Institution: Lancaster University

Unit of Assessment: 3 FHM

1. Unit context and structure, research and impact strategy

1.1 Overview

In 2008 Lancaster University took a strategic decision to make a significant investment in health and medicine as a transformational project. The Faculty of Health and Medicine (FHM) has now matured into a ***thriving, integrated, multi-disciplinary academic community*** of laboratory-based scientists and applied health and care researchers who deliver world leading work focussed on making a real difference to individuals and communities.

Our submission to REF2021 has grown to 101 (92.51 FTE - category A) colleagues as a result of ***sustained investment*** since REF2014 when we submitted 70 (64.6 FTE) staff. This expansion has increased the critical mass in our themes, which represent FHM's research excellence and areas of societal need. This growth trajectory has been realised because health and medicine continues to be an institutional priority for Lancaster University (LU), and because we have achieved a ***significant growth in our student body (up by 39%) who want to receive their education from our internationally leading research-active staff***.

In the REF period there has been ***significant capital investment*** in the building of a ***£41M Health Innovation Campus***. We have also built a culture that attracts and retains the very best academics, with ***investment including 14 appointments at professorial and reader level*** and 7 promotions to professor in the REF period.

Evidence of our ***strong research performance during this REF period in comparison to our previous submission,*** includes a:

- ***98% increase from £20M to £39.6M in research awards***
- ***86% increase in Post-Doctoral Research Associates***
- ***117% increase in graduating Post-Graduate Research Students***
- ***144% increase in the volume of outputs; 1970 papers, 47 books and 112 chapters***

Our ***needs-led research is driven by working across disciplinary boundaries*** and in partnership with patients and the public, local health and care trusts, ***regional*** networks and bodies (*e.g.* Northern Health Sciences Alliance, National Institute for Health Research (NIHR) North West Coast Applied Research Collaboration (ARC), Healthwatch, North West Cancer Research), ***national*** agencies and groups (*e.g.* Scientific Pandemic Influenza subcommittee (SPI-M) of the Government's Scientific Advisory Group on Emergencies (SAGE), Health Research Data UK, British Society of Gerontology, Alzheimer's UK, Macmillan Cancer Support), and ***international*** networks (*e.g.* European Association of Palliative Care, International Health Economics Association, Alzheimer's Europe, World Health Organisation [WHO]). ***Our strong research position makes a significant contribution to our rankings, for example, we are in the top 10*** for Biosciences and Medicine in the Guardian University Guide (2021) and Times Good University Guide (2019) respectively.

1.2 Research Structure

Our research is organised in five cross-cutting themes that span departmental boundaries and disciplines, and represent critical mass of research excellence at Faculty level:

- Ageing
- Mental Health
- Health Information, Computing and Statistics
- Infectious Disease Transmission and Biology
- Social and Economic Inequality in Public Health

These themes were refined following a post-REF2014 review through which we sought to enhance the alignment of research strengths and interdisciplinary potential with major societal challenges. The themes exemplify how our research spans the spectrum from bench to bedside; and from molecular science to patient-orientated solutions. As such, they ***represent a wide variety of research methodologies from experimental to social sciences, acting as engines to enhance interdisciplinarity***.

The themes provide a focus for ***galvanising activity, sharing expertise and ideas, and for providing support***, particularly for colleagues earlier in their careers. Each theme has a lead who facilitates regular meetings and seminars with internationally recognised speakers. There are no restrictions to membership and colleagues can be members of more than one theme. The themes also provide a space to connect academics around grant opportunities and for engaging with external partners and members of the public. ***Whilst activity is organised around these themes, there is considerable engagement across themes, and from academics across the University***. These themes are presented below, with further evidence of their vitality in subsequent sections.

1.2.1 Ageing (lead: Milligan)

This theme includes innovative and ground-breaking research conducted by psychologists, nurses, laboratory scientists, applied health researchers, and social scientists on mechanisms, care and preventative interventions related to healthy ageing, quality of life, and age-related diseases. Included is research on model organisms and neurodegenerative disorders, cancer, supportive and palliative care, and health and well-being of ageing populations.

1.2.2 Mental Health (lead: Jones)

The mental health research portfolio focuses on the development and evaluation of innovative approaches to the assessment, support and treatment of people with bipolar disorder and psychosis across the lifespan, including carers. Additional work in organisations has evaluated workplace interventions to reduce stress, trauma and burnout in a range of occupational settings.

1.2.3 Health Information, Computing and Statistics (lead: Knight)

The work of this theme operates at the interface of statistics, epidemiology and health informatics. It provides a focus for applied quantitative biology as well as methodological research into longitudinal and spatial data arising from biological and health studies. As such it spans geospatial statistical methods, infectious disease models and methods, and health informatics and digital health.

1.2.4 Infectious Disease Transmission and Biology (lead: Hamilton)

Infectious disease research includes microbiology, virology and parasitology, and ranges from insect transmitted diseases to environmental and gastrointestinal microbiology. Research includes laboratory and field-based experimental work conducted nationally and internationally, as well as statistical and computational analysis of many aspects of disease biology, epidemiology and diagnosis.

1.2.5 Social and Economic Inequality in Public Health (lead: McDermott)

Research in this theme explores the extent of health inequalities across populations locally, nationally and internationally, to better understand the mechanisms which produce these health inequalities, and develops the evidence base to inform action to tackle these issues through community engagement.

1.3 Research Strategy 2014-2020

Our overall strategic aim was to develop the quality and volume of research with a particular focus on: ***developing critical mass*** in our research themes (see 2.1.1); ***growing inter-disciplinary research*** (see 1.5) through, *for example*, engagement with the University's Research Institutes, NHS and industry; and enhancing the ***capacity and capability for enabling the translation of research into impact*** on international and national policy and practice (see 1.4 and 4.5 for examples of impact).

Here we briefly illustrate how we have achieved the strategic aims in themes.

1.3.1 Ageing

Ageing research has received additional focus during the assessment period by the establishment of the ***Centre for Ageing Research (C4AR***), a formally recognised LU Cross Faculty Research Centre, co-directed through FHM by **Holland**, which is part of the N8 Northern Ecosystem on Ageing and Multimorbidity, and is collaborating with McMasters University, Canada. End of Life Care is focussed through the International Observatory on End-of-Life Care (IOELC) hosted in FHM and led by **Payne**, **Preston,** and **Walshe**. A notable interdisciplinary project with Lancaster Environment Centre was the first description of the role of magnetite nanoparticles (from air pollution) on the brain resulting in a publication in the top 1% of citations in PubMed (**Allsop**); and a ground-breaking international study of a blood test that can help to distinguish between Alzheimer's and dementia with Lewy bodies.

1.3.2 Mental Health

This theme includes The Spectrum Centre (Directors: **Jones, Lobban**), which has taken a leading role in developing and evaluating interventions delivered face-to-face and digitally, in group or individual formats through multi-centre randomised controlled trials (RCT). These projects have also innovated in digital trial methodology and the implementation of digital interventions in NHS settings. Major grants include: an online RCT to evaluate the clinical and cost effectiveness of a peer supported self-management intervention for relatives of people with psychosis or bipolar disorder (REACT**: Lobban, Jones** and **Rycroft-Malone**); a psychological intervention for suicide applied to patients with psychosis, the CARMS trial (**Jones** and **Lobban**)

; and the clinical and cost effectiveness of adapted Dialectical Behaviour Therapy (DBT) for Bipolar Mood Instability in primary care (ThriVe-B programme **Jones**).

1.3.3 Health Information, Computing and Statistics

Significant projects in this theme include funding from the Gates Foundation for methodological development in Neglected Tropical Disease (NTD) Modelling, the Task Force for Global Health for geospatial methods development and application to NTD control and elimination programmes, and an RCUK GCRF award for capacity building in Ethiopia, Kenya and Malawi (**Diggle** and **Georgi**). Work on infectious disease modelling has increased throughout the COVID pandemic with key publications being used to inform SAGE (22/01/20- ongoing). Both **Read** and **Jewell** are invited members of Scientific SPI-M, **Read** is also an invited member of the WHO COVID-19 modelling group (24/01/20-ongoing).

1.3.4 Infectious Disease Transmission and Biology

Fundamental globally significant research in parasitology and tropical disease has encompassed a wide range of parasites and the diseases they cause, and research into why individuals and groups are vaccine hesitant. This theme also includes research about the host factors that determine how viruses (including influenza viruses and coronaviruses) are transmitted from animals to humans. Significant achievements include the establishment of advanced smart diagnostic platforms for zoonotic, poultry and human viruses leading to their implementation against veterinary and medically important viruses including COVID-19 (**Munir**). Field studies showed that the large-scale application of synthetic sex pheromone with insecticide reduced infection incidence and leishmaniasis in the Brazilian domestic canine reservoir and offers a potential new vector control opportunity to reduce human cases (**Hamilton**).

1.3.5 Social and Economic Inequality in Public Health

Through the Liverpool and Lancaster Collaboration for Public Health Research (**Popay**) we became one of eight members of the NIHR School for Public Health Research (SPHR) in Phase 1 (2012-17, £22 million) and bid successfully to be a member in the second quinquennium (2017-22, £21 million). Focussing on community participation in health inequalities, significant additional funds have been leveraged. For example, an investigation into LGBT young people's mental health inequality (**McDermott**) and NIHR HS&DR funding to research early intervention mental health services, and a Wellcome Trust study which examined the impact of inequality on families of LGBT youth experiencing mental health issues.

1.4 Impact Strategy 2014-2020

Our strategic aim for impact was to ***strengthen and deepen effective engagement with key stakeholders that is aligned with our research themes to drive and support health innovation*** so that we would be in a position to open a new Health Innovation Campus, which we achieved in 2020.

We targeted resources towards ***developing and deepening partnerships***, placing particular emphasis on those relationships that help us shape our work and promote national and international impact. In the UK, this included the NHSE, PHE, other public sector organisations (e.g. councils), the third sector (e.g. hospices), businesses, and local communities and patient/carer groups. Internationally, this included, the European Association of Palliative Care,

WHO, Neglected Tropical Diseases [NTD] Centre of the Task Force for Global Health, and Gates Foundation.

The ***development of impactful resources*** from research has also been supported and resourced (see section 3.4). Table 1 summarises our impact case studies, how they map onto research themes and approach to achieving impact.

