the COVID-19 pandemic using untapped digital and open data (**Davis**). This resulted in a widely accessed open-source visual analysis tool.

Based on our study of the experiences of Somali families bringing up children with autism in Bristol (**Redwood**), ARC West co-produced films in English and Somali, highlighting experiences of accessing services and potential solutions to the barriers Somali families face in the UK. Films are publicly available on YouTube and have been accessed >200,000 times. They are used in medical curricula, and in training for professionals in health, social care and education. NIHR identified it as an exemplar for diversity in community engagement, and it was cited in a report by UN High Commissioner for Refugees.

### 4.4 Indicators of influence

As illustrated below, members of this UoA make numerous contributions to the sustainability of the discipline and in shaping its strategic direction.

#### Chairing of research council funding panels or similar national or international funding bodies

- Academy of Medical Sciences Sectional Committee Six (**Peters**),
- CRUK, Population Research Committee (Epidemiology and Methodology Expert Review Panel) (**Martin**)
- Health and Care Research Wales (HCRW) Senior Research Leaders Selection Panel (**Peters**)
- HCRW Health Research Grants/Fellowships Scientific Board (**Peters**)
- Health Research Board in Ireland, Definitive Intervention and Feasibility Awards Expert Panel (**Peters**)
- Joint MRC, ESRC, WT Review of National Population Cohort Studies (**Lawlor**)
- Marie Curie Research Funding Committee (**Peters**)
- MRC Cohort Strategy & Review Panel (**Lawlor**)
- MRC Economic Impact Panel (**Peters**)
- MRC PHIND Deputy Chair (**Campbell**)
- MRC Population Health Strategy Group (**Lawlor**)
- MRC/NIHR Methodology Research Programme Advisory Group (**Peters**)
- MRC-NIHR Board on Disease Clustering in Multimorbidity co-Chair (**Salisbury**)
- MRC-NIHR Methodology Research Programme Panel (**Peters**)
- MRC-NIHR Trials Methodology Research Partnership Outcomes Working Group (**Avery**)
- NIHR Doctoral Research Funding Panel Deputy Chair (**Crawley**)

## Unit-level environment statement (REF5b)

- NIHR Pre-doctoral Fellowship Selection Committee (**Peters**)
- NIHR Research Design Service Panel (**Peters**)
- NIHR Research for Patient Benefit Southwest (**Blom**)
- Research Council of Norway Funding Panel (**Fraser**)
- Royal College of General Practitioners, Scientific Foundation Board (**Salisbury**)
- Royal Osteoporosis Society research grants committee (**Tobias**)
- WT Basic Science Interview Committee (**Relton**)

## Membership of research councils, national or international funding bodies

In the review period, UoA2 staff were members of >30 national/international funding bodies, including:

- Academy of Medical Sciences (**Gunnell, Davey Smith, Peters**)
- American Foundation for Suicide Prevention's Grant Programme (**Gunnell**)
- Australian National Health and Medical Research Council (NHMRC) Special Initiative in Mental Health Panel (**Caldwell**)
- BHF (**Lawlor, Fraser**)
- CRUK, Population Research Committee (**Martin**)
- Diabetes UK (**Lawlor, Fraser**)
- ERC (**Lawlor**)
- ESRC COVID-19 Panel (**Coast**)
- Marie Curie Research Funding Committee (**Coast**)
- MRC Population & Systems Medicine Board (**Lawlor, Gaunt, Blazeby, Campbell, Davey Smith, Fraser**) Methodology Panel (**Tilling**); Global Health Group (**Davey Smith**)
- NIHR (**Blazeby, Blencowe, Campbell, Coast, de Vocht, Donovan, Hay, Higgins, Hollingworth, Lawlor, Martin, Northstone, Peters, Ridd, Salisbury, Turner, Welton, Whitehouse, Wiles, Wylde**)
- Parkinson's UK (**HendersonE**)
- Public Health Foundation of India-Wellcome Programme (**Davey Smith**)
- Research Council for Health of the Academy of Finland (**Evans, Northstone, Tobias, Richmond**)
- Research Council of Norway (**Relton, Coast, Fraser, Howe, Timpson, Rodriguez**),
- Royal Society Newton Advanced Fellowships Panel (**Davey Smith**)
- Swedish Research Council (**Evans**)
- UKRI Future Leaders Fellowship scheme (**Relton, Turner**)
- Versus Arthritis (**Blom, Judge, Gooberman-Hill, Wylde**)
- WT Basic Science Interview Committee / Expert Review Group / Science Panel (**Relton, Coast, Davey Smith, Timpson**)
- World Cancer Research Fund (**Martin**)
- CRUK Clinical Trials Awards and Advisory Committee (**Blazeby**)
- NIHR Public Health Research Panel Member (**Kipping, Hickman, Campbell, de Vocht**)
- NIHR Programme Grants for Applied Research (PGfAR) sub-committee panel member (**Hickman**)