Table 1: Impact case studies mapped on to research themes and approach

Case study	Theme	Approach to achieving impact
Dying well: improving international palliative and end-of-life care	Ageing, including End-of Life care	Building on an international research programme, extensive engagement, included advisory roles with WHO Eastern Mediterranean Regional Office, Alzheimer Europe, Age Platform and the development of actionable outputs – e.g. MOOCs (**Payne** and **Preston**).
Enhancing and expanding the scope, reach and value of volunteers in palliative and end-of-life care	Ageing, including End-of Life care	Pioneering research by **Walshe**, **Preston**, and **Payne** has established the evidence base for volunteering. Impact delivered through close working links with National Council for Voluntary Organisations Macmillan, various hospices and patients, and the development and implementation of a volunteers' toolkit.
Improving the lives of people affected by bipolar disorder through improved access to psychological therapies and better understanding of bipolar experiences	Mental Health	Co-designed intervention research, and partnerships with NHS England, international guideline groups, James Lind Alliance, MQ and patients, led by **Lobban** and **Jones**, and the implementation of digital support toolkit.
Informing the national and international government policy response to the 2020 SARS-CoV-2	Health Information, Computing and Statistics And	Combined expertise of **Jewell** and **Read** in epidemic modelling has led to novel insights informing policy

pandemic through epidemiological intelligence	Infectious Disease Transmission and Biology	making. Impact delivered through membership of SPI-M of SAGE, Joint Biosecurity Centre (JBC), and PHE.
Planning and delivering the control and elimination of neglected tropical diseases: The impact of model-based geostatistics	Health Information, Computing and Statistics And Infectious Disease Transmission and Biology	Built on an international geospatial analysis techniques research programme led by **Diggle** and **Georgi**, and impact through practical outputs such a risk maps, and close engagement with the WHO, NTD Centre of the Task Force for Global Health, Gates Foundation, and Sri Lankan Ministry of Health.
Mobilising knowledge from lived experiences to reduce social and health inequalities	Social and Economic Inequalities in Public Health	Based on a programme of community led national and international research led by **Popay** and **Halliday**, including engaging outputs such as storytelling, and strategic engagement in and with the School for Public Health Research, PHE, Public Health Wales, and WHO.
Working towards elimination of health and care inequalities experienced by people with learning disabilities	Social and Economic Inequalities in Public Health	Research from the Learning Disabilities Public Health Observatory at LU led by **Hatton** has been put into practice and policy through close links, and advisory roles with for example, Equality and Human Rights Commission, NICE, and Social Care Sector COVID-19 Support Taskforce Learning Disability and Autism Advisory Group.

1.5 Supporting interdisciplinary research 2014-2020

Multi and interdisciplinary research has been at the heart of FHM from its inception. This is evident from its composition including bench scientists, statisticians, doctors, social scientists, clinical psychologists, computational experts, economists and data scientists. This distinctive blend of expertise is directed at finding solutions to societal challenges. Co-location has driven

co-operation naturally, but this is further enhanced by research resources co-ordinated at faculty level.

Constituent departments and groups all have their own personality, but investment in appointments, infrastructure and equipment is always examined through the lens of facilitating critical mass and ***leveraging opportunities that lie at disciplinary interfaces*** (see Section 2.2.1). Perhaps one of the best examples of this has been the establishment of Sports and Exercise Science (SES), underpinned by over £150k investment in a Human Performance Laboratory. Uniquely for the UK, SES is part of Lancaster Medical School but draws upon expertise and collaboration from across FHM, and is one of our most exciting new enterprises.

In addition, FHM ***has partnerships with almost every other department in the University***. University-wide Research Institutes and Research Centres help to catalyse engagement of FHM researchers with others to address Grand Challenges through an interdisciplinary lens. *For example*, RECIRCULATE is a GCRF project (£5.9M) focussed on providing safe and sustainable water in Africa, and is a collaboration across Environmental Science, Engineering, Management School, and FHM.

1.6 Future Strategy 2021-2028

Looking forward, we will continue our aspiration to deliver ***world leading research benefitting individuals and communities*** and establish FHM as a globally significant player. To do this we will focus on the inequalities affecting communities, including those local to us, ***ensuring that the post-pandemic recovery results in improved health outcomes and a narrowing of inequalities***.

We will also establish a ***greater number of international partnerships and research collaborations*** to extend the reach and significance of our research and impact.

Specifically, we will:

- ***Embed partner organisations in our research structure*** by creating key strategic research partnerships through the newly launched Health Innovation Campus and engaging practitioners from the NHS, local authorities, third sectors and SMEs as integrated research theme members through greater use of honorary positions, internships and fellowships. We will strengthen our position as ***leaders in public involvement in research***, continuing to coproduce beneficial research and developing the evidence base about partnership working.
- ***Develop research capacity with the NHS and care organisations*** through cementing Joint Research Office arrangements. This will improve governance and research delivery and facilitate identification and mentoring of early career clinical multi-disciplinary academics. This ***capacity building will extend to our partners in the third sector, local authority and SMEs****,* mentoring and supporting applications to new and emerging research training opportunities. Greater knowledge exchange will be achieved through the placement of our postgraduate students and researchers in partner organisations.
- ***Increase our interdisciplinary focus*** ensuring all FHM staff take up the opportunities that LU's interdisciplinary Research Institutes (see Institutional Statement for more detail), and regional networks such as the N8 and Northern Health Sciences Alliance

[NHSA] offer. We will work to create and deliver incentives, through organisational processes such as promotion and sabbaticals, to facilitate and reward our academics for participation in, and leadership of, large interdisciplinary and cross-sectorial grants.

- To ensure sustainability, we aim to further ***diversify our research income***, particularly in the context of global health and post-Brexit opportunities. Partnership working will provide new funding opportunities including research consultancy, investigator-led industry, and community funding.

To ensure continued impact from our research we will build on existing mechanisms of proven effectiveness, and commit to a ***set of actions***:

1. Facilitating international partnerships and knowledge exchange.
2. Providing co-location facilities and collaborative opportunities for businesses and other health and care organisations in the Health Innovation Campus.
3. Developing a cohort of knowledge exchange fellows, interns, professors of practice and embedded researchers.
4. Supporting activity through institutional impact funding.
5. Developing a policy nexus for engagement and knowledge exchange.

The delivery of the strategy will be co-ordinated through research themes, which we will review on a biennial basis to ensure continued relevance. The impact of the pandemic has been carefully considered in our strategic planning, including sharpening our thinking around inequalities. We are confident that our aims are achievable.

1.7 Open research and reproducibility

We actively support the 8 pillars of Open science, and have created a culture where research data is published alongside research outputs. 37 datasets have been deposited in the University data repository since 2015. The University's Research Data Management (RDM) service checks Data Management Plans, including plans for curation. It validates datasets and metadata records, advises on licensing, metadata standards and repository choice. Engagement in data management has been promoted through 'Data conversations,' focussed on planning, storing, transferring, archiving and sharing digital objects. ***Our data-science researchers are now routinely providing linked access to code repositories within publications, exemplified by their recent high-profile work on Covid-19***.

FHM academics are also providing ***national leadership*** in this area. **Diggle** directs the Health Data Research UK-Turing Wellcome PhD Programme in Health Data Science, which has Reproducible Science as a core syllabus topic. **Edge**, in her role as Chair of the Emerging Applications Section of the Royal Statistical Society (RSS) is working with the UK Reproducibility Network to ensure RSS members are informed of advances in this rapidly changing field.

1.8 Supporting research integrity and ethics

The governance of research ethics is a critical element of our sustainable research culture. All research conducted by LU staff and students ***must adhere to the ethical standards set out in the University's Code of Practice including adhering to funding and subject-specific professional body requirements***. We operate mechanisms to ensure all research, especially studies involving human participants and personal data, are conducted in a way which respects the dignity, rights and welfare of participants. Additionally, use of animals or genetically modified organisms are assessed through the LU Animal Welfare & Ethical Review Body and Faculty Genetic Manipulation Safety Committee.

All researchers, including doctoral students have to seek ethical review approval for both funded and non-funded projects. These reviews are managed by the FHM Research Ethics Committee (FHMREC) administered by a University-funded FHM Research Ethics Officer. The FHMREC is a sub-committee of the University's Research Ethics Committee. The FHMREC also offers advice and training on ethics. For projects that involve NHS patients from other Faculties, the Deputy Chair of FHMREC and the Clinical Research Support Officer provide advice on applications and sponsorship arrangements prior to Health Research Authority assessment.

The University, with assistance from FHM, has remodelled its faculty-based ethics committees based on our approach. The University and the Faculty RECs are now moving to an electronic system, with FHM playing a major role in this transition.

2. People

2.1 Approach to staffing

During a period of sustained growth, we have developed ***a collegiate and vital research environment in which, irrespective of career stage or personal characteristics, our staff have the opportunity and support, to flourish***. Our multi-disciplinary community is built on a foundation of respect and fairness, and it is these values that underpin our approach.

We have developed policies and processes to ensure academic staff have the ***time, resources, and organisational support*** necessary to achieve excellence and impact from their research. This developmental context reflects the findings of the last staff survey in which ***94% of FHM staff agreed that 'LU is a good place to work'***. We take a ***collective responsibility*** for developing and sustaining this supportive environment.

2.1.1 Staffing Strategy and Profile

Recruiting, developing and retaining excellent staff in areas of strength, and embedding research into all aspects of our organisation and practice are key strategic objectives. Our growth strategy has enabled us to recruit excellent researchers:

1. to ***maintain and enhance strength in multi-disciplinary research themes***,
2. *where there is* ***strategic need***, for example, succession planning,
3. to ***develop new and emerging talent***, and
4. to ***strengthen clinical academic*** capacity.

During the assessment period there have been ***54 new academic appointments in FHM: 32 Lecturers, eight Senior Lecturers, one Reader and 13 Professors*** from 38 UK HEIs, four international HEIs and eight from the NHS. The balance of recruitment across these levels, and the age profile of REF submitted staff (Figure 1) reflects our approach to '*growing our own*' underpinned by our support for earlier career academics through the Concordat and senior mentorship, and an environment reflective of Athena Swan Silver practices. ***We have an excellent retention rate*** with 63% of those returned in REF2014 still working with us, 27% of staff leaving for new appointments elsewhere, frequently for promotion, and 10% retiring. ***All category A staff are on indefinite contracts***.

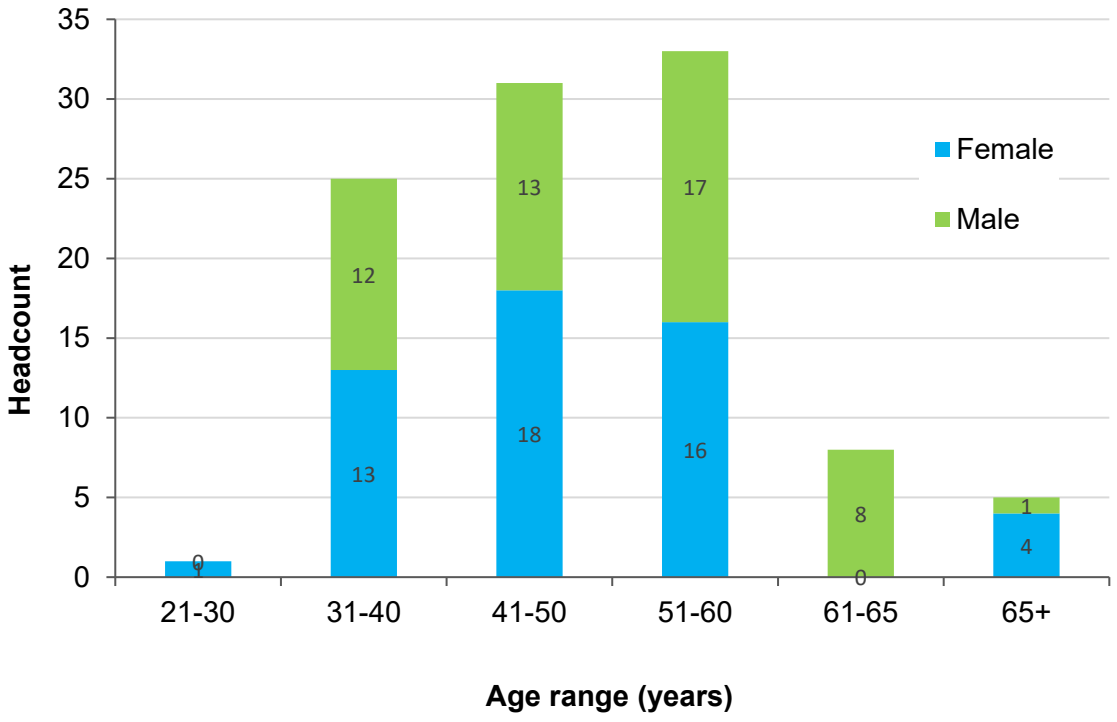

Figure 1: Age profile and gender of FHM staff submitted to REF2021

Consistent with our strategy, we have appointed to ***strengthen capacity in and at the boundaries of our multi-disciplinary research themes***: for example, Health Information, Computation & Statistics (**Jewell, Knight, Read, Sedda**), Ageing (**Holland**), Mental Health (**Hardy, Morris, Palmer-Claus**), Infectious Disease Transmission & Biology (**Isba, Munir, O'Shea, Unterholzner**), Social & Economic Inequality in Public Health (**Ahmed, Kaley, Janke, McDermott, Mateus**). Our appointments include nurses, doctors, data scientists, biochemists, parasitologists, psychologists, forensic anthropology, and public health experts.

We have also successfully appointed where there is ***strategic need***. For example, high profile appointments in **Black** as University Pro-Vice-Chancellor for Engagement, President Royal Anthropological Institute of Great Britain and Ireland and member of FHM, and, **Rycroft-Malone** as Executive Dean of FHM, Director of the NIHR Health Services & Delivery Research Programme, and Chair, National Institute for Health & Care's (NICE) Implementation Strategy Group.

To support our drive in recruiting ***new and emerging talent*** we recognised the potential of our own PhD graduates in appointing **Giorgi** and **Edge** (Health Information, Computation & Statistics), and **Kaley** and **Robinson** (Mental Health) as Lecturers. The *Anniversary Lecturer (AL) scheme*, was a University-wide scheme to recruit the best international early to mid-career researchers. We appointed four *ALs* (**Knight, Sedda, Janeke**) on five-year contracts comprising 100% research in the first two years, tapering to a minimum of 40% research by year five. Each AL has been prolific, publishing over 160 outputs between them, with at least 10 being evaluated as 3* and 4*. Significant individual achievements include **Knight** advancing to a Professorship, and being appointed as co-Director of LU's Data Science Institute, one of Europe's strongest single-institution data science community.

To reflect our strategic objective to ***grow our clinical academic community*** and collaborative working with health and care partners, we made five new clinical academic appointments. These posts are 50:50 FTE with the NHS Trusts and include: **Emsley, Logue**, **Shelton, Nwosu**, and **Gadoud**. 158 honorary appointments contribute to collaborative working between FHM and health and care organisations.

2.1.2 Developing staff

All research ***staff irrespective of their career stage have protected time to undertake research*** and have ***access to a wide range of support and resources tailored to their needs.*** FHM policies and practices are aligned with the *European HR Excellence in Research Award*, which we have retained since 2011. During 2014-20 ***FHM invested £380,243*** in supporting researchers' and PhD students' development needs. FHM academic staff undertook ***1,243 internal training or development activities during this period***, which included 56.6% undertaken by females.

All staff identify individual training needs as part of the annual ***Performance Development Research (PDR)*** process, which is an opportunity to review progress, identify challenges and target support, including setting personal development objectives. Engagement in this process is excellent with an average 95% of FHM academic staff completing annual PDR during this period. Staff receive mandatory training in equality, diversity and inclusion (EDI), wellbeing and mental health, and in 'Recruiting the best', which is reviewed annually in PDR discussions.

LU's ***Organisation and Education Development*** team provide formal training opportunities in researcher development, leadership and personal effectiveness. Leadership programmes include LU's Bonington Programme that is designed to develop the next generation of senior leaders. External development is accessible via ELEMENTA's 'Leading the Global University.' A bespoke approach to development takes place in research themes, through for example, writing retreats, methods workshops, and convening investigator teams for funding opportunities. LU Research Institutes support large and multi-disciplinary funding applications and foster peer-led learning opportunities.

FHM is fully committed to the ***Concordat to Support the Career Development of Researchers*** to which LU is a signatory. This commitment is underpinned by a code of practice which sets out the roles and responsibilities of principal investigators, research staff and the University, which we have embedded in FHM policy and practice. We are currently analysing data from the Culture, Employment and Development in Academic Research Survey which will enable us to co-create a new FHM concordat action plan to further improve our environment.

Personal support through ***mentorship and coaching*** is available to all staff. *For example,* all new staff are assigned a mentor to support career pathway development, and focussed research mentorship is available through senior faculty providing advice, co-authoring opportunities, and co-applicant and co-principal investigator support. Focussed input on career and work goals is provided through coaching.

2.1.3 Developing those at the beginning of their research careers

Those who are ***earlier in their career have lighter teaching loads*** to help them in developing an independent research profile, and the space to integrate into their research group. New lecturers undergo three years' probation in which they are supported to meet milestones through annual PDR discussions and senior academic mentorship, including encouragement to access

University development opportunities (more detail in institutional statement). Post-doctoral researchers and fellows benefit from being integrated into research programmes, themes and laboratories, and from support and mentorship by senior faculty, and involvement in FHM's ***Researcher Career and Development group (RCAD).***

RCAD is a self-organised group with a membership list of over 40 researchers, which meets monthly to provide a ***supportive forum for researchers to discuss career development challenges and opportunities***. RCAD also organises events with financial support from FHM, including group coaching, a workshop to inform the lone researcher working policy, and an event to share knowledge about different employment models. ***RCAD members are represented on several Faculty-level committees***, *for example* Faculty and Divisional Research Committees, Human Resource Committee, Equality Enhancement Committee. Membership of these bodies provides a mechanism for researchers to participate in strategic decision making about policies affecting employment practices and career progression.

RCAD produced a report for FHM and the University (2016) on improving work-life balance and the integration of contract researchers into the academic faculty. Their recommendations have influenced our approach. Specifically, we introduced a ***Career Bridging Scheme*** to allow continuing employment between grants. To date, we have supported 17 researchers (65% female: 35% male) on grades 7-9 who have used the time to apply for funding, and for writing and submitting publications. We also established a ***Small Grants Scheme*** for those earlier in their career to help pump-prime applications for external funding (see section 3.2).

To build up experience that will benefit career progression, ECR lecturers and post-doctoral researchers are supported to deliver teaching, are eligible to participate in the University's Associate Teacher Programme, and are expected to gain Associate Fellowship of the Higher Education Academy. Post-doctoral researchers are included in the annual PDR process. As evidenced above, we actively encourage early career staff to take up positions of responsibility, integrating them into FHM and enhancing their work profile.

2.1.4 Supporting dedicated research time

All academic staff can apply for ***Academic Research and Education Leave (AREL)*** after seven terms of qualifying service to spend uninterrupted time on focussed academic goals. A total of ***238.2 sabbatical months were taken by 24 (12 males, 12 females)*** academics during the REF period. Achievements include, for example, winning a first UKRI grant by an earlier career researcher, cementing new industry contacts and in-kind funding, developing new collaborations, and significant increases in output productivity.

2.1.5 Supporting exchange

Numerous resources and structures *support exchange* with external organisations. In recognition of the importance of this activity and our role as a Civic University, FHM introduced a new role; an ***Associate Dean for Engagement*** (**Isba)** to take leadership and oversight of our approach to engagement and exchange. We also have forums for supporting exchange, *for example*, the ***Partnership Forum*** works strategically to increase collaborative research and knowledge exchange between LU, industry, health and social care across the region. The ***Work and Health Forum*** connects academics, health professionals, policy leaders, council leaders and local citizens to develop new evidence-based approaches towards enabling people with long term conditions to maintain or enhance work productivity.

FHM's ***Staff Development Fund*** supports individuals and teams to engage in opportunities that enhance networking and knowledge exchange. Dedicated funds enable exchange between researchers and non-academic partners, and have been beneficial in setting up collaborations (see sections 3 and 4). LU has made a significant investment in infrastructure (see section 3.3.1) to support exchange through the development of the Health Innovation Campus' business engagement team. These investments should lead to a step change in future collaborative working.

Supporting our engagement with the NHS community, and aligned to the strategy for ***growing our clinical academic community*****,** we are awarded four Academic Clinical Fellowships and Clinical Lectureships per year through the ***NIHR Integrated Academic Trainee Scheme***. Awardees have gone on to join us as permanent staff (*for example*, **Shelton**). Additionally, Health Education England commissions us to provide supervision for Public Health (PH) Registrars training to take up senior PH roles, including two FTE 12-month placements each year. Building up these schemes is central to our ambitions to continue to grow practice-academic capacity.

2.1.6 Reward and recognition

Promotion processes are transparent and accessible. In 2015/16 FHM introduced a ***promotion support programme*** which includes tailored support to those interested in applying for promotion. Individuals are assigned a promotion mentor, participate in preparation workshops and receive support with writing their case. FHM Promotions Committee members provide feedback on all applications before submission to the University Promotions Committee. ***Introduction of the support programme has resulted in a 75% increase in success rates across all grades and equal distribution between females and males***.

LU's promotions criteria have clear routes to recognising achievement through promotion and celebrating success. Promotion can be achieved through research and teaching impacts, and through engagement with business, government, civil society and wider community. The ***annual Dean's Awards*** celebrate valued work practices, including excellence in research and engagement.

Our administrative and specialist technical staff are included in all FHM activities as part of our research ecosystem. Issues of relevance to their working environment are discussed in an annual away day and a dedicated technicians' website has been developed and launched (Lancaster Technicians Development website**).** FHM's Chief Technician led a project that resulted in LU receiving an award for its progress in recognising the contribution of technicians to scientific research from the Technician Commitment.

2.2 Recruitment, training and supervision of Post-graduate Research (PGR) students

Over the REF period FHM's doctoral programme community has grown significantly. ***This included 631 registrations, up from 270 in the previous REF, and 291 completions, up from 134.*** We align doctoral programmes and admissions with research themes to enable students to study with internationally excellent supervisors in research-intensive environments. We have a pioneering blended learning PhD programme that provides an accessible route to doctoral study for those working in health and care.

2.2.1 FHM's approach to the recruitment of research students is open and inclusive.

Recruitment of PGR students is in line with best practice guidance and recommendations from the UKRI 'Equality, diversity and inclusion in research in innovation: UK Review' (2019). This includes writing carefully constructed advertisements that promote opportunities to a diverse range of applicants. Advertisements are scrutinised for the use of gendered terms, and ensuring images, where used, represent actual students and staff, and the diversity of their cohort. Throughout all stages of the recruitment process applicant numbers are checked against protected characteristics. The make-up of our doctoral community is illustrated in Figures 2, 3, and 4.