## Membership of National Clinical and Health Policy Guideline Groups

- NICE Atopic Eczema in Children update 2016 (**Purdy**)
- NICE Cancer Drugs Fund reappraisals committee (**Welton**)
- NICE Domestic Violence and Abuse Guidelines (**Feder**)

**Unit-level environment statement (REF5b)**

- NICE Guideline Development Group for 'Managing Common Infections' (**Hay**)
- NICE Guideline Development Group for Antimicrobial Stewardship (**Hay**, Chair)
- NICE Multimorbidity Guideline (NG56) (**Payne**)
- NICE Public Health A committee (**Yardley**)
- NICE Public Health Advisory Committee F (**Macleod**, Vice Chair)
- NICE Quality Standards Advisory Committee (QSAC) on effective antimicrobial stewardship (**Hay**)
- NICE Service Guidance Methods Expert Working Group (**Welton**)
- NICE Technology appraisals committee B, ) including representing the committee at appeal for pifrenidone (TA504) (**Welton**)
- NICE Total hip replacement and resurfacing arthroplasty for end-stage arthritis of the hip paediatric lead on NICE guidance committee CG37 (**Fleming**)

**Membership of national or international research or health strategy panels**

- Advance HE UKRI ED&I Review, External Advisory Group (**Gooberman-Hill**)
- Alzheimer's Society Care, Implementation and Public Health Grant Advisory Board (**Ben-Shlomo**)
- Blueprint Group, Evaluation of Vaccines and Therapeutics for Emerging Diseases (**Sterne**)
- British Orthopaedic Association Research Committee (**Whitehouse**)
- British Hip Society Research Committee (**Whitehouse**)
- Cleft and Craniofacial Conditions, Clinical Studies Group (**Wren**)
- Cochrane Scientific Committee (**Higgins**)
- Danish Cancer Research Centre, Scientific Advisory Board (**Relton**)
- European Molecular Biology Laboratory, Scientific Advisory Committee, Research Strategy Review (**Relton**)
- European Monitoring Centre on Drugs and Drug Addiction (EMCDDA) Scientific Board (**Hickman**)
- European Federation of Orthopaedics and Traumatology Basic Science Task Force (**Whitehouse**)
- Health Foundation Advisory Panels; Social and Economic Value of Health in a Place (**Howe**); Inquiry into Young People's Future Health Prospects (**Campbell**)
- National Chlamydia Screening Programme Expert Review Panel (**Horner**)
- Norwegian Primary Care Research Network International Advisory Board (**Hay**)
- Parkinson's UK Cohort Studies Council (**Ben-Shlomo**)
- Public Health, Health Services and Primary Care Panel, REF2014 (**Donovan, Peters**)
- Research Foundation of Flanders (**Blom**)
- Royal Osteoporosis Society Clinical and Scientific Committee (**Clark**)
- Scar Free Foundation Research Council (**Wren**)
- Song-Kids Life Participation Expert Working Group (**Hamilton**)
- UK National Parkinson's Portfolio Committee (**HendersonE**)
- UNICEF Advisor (**Blair**)
- Versus Arthritis Musculoskeletal Research Advisory Group (**Clark**)
- WHO NIHR Global Health Research Group, Prevalence, Quality of Life, Economic and Societal Impact of Arthritis in Tanzania, External Advisory Group (**Gooberman-Hill**)
- WHO Cost-Effectiveness of Interventions to Prevent Suicide, Expert Advisory Panel, Suicide in Humanitarian Settings Review, Advisory Group and World Suicide Report, Working Group (**Gunnell**)

**Unit-level environment statement (REF5b)****Leading positions in professional subject associations or learned societies**

- Association of Breast Surgery and British Association of Plastic, Reconstructive and Aesthetic Surgeons, joint guidelines on biological and synthetic mesh assisted breast reconstruction procedures (**Potter**)
- BASHH Bacterial Specialist Interest Group (BSIG), Sexually Transmitted Infections (STI) national guidelines (**Horner**)
- British Geriatric Society Falls and Bone Health Section, Chair, (**Gregson**)
- Child Speech Committee of the International Association of Communication Sciences and Disorders, Chair (**Wren**)
- Child Speech Disorder Research Network, Chair (**Wren**)
- European Orthopaedic Research Society, President (**Blom**)
- International Society for the study and prevention of Perinatal Infant Death (ISPID) Chair (**Blair**)
- National UK NHS Cleft Development Group (**Sandy**)
- Royal College of Physicians Falls and Fragility Fracture Audit Programme, Scientific Committee Chair (**Gregson**)
- Royal Pharmaceutical Society Polypharmacy guidance (**Payne**)
- UK Renal Registry, Medical Director (**Caskey**)
- UK National Osteoporosis Guideline Group (**Gregson**, Chair)
- Royal College of Surgeons Oesophago-Gastric Surgery Research, Associate Subspecialty Lead (**Blencowe**)
- Royal College of General Practitioners Research Paper of the Year Awards Panel (**Salisbury**, Chair)