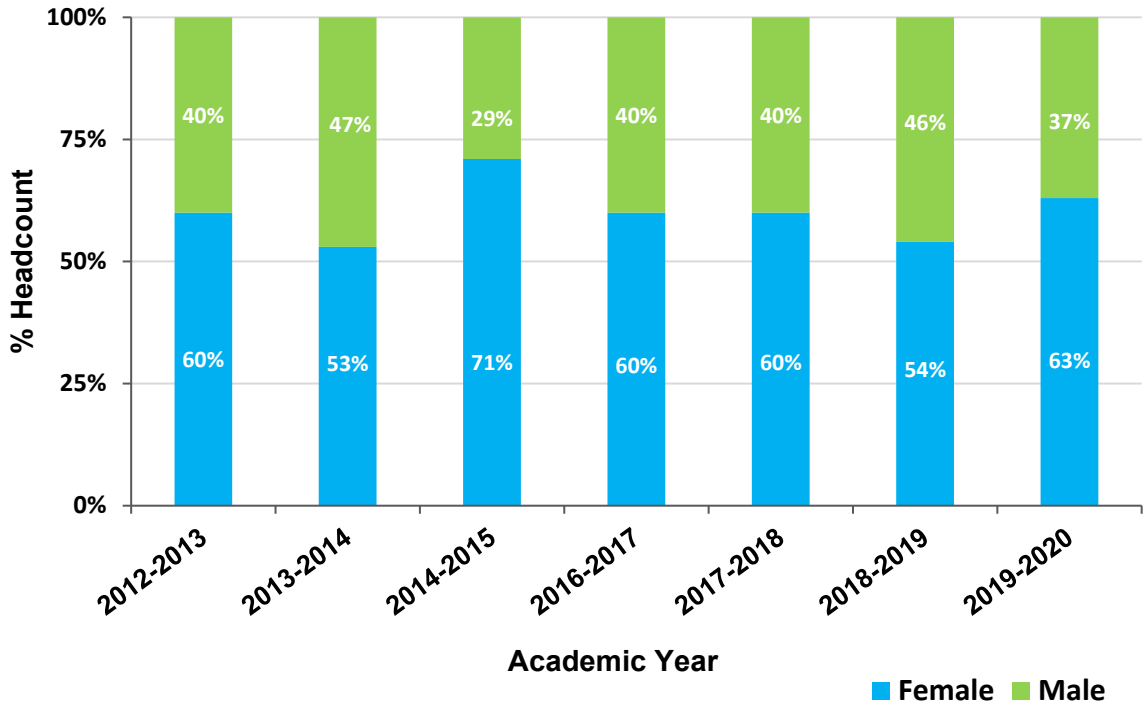

Figure 2: Gender profile (%) of FHM PGR students, 2012-2020

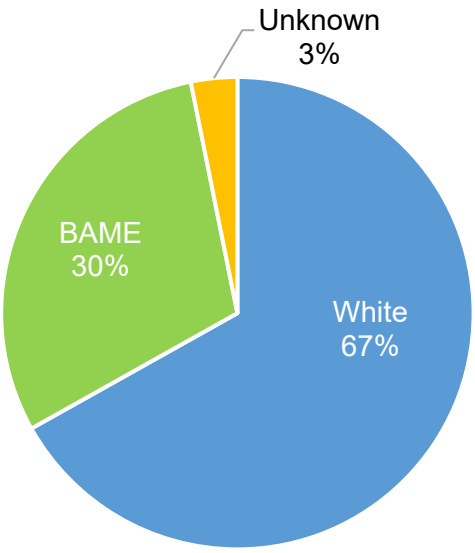

Figure 3: Ethnicity profile (%) of FHM's PGR students, 2014-2020

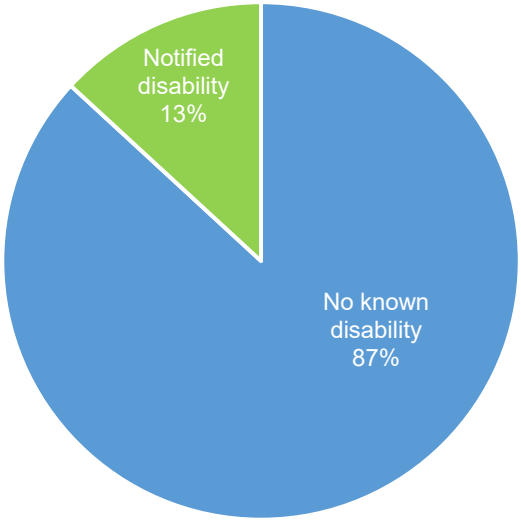

Figure 4: Percentage of FHM's PGR students with/without disabilities, 2014-2020

Studentships are funded from a variety of sources: ESRC North West Doctoral Training Centre (ESRC/DTC), CLARHC/ARC, Charites, Morecombe Bay NHS Trust, and through self and LU funded studentships.

2.2.2 Training and support for PhD students

Vitae's Researcher Development Framework (RDF) is used to map training needs. All students are members of the University's Doctoral Academy ensuring research training aligns with the RDF.

At induction, all doctoral students are required to undertake a ***Development Needs Analysis*** (DNA), to assess their training needs. This is reviewed in annual progress meetings. Students benefit from training available at programme, Faculty, University and wider regional levels in

specialist, for example, lab-based skills and particular methods, and generic research skills, such as knowledge exchange and career skills. Research ethics training is mandatory in FHM. The University Library provides PGRs with training (including the possibility of one-to-one consultations), on information retrieval, referencing and data management. The Doctoral Academy provides a focal point for engagement with wider development initiatives via, for example, the ESRC/DTC, and MRC Doctoral Training Partnership. All PGRs have access to a suite of on-line modules, which are of particular benefit to our part-time and distance learning students. Team supervision, including at least two supervisors meeting their student every month, leads to a more collaborative and diverse student experience.

Mechanisms to ensure that students ***integrate into FHM's academic community*** include:

- Supervisor and student being embedded in research themes.
- Research events and seminars that foster students' research and presentation skills in a supportive environment.
- Being part of writing teams and encouraging students to write for publication during their studies, which has resulted in over 350 co-authored peer reviewed publications during the REF period.
- Supporting engagement of part-time and distance learning students using video-conferencing, virtual chat rooms and webinars.
- Funding to support attendance at conferences, including 58 students presenting at national conferences, and 71 students presenting at international conferences.
- Participation in both LU and FHM's PGR annual research symposiums.

To prepare students for life after their research degree we provide ***courses on career options inside and outside academia,*** and on effective CV preparation. We also provided placement opportunities.

Of the 95 PhD graduates who responded to a destination of leavers questionnaire, all but one was in employment within six months of graduating, typically working in health care (Figure 5).

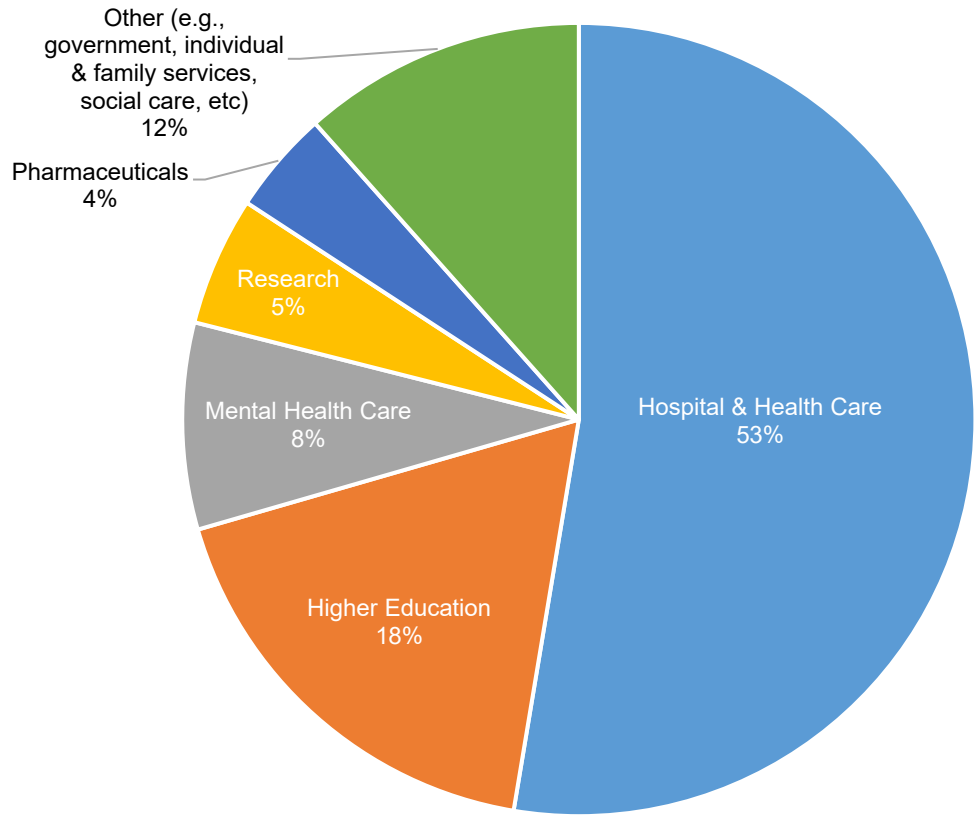

Figure 5: Employment destinations of FHM PGR students, 2014-2020

2.3 Equality, diversity and inclusion (EDI)

2.3.1 FHM's progress and commitment to EDI is recognised by our ***Athena Swan Silver*** **award** (2018). Our commitment to the Disability Confident scheme and Stonewall Global Diversity Champions Programme, also ensures that best practice is embedded in our structures and processes. Feedback from Athena Swan panel commended the evidenced personal commitment and shared responsibility across FHM on EDI issues. The gender profile of REF21 submitted staff is balanced (Table 2).

Table 2: Gender profile (headcount) of FHM staff submitted to REF2021

	Lecturer	Senior Lecturer	Reader	Professor	**Total**
Male	23	16	0	12	51
Female	20	16	1	15	52
Total	**43**	**32**	**1**	**27**	**103**
Ratio (M:F)	1:09	1:1	0:1	1:1.25	1:1.02

Leadership and oversight of EDI is managed via FHM's formally constituted ***Equality Enhancement Committee*** (EEC), which is co-chaired by an academic (the Dean) and a professional services staff member (Faculty Manager), and reports to FHM's executive group. Diversity training is mandatory for all staff. FHM are implementing the Silver award action plan to realise our ambition to apply for a Gold award in our next submission.

There has been an increase in women being promoted to senior lecturers and professors (Table 3) through the promotion support programme (section 2.1.6).

Table 3: Number and percentage of successful promotions cases by gender, 2014-2020

Cases	Grade 7 & 8		Grade 9		Reader & Chair		**Total**	
	M	***F***	***M***	***F***	***M***	***F***	***M***	***F***
Total submitted	12	9	12	16	1	9	25	34
No. successful	10	9	8	10	1	7	19	26
% success	**83**	**100**	**67**	**63**	**100**	**78**	**76**	**76**

The 54 new academic appointments over the REF 2021 period include a good gender balance: 13 Professors - 8 female, 5 male; one Reader - female; eight Senior Lecturers - 4 female, 4 male; 32 Lecturers - 16 female, 16 male.

Reflective of the balance within LU, 84% of FHM academic staff are White, 10% BAME, and 6% unknown. In autumn 2020, FHM's EEC commissioned a review of race equality and set up an FHM ***Race Equality Task & Finish Group.*** This group will be delivering an action plan in Summer 2021 that will accelerate our progress on this agenda, which to date has included decolonising the medical curriculum. FHM's actions align with LU's intention to commit to the Race Equality Charter in 2021.

Our commitment to ***wellbeing*** is evident in our policies and practices, which has been given even greater focus during the pandemic. Oversight is managed through FHM's Safety, Health and Wellbeing Committee, chaired by the Deputy Dean. Additionally, we established a ***Staff Wellbeing Engagement Sub-Group*** with members from across FHM including those with academic expertise in health, wellbeing and mental health, to ensure an evidence base for our approach. A combination of initiatives characterise this approach:

- 26 members of FHM staff have undertaken training to become Mental Health First Aiders, and their accessibility made known through an electronic badge.
- Topic specific awareness and support workshops, *for example* about menopause in the workplace, depression in older people, change management in advance of moving to Health Innovation Campus.
- Access to specific wellbeing sessions, *for example* mindfulness, remote working support, desk yoga.
- Collation and signposting of wellbeing resources in an easily accessible format.
- Encouraging the use of personal wellbeing action plans.
- Mental health as a mandatory training requirement.
- Access to free 24/7 employee assistance, including counselling.

We foster a ***healthier work-life balance*** through a 7pm to 7am and weekend no email policy, and scheduling meetings between 10am and 4pm to support those with family commitments. We have working from home guidance and offer ***flexible working*** without detriment. ***During the REF period 184.5 months of maternity, adoption and shared/parental leave was taken***.

During COVID, we have operated within a caring responsibility framework to be even more flexible in support of colleagues.

We provide ***disabilities support*** for long-term physical and mental health conditions through occupational health services and adaptations to workload. We provide a supported return to work in a suitable role to enable individuals to thrive, working with a staff member's health support team if requested. We provide technology, training and coaching support for those with dyslexia and related disabilities.

Our bullying, harassment and sexual misconduct, safeguarding and lone worker policies protect both our staff and collaborators. We ***promote an environment free from bullying, harassment and sexual misconduct***. FHM's policies complement formal University reporting and resolution processes, offering a route to rapid resolution through personalised support.

EDI considerations – REF submission

Consistent with the University's REF Code of Practice, all those leading on REF received additional EDI training. The output selection was conducted solely on the predicted output rating using transparent evaluation processes. Regardless of any protected characteristics of individual staff members, outputs with the highest rating were selected for inclusion. Statistical analyses were conducted to examine whether any unconscious bias might have influenced the selection process. These indicated no significant effect on selection.

3. Income, infrastructure and facilities

3.1 Research Funding

Strategic investment in our research themes and facilities, whilst growing our critical mass, has resulted in ***FHM research awards doubling from £20M in REF2014 to £39.6M in this REF period; a 98% increase***.

This represents a mean total awarded per year of £5.7M with an increase in annual awards from £4.55M in 2014, to £9.58M in 2020 (Figure 6). With ***the growth in FTE over this REF period, this is an increase of 47% in awards per FTE/ year; from £70.4k/ FTE in 2014 to £103.8k/ FTE in 2020***.

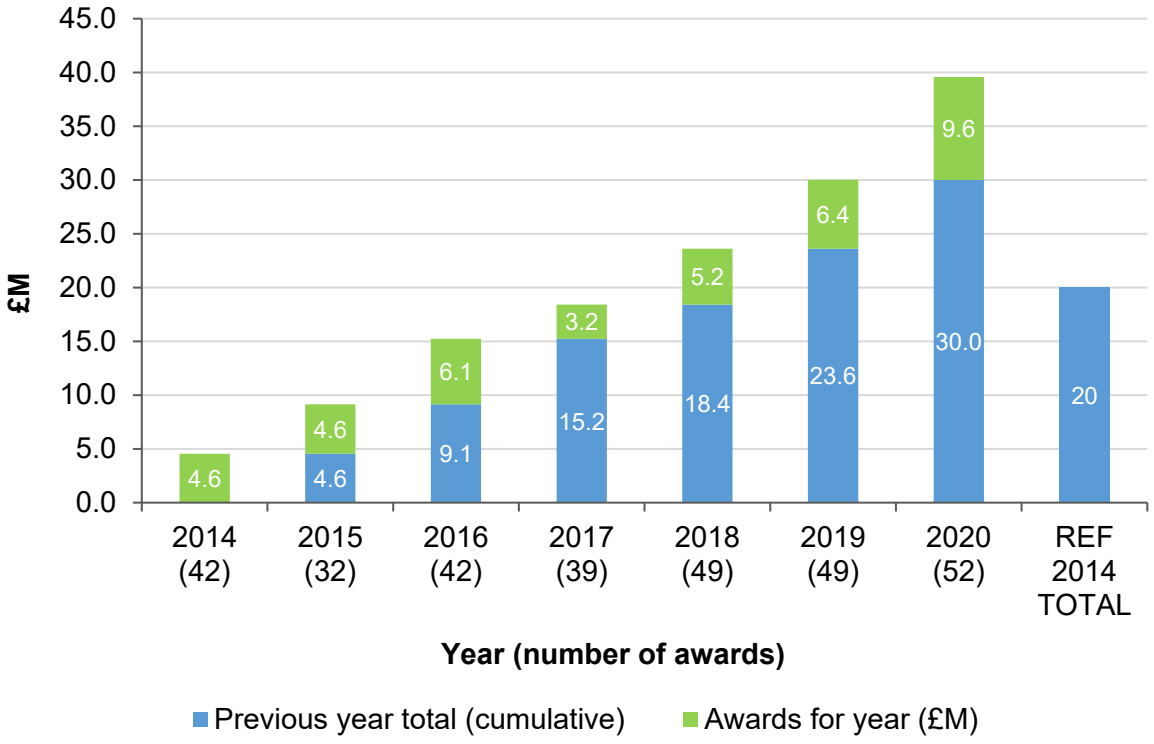

Figure 6: Research award value per year and cumulative, number of awards per year 2014-2020 and total income REF2014

Our strategy of aligning research strengths and interdisciplinary potential with major societal challenges across our research themes has resulted in a doubling of research award value due to a ***focus on larger, multi-disciplinary grants, targeting major research funders***. Our grant awards per FTE/ year have decreased from 0.65 in 2014 to 0.56 in 2020, whilst award amount has increased, reflecting this collaborative approach.

Our research is ***diverse, and often interdisciplinary, and our funding profile reflects this, with prestigious funding awards from all major health-related research funders***. The growth of our clinical academic numbers, and strategic development of partnerships with health and care providers, has allowed us to ***achieve our aim of increasing NIHR funding; which now represents our largest funder with £16.6M of awards*** over the period. Other notable funding sources include the Wellcome Trust (£4.3M), EU (£2.8M), and UKRI (£6.5M across MRC, BBSRC, EPSRC and ESRC) (Figure 7). This excellence is reflected across all our research themes (see Table 4).

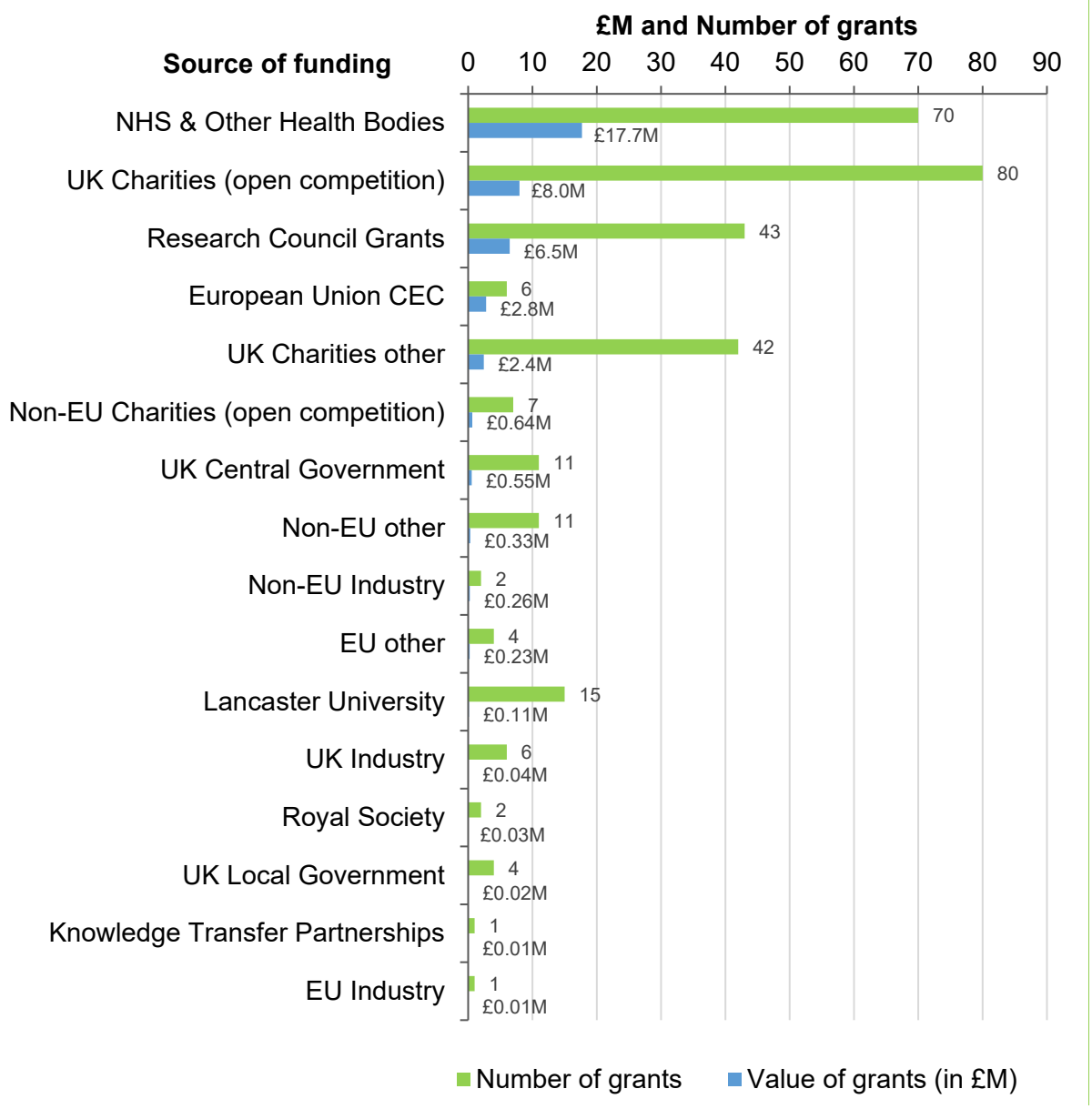

Figure 7: Distribution of FHM research award funders, 2014-2020

Table 4: Examples of project grants led by FHM investigators across research themes

Theme	Principal Investigator	Grant title	Funder	Dates	**Total award**
Ageing	Froggatt	The Namaste Care intervention to improve the quality of dying for people with advanced dementia living in care homes	NIHR HTA	2016-2019	£508k
Infectious Diseases	Benedetto	Integrated multiomics of host-bacteria interactions during *C. elegans* gut infections	BBSRC	2020-2024	£742k
Health Informatics	Black	H-unique: In search of uniqueness - harnessing anatomical hand variation	EU	2019-2023	£2.17 million
Inequalities	Popay	What are the health and health inequalities impacts of the Big Local community empowerment initiative in England?	NIHR PHR	2018-2021	£704k
Mental Health & Inequalities	McDermott	Identifying and evaluating mental health early intervention services and self-care support for lesbian, gay, bisexual and transgender young people: A mixed methods study	NIHR HS&DR	2019-2021	£956k

3.2 Strategy for generating research income

Our strategy for securing research funding has ***8 elements***:

1. We work to enhance grant application quality through ***rigorous pre-submission peer review*** and by early engagement with the University's Research Development Managers and other technical and professional support staff, including use of the NIHR Research Design Service North West (RDS NW) which is hosted within FHM**.** ***FHM has a dedicated professional Research Development Officer*** who supports the financial and logistical aspects of grant preparation.