**Positions in professional subject associations or learned societies**

- Academy of Medical Sciences (AMS) Methods of Evaluating Evidence Working Group (**Lawlor**)
- Association of Social Anthropologists of the UK and the Commonwealth Networks Officer (**Gooberman-Hill**)
- Association of Surgeons in Training National Research Collaborative Committee (**Blencowe**)
- British Geriatrics Society Movement Disorders, Section Chair 2017-2019 (**HendersonE**)
- British Obesity and Metabolic Surgery Society, Research Lead for Dietetics (**Coulman**)
- CFS/ME Research Collaborative (CMRC) (**Crawley**, Deputy Chair)
- British Society for Rheumatology Conference Committee (**Clark**)
- European Association of Social Anthropologists Treasurer and Trustee (**Gooberman-Hill**)
- European Federation of National Associations of Orthopaedics and Traumatology, Board of the Speciality Societies, Orthopaedics Committee (**Blom**)
- European Federation of National Associations of Orthopaedics and Traumatology Education Committee (**Blom, Whitehouse**)
- Galton Institute Council (**Relton**)
- Healthcare Quality Improvement Partnership Methodological Advisory Group (**Blom**)
- International Association of Communication Sciences and Disorders Board (**Wren**)
- International Expert Panel for Multilingual Children's Speech (**Wren**)
- International Health Economics Association (iHEA) Executive Board (**Coast**)
- International Network on Hepatitis among Substance Users (INHSU), Executive member (**Hickman**)

## Unit-level environment statement (REF5b)

- International Society of Nephrology, Executive Committee, Secretary/ Treasurer (**Caskey**)
- Netherlands Organisation for Scientific Research, Spinoza Prize Selection Committee (**Davey Smith**)
- Royal Anthropological Institute, Council and Trustee (**Gooberman-Hill**)
- Royal College of General Practitioners Kidney Care Network (**Horwood**)
- Royal College of Speech and Language Therapists Advisor (**Wren**)
- Society for Research Synthesis Methodology, Trustee (**Higgins**)
- Society for Study of Addiction (SSA) Trustee (**Hickman**)
- UK and Ireland Occupational and Environmental Exposures Society, Steering Committee (**TaylorC**)
- Vascular Society of Great Britain and Ireland Research Committee, Associate Surgical Specialty Lead (**Ambler**)

## Editorial / Associate editorial positions

Editorial positions have been held by the staff returned in this UoA (since REF2014) with the following scientific journals: Addiction, Biometrical Journal, British Journal of Health Psychology, British Journal of Urology International, BioMed Central (BMC) Biotechnology, BMC Family Practice, BMC Medicine, BMC Medical Research Methodology, BMC Musculoskeletal Disorders, BMC Public Health, BMJ Paediatrics Open, Child Abuse Review, Clinical Trials, Cochrane Handbook for Systematic Reviews of Interventions, Diabetologia, European Journal of Clinical Investigation, Folia Phoniatica et Logopedica, Hip International, International Journal of Epidemiology, Journal of Bone and Mineral Research (JBMR-Plus), Journal of the Royal Statistical Society Series A (JRSS A), Longitudinal and Life Course Studies, Nature Reviews Cardiology, Nicotine and Tobacco Research, Obesity, PLoS Genetics, PLoS Medicine, Scientific Reports, Trials, Medical Decision Making, Medical Decision Making Policy & Practice, Research Synthesis Methods, Rheumatology, Social Science & Medicine, Therapeutic Advances in Chronic Diseases.