2. We have ***increased support for new and earlier career academic staff.*** All are line-managed by their research theme leader or Head of Department and have an academic mentor within a broader culture of providing support for grant applications, papers and mock panel interviews. ***Our support for ECRs has increased the number of prestigious early career fellowships held by department members from four at the***

last REF to 10 during this REF period, including three NIHR fellowships awarded to our growing cohort of clinical academic trainees (Table 5).

Table 5: Funders and value of FHM's personal research fellowships for earlier career researchers

Theme	Funder (n)	Total value
Ageing	MRC (1), NIHR (1)	£716k
Infectious Diseases	Wellcome Trust (2)	£905k
Health Informatics	MRC (3)	£694k
Inequalities	MRC (1)	£250k
Mental Health	NIHR (2)	£490k
Total Fellowship funding (10 awards)		**£3.6 million**

3. Our ***research themes act as the catalyst for larger grant applications.*** Often through the cascade of opportunities from research development managers, ***theme leaders identify large grant opportunities*** and task key colleagues with developing bids, bringing in others as multi-disciplinary co-investigators. *For example*, in response to an NIHR Health Technology Assessment call for efficient study designs, **Lobban** (Mental Health) developed a successful application (£636k) with **Hollingsworth** and **Jones** as co-investigators, with **Mateus** and **Sellwood** joining the team post-funding**.** This trial of a peer supported self-management intervention also underpins an impact case study, and has developed academic careers; the trial manager is now a Lecturer in the mental health theme (**Robinson**).

4. We have prioritised support for participation in ***prestigious regional collaborations*** (Table 6) including the NIHR North West Coast Collaboration for Leadership in Applied Research & Care (CLAHRC) and subsequent Applied Research Collaboration (ARC), totalling funding of £4.3M for FHM during this period, allowing us to conduct high impact applied health research with regional partners.

Table 6: Major collaborative grants awarded to FHM since 2014

Grant title	CI	Funder	Dates	FHM Total award
NIHR School of Public Health Research	**Popay**	NIHR	2017-2022	£1.2 million
NIHR Research Design Service North West	**Hatton**	NIHR	2015-2023	£3.8 million
NIHR North West Coast Collaboration for Leadership in Applied Health Research & Care	**Popay**	NIHR	2014-2018	£1.7 million
NIHR Applied Research Collaboration North West Coast	**Walshe**	NIHR	2019-2024	£2.6 million
Health Data Research UK North	**Knight**	HDR UK	2020-2023	£165k

5. We use ***pump-priming to stimulate research***. In this REF period, we have ***made 19 internal pump-priming awards, totalling £120,485*** (~£6k per project). In each case this provided a platform for larger bids to major funders. These have been awarded across FHM, with the greatest impact in laboratory research, allowing pilot work to be conducted to enhance grant submissions. One such example is **Urbaniak** (Infectious Diseases): awarded £4,781 internal funds in 2014, which supported a successful MRC grant application in 2015 (£527k) to study the Trypanosoma brucei cell cycle. A further £4,805 of internal funding in 2017 then led to an award of £405k from BBSRC in 2020 to study iron sensing in trypanosomes.

6. We ***have diversified our research income and built relationships with local funders*** to make us more resilient to changes in funding patterns. ***We received grants from 126 different funders*** during this REF period (Figure 7). Our NIHR awards are split between infrastructure and project funding, covering all funding streams, and we have received substantial funding from all research councils except NERC. We received 28% of our research funding from charities, making us susceptible to decreases in charity income such as during the pandemic. To reduce the risk of dependence on any one charity, we applied widely and have funding from 60 different organisations.

7. We have developed ***close and successful relationships with three charity funders*** that serve our region. The largest of these is North West Cancer Research which has awarded researchers in our Ageing theme over £1.9M during this period, including £441k (**Allinson**) to fund a Lecturer, Research Fellow and two PhD studentships. Much of this funding has been to earlier career researchers including **Jackson-Jones** for work on cutaneous squamous cell carcinoma (£106k) and **Mort** for research on a preclinical model for UV exposure and early melanomagenesis (£251k). We have also targeted local foundations for small grant funds for development and pilot studies. The Dowager Countess Eleanor Peel Trust awarded small grants for ageing research in Lancashire, which totalled £72k to FHM in this period. A second, the Sir John Fisher Foundation has awarded FHM £442k since 2014, including £77k to **Gadoud** to explore the use of health informatics to improve the quality of end-of-life care.

8. We have ***diversified of our research areas allowing diversification of funding sources***. *For example*, alongside the expansion in clinical academics leading to increased NIHR funding, the development of Sports and Exercise Medicine has led to new collaborations and funding opportunities. Sport England have funded a team of FHM researchers (£301k), led by **Holland**, working in partnership with Lancashire County and Blackburn with Darwen Borough Councils, to conduct a mixed-method whole system evaluation of the delivery pilot of 'Together an Active Future'.

3.3 Facilities and equipment

During this period, we have invested significantly in our accommodation and facilities. This is exemplified by a ***£41 million investment in the Health innovation Campus*** as well as investments in specialist research equipment and core facilities.

3.3.1 Health Innovation Campus

Completed in April 2020, the ***Health Innovation Campus provides office, meeting and engagement space for FHM academics*** and state-of the art teaching facilities for our medical school***,*** alongside ***office space for health-focussed local industry and third sector partners*** **(Figure 8)**. The total investment of £41M comprised £17M Local Growth Deal Funding from the Lancashire Local Enterprise Partnership, £8.5M from European Regional Development Fund (ERDF) with the remainder invested by Lancaster University. As well as physical space, the EDRF funding supports a team of partnership development and business support managers to connect researchers in FHM, and the wider University, with industry and other potential collaborators. Going forward, the ***Health Innovation Campus will act as the catalyst for the delivery of our future strategy*** (section 1.6), especially "*embedding partner organisations in our research structure"* to deliver future research impact.

Figure 8: Health Innovation Campus

3.3.2 Facilities and equipment for laboratory sciences

FHM's research in the infectious diseases and ageing themes is dependent on ***world-class laboratory facilities***. As such, we have continually invested over this REF period to ensure we maintain research profile and outputs, including in the following ways:

1. Biomedical and life sciences research is ***equipped with the advanced technological facilities expected of a world-class research department*****,** facilitating interdisciplinary and multiscale research. The research laboratories associated with individual research groups, as well as the multi-user facilities, are "well-founded" with all the standard laboratory equipment researchers in these areas require. Equipment necessary for routine preparations (*for example*, centrifugation, plate reading, cell handling Class 2 & 3 Bio Safety cabinets, CO_2 incubators, -80C freezers) associated with genetic, biochemical and cell biology research is standard, and with a programme of renewal.

2. ***Improved facilities include an upgrade*** of the specialist animal physiology laboratory and introducing three Containment-Category 3 microbiology laboratories and fly laboratories. These support our core research in 'Ageing and neuroscience', 'Cancer and genome stability' and 'Microbes, pathogens and Immunity' and represent a ***£200k investment over the period, building on the 2012 £12m laboratory refurbishment.***

3. ***Increased scope of research.*** The tools and resources necessary to expedite measurement and analysis are available across all the major categories of research, ranging from modelling, data handling and analysis, through to advanced molecular measurements at the single cell and whole organism levels. This means the ability to handle molecular preparations and analysis is available for each of the classes of macromolecule.

4. ***Improvement in biological imaging*** to ensure that for cellular studies we have available:

    a. Several advanced imaging modalities facilitating live cell measurements microspectrofluorimetry confocal platforms (Zeiss Airyscan), as well as several additional optical analytical tools such as live cell fluorescence-based tools (on Zeiss and Leica platforms) including FRET and FRAP.

    b. More specialised imaging modalities include Confocal Raman and single molecule/particle applications.

    c. With plasmonic systems (both SPR and imaging) for living cells analysis and molecular microarrays directed at rapid and sensitive molecular profiling for disease management and detection in continuous development.

    d. Recently replaced instruments namely:
        i. the Fluorescence-activated flow cytometer cell sorter - ***£205K, University capital equipment fund***;
        ii. the Laser Scanning Confocal at a cost of ***£375K funded by the EPSRC laboratory improvement allocation***.

5. Our ***Human Performance Laboratory*** is a specialist testing facility for Sports and Exercise Science research, finalised in 2019, it includes facilities for testing in the psychological, physiological and biomechanical domains. Exercise equipment includes an HP-Cosmos treadmill, Monark and Lode static bikes and a Biodex dynamometer. Analytical equipment includes Galvanic Skin Response equipment, a Cortex online gas analyser, Pasco force platforms, Optojump gait analysis and facilities for blood analysis. This ***represents a £150k investment in the research careers of four new lecturers in Sports and Exercise Science***.

6. ***Improved data analysis***. High End/Performance Computing (HEC) is available as a LU campus resource, with data archiving locally and cloud-based. This facility offers 10,000 cores, 49TB of aggregate memory, 24 Tesla V100 GPUs, 230TB of high-performance file store for general use and 4PB of medium performance file store for GridPP data. The computing facilities cater for analysis of molecular interactions through to Big-Data research questions across University Faculties, as well as to external partners.

7. ***Cross HEI access to facilities***. Where larger scale analyses are required, we have, *for example*, engaged with the BBSRC Earlham Institute, Manchester Institute of

Biotechnology, and NASA. We have engaged in supply and receipt of material to/from University of North Carolina's germ free and transgenic mouse model facilities, we have supplied embryonic sand fly tissue to, and exchanged and received cell lines to/from the Tick Cell Biobank at Liverpool University. Researchers have used our facilities from the Institute of Molecular Medicine (iMM) at Lisbon University, the Sapienza University of Rome, and the University of Eastern Finland.

3.3.3 Facilities and equipment for applied health research

We have also ensured investment and maintenance of infrastructure and facilities for our applied health researchers, including:

1. Private ***rooms to conduct research*** interviews and focus groups within our new purpose-built Health innovation Campus, including integral audio and filming equipment.
2. ***Institutional licences for research survey software*** (Qualtrics), along with a faculty pool of ***digital recording devices*** and an institutionally negotiated ***contract for transcribing***, creates an efficient approach to conducting qualitative studies.
3. Installation of ***ESRC-funded 'SafePods'*** in the Library in 2021, which will provide a facility for researchers to access sensitive governmental data ranging from welfare to tax records (£25k/ pod)

3.3.4 Faculty access to research equipment funding, includes:

1. An annual call for the ***FHM Equipment Fund*** (£265k spend 2014-20) allowed all researchers to make equipment requests, which are strategically prioritised for support by a committee chaired by the Dean. *Examples* include: a bio-analyser, air handling units, personal alarms for personnel carrying out interviews off campus, glucose monitors, ultra-low freezers, centrifuge rotors and tablets for data collection.
2. The annual ***University Capital Fund*** allowed FHM to bid for larger investment in equipment. *For example*, a new flow cytometer/cell sorter was purchased (£205k) and used by laboratory researchers across the infectious diseases and ageing.
3. A ***University matched funding scheme for capital equipment in research proposals***. *For example*, Crest X-light v3 Spinning disc scan head and DigitalPixel 200M Environmental chamber (LU/£57k and NWCR/£50k); plate reader (LU/£20k and BBSRC/£20k), and microinjection platform (LU/£11k and Wellcome Trust/£11k).