## Academic awards and other honours received

In recognition of her outstanding contribution to health Deborah **Lawlor** was awarded a Commander of the Most Excellent Order of the British Empire (CBE) (2017). Among several Fellowships and awards, we also have five Officers of the Most Excellent Order of the British Empire (OBEs) (**Donovan, Feder, Golding [emerita], SharpD, Yardley**), one Fellow of the Royal Society (**Davey Smith**), one Fellow of the Royal Society of Edinburgh (**Davey Smith**), eight Fellows of the Academy of Medical Sciences (**Blazeby, Blom, Davey Smith, Donovan, Lawlor, Golding [emerita], Gunnell, Peters**), two Fellows of the Academy of Social Sciences (**Campbell, Donovan**), ten NIHR Senior Investigator Awards (**Blazeby, Blom, Campbell, Hay, Higgins, Lawlor, Salisbury, Sterne, Hickman, Ness** and emeriti **Donovan, Gunnell** and **Peters**), and an NIHR Research Professor (**Hay**). **Davey Smith** has been awarded the International Epidemiological Association Richard Doll Prize (2017), a Lifetime Achievement Award from Vereniging voor Epidemiologie (Netherlands Epidemiological Society) (2019), is an elected Foreign Member of the USA National Academy of Medicine and of the Royal Netherlands Academy of Arts and Sciences (KNAW), and the recipient of an Honorary DSc from the University of Glasgow and Erasmus University, Rotterdam.



## Unit-level environment statement (REF5b)

### Government advisory roles and membership/input into all-party parliamentary groups (APPG)

UoA2 researchers contributed to multiple advisory committees including:

- APPG on Fetal Alcohol Spectrum Disorder (**Zuccolo**)
- APPGs on Suicide and self-harm prevention (**Biddle, Gunnell**) and Social media and young people's mental health and wellbeing (**Biddle, Davis**)
- Department of Health Suicide Prevention Strategy Advisory Group & Task and Finish Group on Suicide Prevention During COVID-19 (**Gunnell**)
- Department of Health Policy Research COVID-19 Recovery Programme (**Donovan, Hollingworth**)
- Expert Advisory Panel, Healthcare Quality Improvement Partnership (HQIP) on Specification for National Confidential Inquiry into Suicide and Homicide (**Gunnell**)
- Government Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare Associated Infections (**Hay**)
- Joint Committee of Vaccination and Immunisation (**Finn, Christensen**)
- Maternal and Infant Health Team, Improving Health and Wellbeing Division, Scottish Government (**Blair**)
- Medicines and Healthcare products Regulatory Agency (MHRA) Expert Advisory Group on Isotretinoin (**Gunnell**)
- National Strategic Group on Viral Hepatitis (**Hickman, Vickerman**)
- Under 5s Expert Working Group for UK Chief Medical Officers' Physical Activity Guidelines (**Kipping**)

### Directorships and senior NHS Trust roles

Our staff fulfil a range of senior advisory roles in local NHS Trusts. Additional charitable and non-executive roles include Samaritans Trustee (**Gunnell**), Lifeskills Charity, Board Director, Bristol (**Blair**), ChildSpeech Ltd Director (**Wren**), University Hospitals Bristol and Weston NHS Foundation Trust Appointed Governor (**Blom, Peters**), Member, Bristol Health Partners Executive Group (**Peters**).

### Honorary Chairs

Honorary positions bestowed include: Honorary Chair in Primary Care, University of Dundee (**Macleod**), Honorary Faculty, Centre for Cancer Epidemiology, Tata Memorial Centre, Mumbai India (**Relton, Davey Smith**), Honorary Professor of Health Sciences, Faculty of Health Studies, University of Bradford, UK (**Lawlor**), Honorary Professor of Epidemiology, The Robinson Institute, University of Adelaide, Australia (**Lawlor**), Honorary Professor of Public Health, University of New South Wales Sydney, Australia (**Hickman**), Honorary Professor, School of Population and Global Health, University of Melbourne, Australia (**Campbell**).

### Visiting Professorship (VP)

VP in Epidemiology, Department of Non-Communicable Disease Epidemiology, London School of Hygiene & Tropical Medicine, UK (**Lawlor**); VP in Epidemiology, Division of Women's Health, School of Medicine, Kings College London, UK (**Lawlor**); VP Faculty of Medical Sciences, University of Trento (Davis); VP University of Groningen (**Davey Smith**); VP in Residence, University of California-Los Angeles (UCLA) Fielding School of Public Health (**Davey Smith**); VP in Epidemiology, Harvard T.H. Chan School of Public Health, USA (**Lawlor**); VP of Medicine, Duke University, USA (**Donovan**); Adjunct Faculty with Public Health Foundation of India (**Davey Smith**).

**Unit-level environment statement (REF5b)****Other advisory roles**

Many of our academics have contributed to professorial promotion assessments in highly esteemed institutions around the globe including Oxford University, Harvard T.H. Chan School of Public Health, Columbia University, Erasmus MC Rotterdam and Johns Hopkins University.

**Highly cited researchers**

Highly Cited Researchers 2014-2020; recognising researchers that rank in the top one per cent most cited works in their field: **Ades, Bowden, Davey Smith, Gaunt, Gunnell, Hickman, Higgins, Lawlor, Ness, Relton, Ring, Sterne, Tilling, Timpson.**