3.4 Supporting the generation of impact

Since 2014 we have made significant inroads into embedding an impact culture within FHM including for established and earlier-career staff, and PGRs, which has been enabled through the following actions:

1. Investment in dedicated FHM ***Impact Development Manager (IDM) and Impact Support Officer*** to provide tailored expertise, guidance, and support at all stages of the research cycle.

2. Delivery of ***three FHM Impact Conferences*** (2015, 2017 & 2019), including presentations on impact from internal and external speakers, alongside workshops on developing and evidencing impact from experts.

3. The introduction of an ***annual impact census*** to identify emerging and maturing examples of research impact, and activities that would benefit from additional support.

    a. From the census we developed a 'pool' of impact cases. Using this, our REF steering group, supported by the IDM, was able to select and further support the cases that have been submitted.

    b. During internal peer-review of grant applications we provided advice and improvements to impact statements required by UKRI, and other funders.

    c. Support research theme based impact activity included training to encourage the sharing of best practice, engaging external advisors and signposting researchers with impact and knowledge exchange capabilities to relevant support teams.

4. FHM managed a ***dedicated fund for accelerating potential impact*** through the Research Committee, ***which distributed £44k over the REF period***. The funding has enabled researchers to further their engagement with beneficiaries, specifically:

    a. it has supported 20 FHM projects, which has generated the seven case studies being submitted to UoA3 with others being developed further for REF 2028 (see section 4.5)

    b. to engage external speakers on impact, fund meetings with non-academic stakeholders, and engage stakeholders early in projects to ensure impact for new projects.

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

To allow us to deliver world-leading research, we have placed engagement at the heart of our strategy. ***True co-production with patients, the public and other stakeholders*** throughout the design, delivery and dissemination of our research is the key to our success.

4.1 Supporting effective collaboration nationally

FHM has an ***Associate Dean for Engagement*** and a further ***Engagement Lead*** in each department, to drive the implementation of our academic-led engagement strategy. A full-time ***Partnership Development Manager*** facilitates engagement with stakeholders including the NHS, local authorities, third sector, government agencies and industry to develop opportunities for effective and responsive research collaborations.

Recognising that collaboration is a vital part of research excellence, ***FHM is a member of several high-profile national academic research collaborations***, with in-kind or financial contribution from the University to support our membership. These provide the infrastructure and resources for FHM academics across research themes to work in partnership and generate internationally significant research with impact, *for example*:

1. We continue to be a key partner in the ***NIHR Applied Research Collaboration*** (ARC) North West Coast in its transition from a Collaboration for Leadership in Applied Health & Care (CLAHRC). The ARC has 13 FHM academics named on the award and **Walshe** is the Equitable Place Based Health and Care Theme lead. Engagement in the CLARHC/ARC over the REF period has led to greater regional cross-sector working and user-centric research, including a recent example led by FHM; Dear Diary: Life under Lockdown recorded by people across the North West.

2. We played a significant role in the ***Connected Health Cities*** Project (**Emsley** and **Knight**) through our membership of the NHSA, building capacity though four funded PhDs in collaboration with NHS clinicians. One *example* was the development of an early warning system for chronic respiratory disease admissions with the vanguard Morecambe Bay Respiratory Network Integrated Care Partnership (ICP). Additionally, we have been developing an exemplar of the use of informatics in integrated care with Bay Health Partners. As a result of this collaboration, the ICP's clinical lead joined FHM as a substantive Clinical Senior Lecturer (**Gatherall**), allowing us to strengthen our research into innovative care pathways with local health partners.

3. FHM is a partner in the ***Health Data Research UK (HDRUK) North Better Care*** partnership (2020) including universities and health trusts in Liverpool, Sheffield, Durham and Newcastle combining expertise from our ageing and health informatics themes, with Associate Director (**Knight**), Patient, Practitioner and Public involvement (**Preston**), and Implementation lead (**Rycroft-Malone**) roles. This ***places us in the National HDRUK network***, which includes practitioners and academics from all regions in the UK, providing a platform for future collaborative opportunities and investment.

4. We co-direct the ***Liverpool and Lancaster Universities Collaboration*** for Public Health Research (**Popay** and **Hollingsworth)** one of eight academic members of the ***NIHR School for Public Health Research*** working collaboratively to build research capacity in public health and funded since 2011. Whilst led by our Social and Economic Inequalities

in Health theme, membership has facilitated academics from across FHM and the university to collaborate in major UK public health research projects. This includes leading significant studies on community engagement and empowerment, informing NICE guidance.

4.2 Supporting effective collaboration internationally

Our collaborative reach ***links to research themes and international health priorities*****,** for example:

1. **Payne** and **Preston** in the *Ageing* theme provide UK leadership for ***multiple EU FP7/H2020 grants in palliative care*** including collaborations with 15 partners over 6 countries. These include the ***ACTION trial*** of advanced care planning, the ***MyPal trials*** of patient reported outcome (PRO) systems and ***EURO IMPACT educational and research training network*** aimed at monitoring and improving palliative care in Europe, including Italy, Denmark and Belguim. **Holland** was UK and work package lead for the ***European Innovation Partnership on Active and Healthy Ageing***, a highly successful programme resulting in 13 publications, including international position statements. FHM (**Dawson**) was a partner in the H2020 "***Neurologic and Psychiatric Disorders: from synapses to networks***". This network including the Universities of Lisbon, Eastern Finland, Rome La Sapienza aimed to promote multidisciplinary research and the mobility of researchers, with LU hosting the third network event and a funded PhD student.
2. Members of the Health Informatics and Infectious Diseases themes are partners in many ***highly productive international research networks***, including with the University of Florida and ***US Center for Disease Control*** on several influenza epidemiological studies (**Jewell**); and with the ***NTD Centre of the Task Force for Global Health*** on studies supporting disease control programmes in Africa (**Giorgi**, **Diggle**). **Knight** is a member of the ***Psychiatric Genomics Consortium***, ***International Consortium for the Genetics of Inflammatory Disease***, and the ***International Consortium of the Genetics of Blood Pressure*** leading to many outputs including in Nature. Capitalising on LU's investment in its Ghana Campus, **Pickup** leads 2 work packages in LU led ESRC funded ***RECIRCULATE project***, providing innovation in water supply whist working partnership with local academic and communities in Nigeria and Ghana to build capacity across Africa.

4.3 Public participation in research

Patients and the public are involved in the ***full research cycle in FHM***. We support several public and patient involvement (PPI) groups in ageing, palliative care, mental health, and a generic public panel in Lancaster Medical School. These panels work with us to ***co-produce our research proposals, join as co-applicants, and input into running studies and co-design of dissemination activities***. *For example*, the Spectrum Centre employs a peer-researcher with lived experience as a team member who coordinates ***Spectrum Connect***, their patient involvement group. The Centre for Aging Research partner with ***Continuing Learning Group*** a senior learners' society, supporting them to access undergraduate lectures and space to hold meetings, to which they invite researchers and students to share their work. One

member has an honorary University position and the group supports the centre through co-research, advising PhD students, and supporting public engagement events.

We provide ***leadership to other researchers, and the wider health and care community*** on public and community involvement in research. *For example,* **Popay** led an MRC Methodology Research Programme funded project to develop a ***Public Involvement Impact Assessment Framework*** with members of the public. Alongside her work on the lottery-funded community empowerment initiative, Communities in Control, this formed a body of evidence used to form the ***2016 NICE guideline (NG44) "community engagement: improving health and wellbeing and reducing health inequalities***". **Morbey** is a PPI advisor for the NIHR North West Research Design Service and contributed to the development of the NIHR's "***A brief guide to public involvement in funding applications***" and provides advice to researchers across the North West about best practice in public involvement.

4.4 Public engagement

We have an ***extensive record of facilitating public understanding and dissemination of our science*** through public engagement and Citizen Science. ***31 FHM presenters made 249 radio appearances including in the BBC Radio 4 Today programme, BBC 5Live*** and local stations - reaching a total audience of 107,426,823. We have had ***20 presenters making 278 appearances on 18 different national and international TV stations***, including the BBC and ITV, and international stations such as Aljazeera, Turkish television and other European channels. FHM academics are regular contributors in ***The Conversation***, generating 13 million reads of 81 articles, with **Taylor, A** and **Gatherer** the top publishers at Lancaster University, with a combined 11 million reads.

Members of our Infectious Disease Transmission and Biology theme have an active media profile. *For example*, **Gatherer's** media work related to Zika research led to 10 BBC radio and TV interviews. ***Media activity which has increased further since the start of the COVID-19 pandemic***. **Gatherer** and **Munir** have appeared over 400 times on national and international broadcast channels. **Read** appeared on the BBC4 Inside Science programme (23/07/20) discussing the role of pre-prints over peer review during the pandemic. Researchers in this theme also have ***an innovative public engagement programme***. *For example*, **Dillon** develops artwork for ***public engagement events for groups that may not usually have opportunity to engage with scientists***, such as homeless groups. This interdisciplinary activity with colleagues from the Lancaster Institute of Contemporary Arts focuses on microbiology, creating workshops for artists as part of arts festivals and bring them into the labs in Lancaster for arts science projects. This included the 2018 ***Wellcome funded*** ***Parasiteseeing*** and the ***Endosymbiotic Love Calendar*** .

Our anatomy academics are experts at public engagement. **Black** is internationally renowned for her ***best-selling non-academic books; All that Remains (2018)*** Saltire book of the year (2018) and ***Written in Bone (2020)***. She frequently gives public lectures on her work, for example, *How Does Forensic Anthropology Help Solve Crimes?* at the Royal Institution in 2019, and makes regular appearances in the media, most recently in The Big Scottish Book Club on BBC Scotland (2020).

FHM has contributed to Lancaster University's ***Campus in the City*** since 2015. Led by **Taylor, A**, our staff and resources from the Clinical Anatomy Learning Centre give the public a tour of

the inside of the human body. More than 1,000 members of the public have engaged with this project. **Taylor, A** led a study to find out what the public knew about the human body, using the results to inform curriculum design and delivery for medical students. The pilot study led to a research collaboration with Oxford University and the Zooniverse, world leaders in citizen science. The collaboration is ***the world's largest study into what the public know about their bodies***.

In the *Ageing* theme, **Allsop** and colleagues have worked extensively on developing treatments for dementia. To fund this work, **Allsop** and **Foulds** launched the Defying Dementia campaign in 2015. This ***fundraising campaign was one of the first University-based crowd-funding schemes*** raising £300,000 to date. Significant impacts from this fund include supporting people living with dementia in the region via ***'Dementia Hubs',*** a network of regular events led by FHM researchers, which brings together third sector organisation, academics, people living with dementia and their families. The hubs have been running since 2016 and have reached around 2,500 people living with dementia. The Centre for Ageing Research (led by **Holland**) has run an annual ***"Town and Gown"*** event at Lancaster Town Hall since 2015 that receives considerable wider interest. This brings together academics, practitioners, city councillors and members of the public to hear about the latest developments in ageing research and practice. These have included *Dementia and the Imagination: Arts and Design for Health* (2017; 106 attended, 86 non-academics), *Technology to Support Health* (2018; 104 attended, 74 non-academics), *Community models and technologies to support healthy ageing* (2019; 63 attended, 55 non-academics) and *Maintaining Health in Older Age* (2020; 79 attended, 57 non-academics).

4.5 Wider contributions

Beyond our impact case studies we have been responding to national and international priorities in multiple ways, *for example*:

Young person's mental health and suicide: In response to National Suicide Prevention Strategy, The Queer Futures study led by **McDermott** and funded by the DHSC PRP Programme produced ***the first national evidence on LGBTQ+ youth, suicide, self-harm and help-seeking***. The results have been used as evidence by the UK Government National Suicide Prevention Strategy Advisory Group, House of Commons 2016 Suicide Prevention Inquiry, and the UK Government Equalities Office.

Multiple long-term conditions [MLTC]: Working in partnership with regional NHS and industrial partners as the Lancashire Care Innovation Alliance (LCIA) **Milligan** led one of seven ***'Testbeds'*** awarded competitive funding by NHS England. This pioneering programme focused on testing the effectiveness of targeted combinations of existing health technologies to improve self-management of older patients with MLTCs. Findings showed these technologies made no difference to hospital service usage with costs exceeding savings; thus providing important evidence to discontinue the 'Testbed'.

Menstrual symptoms and menopause in the workplace: **Hardy's** research has been ***informing industry practice*** (e.g., Aviva) and ***guidance for general practice*** (e.g., British Menopause Society). She is also called on for expert advice: Public Health England's Reproductive Health Systems Leadership Forum, UK Parliament's Menstrual Health Coalition,

the Cross-Government Policy Group on Pregnancy Loss and Death of a Baby and the European Society for Medical Oncology (ESMO) Resilience Taskforce.

Parkinson's disease: Working with the charity Parkinson's UK, **Simpson** and **Eccles** developed and validated a new scale: ***Parkinson's UK Scale of Perceived Control***. The scale is being used by the charity in nationwide surveys (>2000 respondents) and results used to inform their campaign activities. It is included in their First Steps programme for the newly diagnosed and was incorporated into a membership survey about experiences of COVID-19 helping them shape their pandemic response.

COVID-19*:** There has been a wide response to the pandemic across FHM beyond our impact case study (**Jewell** and **Read**). **Munir, Worthington** and **Jackson-Jones** are ***developing a vaccine*,** which can be delivered nasally, and is recognised by WHO as a vaccine candidate. **Munir,** in collaboration with Brunel University and the University of Surrey, has also developed a ***rapid COVID-19 test, Virus Hunter 6 (VH6), designed for use in mass testing programmes. It has received Medicines and Healthcare Products Regulatory Agency (MHRA) approval, has a CE marking, and is currently undergoing further validation.

Funded by the MRC and in collaboration with 68 care homes **Knight** and **Preston** are conducting innovative mixed methods research into the ***effects of the pandemic on care home residents to inform future policy***. Due to her expertise, **Knight** is a member of the Government's SAGE Social Care Working Group.

FHM has also played a civic role through the pandemic. We worked with colleagues in Morecambe Bay Foundation Trust to establish a ***PCR diagnostic testing laboratory*** using FHM equipment, our staff worked with NHS staff to provide diagnostic testing on a seven-day basis until national testing capacity was sufficiently increased. We worked with our local Primary Care Network to set up a ***first wave vaccination centre*** in the Health Innovation Campus, where people have been receiving vaccinations since December 2020.

4.6 Contribution to and recognition by the research base

Our staff have made significant contributions through service to health, care, and medicine, nationally and internationally over this REF period (Table 7).

Table 7: Number of researchers engaged in academic activities

Funding committee membership	Journal editorship/ associate editorship	Keynote lectures	Visiting academic positions
30	23	39	15

Our commitment to peer-reviewed science involved ***23 academics acting as editors or associate editors*** on international peer-review journals (Table 8), ***with an additional 11 editing special issues***. This includes editorship of the highest quality international journals, *for example*, **Walshe** is Editor of Palliative Medicine (highest ranked journal in Palliative Care), and **Hollingsworth** is Co-Editor of the journal Health Economics (the journal of the International Health Economics Association).

Table 8: Examples of FHM Roles in International Journals

Journal	Name	Role	Date
Palliative Medicine	**Walshe**	Editor	2011-present
Journal of Applied Research in Intellectual Disabilities	**Hatton**	Editor	To 2018
Health Economics	**Hollingsworth**	Editor	2019-present
Health Economics Letters	**Hollingsworth**	Editor	2013-2018
BMC Palliative care	**Preston**	Section Editor	2016-present
The Sport and Exercise Scientist	**Bampouras**	Section Editor	2019-present
The Neurohospitalist	**Emsley**	Associate Editor	2019-present
BMC Palliative Care	**Hughes**	Associate Editor	2015-2019
Annals of Palliative care	**Preston**	Associate Editor	2020-present
Frontiers in Microbiology	**Robinson**	Associate Editor	2019
BMC Molecular and Cell Biology	**Robinson**	Associate Editor	2019
International Journal of Health Policy & Management	**Rycroft-Malone**	Associate Editor	2013-present

FHM researchers have held ***30 positions on research funding committees***. *For example*, the Alzheimer's Society (**Allsop: chair 2006-2017; Swarbrick: 2019**; **Hawkes: 2019 onwards**), Wellcome Trust Sustaining Health Committee (**Diggle: 2013-2017**). Newton Fund Biological and Medical Sciences (**Taylor, A: chair 2017-present; Mateus 2018-2019**), NIHR Health Technology Assessment (**Logue: 2016-2020**), NIHR Research for Patient Benefit (**Emsley: 2016-present**, **Hatton: 2018-2020**), NIHR HS&DR Prioritisation Committee (**Walshe 2016-2020). Diggle (2012-2016)** was Chair of the MRC Strategic Skills Fellowships Schemes Panel**,** and **Rycroft Malone (2014-present)** is Programme Director and Chair of the NIHR HS&DR Programme and funding committee, and during the pandemic has played a key role in the delivery of COVID-19 research funding including membership of the Urgent Public Health Oversight Group, member of the UKRI/NIHR Rapid Response Panel, and Deputy Chair of the UKRI/NIHR Mental Health, and UKRI/NIHR Long COVID funding committees.

We provide ***leadership for research, scholarship, and clinical practice by undertaking key positions in subject associations/societies*** (examples in Table 9).

Table 9: Key leadership positions in subject associations and clinical practice

Committee; role	Name	Date
NICE Implementation Strategy Group; Chair	**Rycroft-Malone**	2012-present
Joint Parliamentary Committee on Human Rights; Special Advisor	**Hatton**	2019
NICE bipolar Guidance Development Group, Bipolar Disorder; member	**Jones**	2012-2014
NICE Guideline Development Group, Mental health in people with learning disabilities, member	**Hatton**	2019
Communities and Local Government committee evidence enquiry on Housing for older people, panel member	**Holland**	2017
World Health Organization, Influenza Incidence Analytics Group	**Read**	2018-present
Public Health England; honorary academic	**Hatton**	2017-present
Independent Advisory Committee for the Global Burden of Disease, Bill & Melinda Gates Foundation; member	**Hollingsworth**	2014-2018
National Peer Support Worker Task & Finish Group, Health Education England; member	**Lobban**	2019-present
International Health Economics Association; Director	**Hollingsworth**	2010-2017
World Obesity Federation; Health Services Committee	**Logue**	2018-present
Royal Statistical Society; President	**Diggle**	2014-2016
Chartered Royal Anthropological Institute, President	**Black**	2018-present

FHM academics are making ***extensive contributions to the international research base***. Our academics have delivered over ***700 presentations at international and national meetings***, including ***39 keynotes*** given by research leaders from across the themes (Table 10). 24 researchers were members of ***scientific committees*** for international conferences, including for major international events such as International Health Economics Association, ISPOR Europe (**Mateus**), Infectious Disease Dynamics (**Read**) and the European Association for Studies in Science and Technology (**Goodwin**). **Holland** has been appointed as Chair of the British Society of Gerontology Annual Conference to be held in Lancaster in 2021.

We ***collaborate with partners across 34 countries***. We have acted as external examiners for 114 PhD/MSc external candidates across the world including in Auckland, Rome, Melbourne, Toronto, and Malaysia. We have welcomed ***68 international visitors*** to FHM for periods

ranging from a few days to a year, and ***our staff hold 15 visiting academic positions in non-UK Universities***.

Table 10: Illustrative Keynote Addresses given by members of FHM, 2014-2020

Event	Date	Speaker	Place
Royal Statistical Society Presidential Address	2015	**Diggle**	London
John Stuart Hunter Lecture	2015	**Diggle**	UAE
Royal College of Psychiatrists Faculty of Intellectual Disabilities Annual Conference	2015	**Hatton**	Newcastle
British Association for Behavioural and Cognitive Psychotherapy Annual Conference	2015	**Jones**	Warwick
Norway Early Intervention Psychosis conference	2015	**Lobban**	Oslo
Smart Ageing Cities Masterclass: World Cities Summit	2016	**Holland**	Singapore
MIND national conference	2016	**McDermott**	Bristol
Royal College of Emergency Medicine Annual Scientific Meeting	2017	**Isba**	Liverpool
GEOMED 2017	2017	**Read**	Porto
Annual Conference of Taiwan Academy of Hospice Palliative Medicine	2017	**Walshe**	Taipei
International Association for the Scientific Study of Intellectual and Developmental Disabilities 16th World Congress	2018	**Hatton**	Glasgow
International Society for Bipolar Disorders Conference	2018	**Jones**	Mexico City
Alzheimer's Europe Conference	2018	**Swarbrick**	Barcelona
Colin White Lecture	2018	**Diggle**	Yale
13th European Congress on Epileptology	2018	**Emsley**	Vienna
International Symposium on Youth Suicide	2019	**McDermott**	Melbourne
Global Implementation Conference	2019	**Rycroft-Malone**	Glasgow
American Association of Anatomists	2019	**Taylor, A**	Orlando

4.7 Prizes, awards, and honours

There has also been significant external recognition for FHM academics' contributions during this REF period, including:

Dillon: ***Microbiology in Society Award*** (2020) for the Endosymbiotic Love Calendar (http://slyrabbit.net/endosymbiotic-love-calendar/).

Hardy: ***National Research Award for Excellence in Occupational Psychology*** (2019) by the British Psychological Society.

Taylor, A: ***Basmajian Award from the American Association of Anatomists*** (2019), the first academic outside North America to receive this prestigious award.

Payne: ***EAPC Cicely Saunders Award*** (2020) for lifetime contribution to palliative care.

Diggle: ***Royal Statistical Society Barnett Award*** (2018) for Environmental Statistics.

Rycroft-Malone: ***Thomson Reuters Highly Cited Researcher*** (social sciences) (2016) in recognition of ranking among the top 1% of researchers for most cited in their specific field.

Black: ***Dame Commander*** of the most Excellent Order of the British Empire (2016); ***Honorary Doctorate*** by the Law School at the University of Aberdeen (2019); ***Elected fellow of the British Academy*** (2020); appointed to the ***House of Lords as a crossbench life peer*** (2021).