

Institution: Liverpool John Moores University (LJMU)
Unit of Assessment: UoA3 Allied Health Professions, Dentistry, Nursing and Pharmacy
1. Unit context and structure, research, and impact strategy

Unit context

Research submitted to this UoA takes place in the Faculty of Science (FSC); within the School of Pharmacy and Biomolecular Sciences (PBS) and the School of Sport and Exercise Sciences (SES), and in the Faculty of Health (FHE); within the Public Health Institute (PHI) and School of Nursing and Allied Health (NAH). In 2019, the Faculty of Education, Health and Community (EHC) was reorganised to form FHE, enabling a research strategy more targeted towards applied health research to be introduced. During this reorganisation, Nutrition was incorporated into FSC within SES. Due to this multifaceted arrangement, the Institute for Health Research (IHR) is a vital nucleus for research governance, leadership and support and is integrated within the management of all five LJMU Faculties; all 77 Cat A staff submitted to this UoA are full IHR members. To provide greater strategic leadership **Hutcheon** was appointed as Director of IHR in 2016, expediting an increase in the range and quality of collaborative health and health-related research activities across the University and with external partners. The IHR is governed by an Executive Board (Head of IHR; Pro-VC Research; Pro-VC Faculty Deans) and an Operations Board (Head of IHR; Faculty Associate Deans Research; IHR Interest Group leaders). Members facilitate researcher-led activities and support two-way communication across the University and with external agencies. The IHR reports to both FHE and FSC Research Committees (FRCs) and the University Research and Knowledge Exchange Committee, to ensure effective communication and that the respective research strategies are aligned. The IHR research environment benefits significantly from enthusiastic support from the Faculties and the wider University where 'Health and Wellbeing' is one of three priority LJMU research themes. LJMU annually funds IHR cross-Faculty Postgraduate Research (PGR) studentships (4 per annum 2016-2018, 2 in 2019); Institution-level PhD Scholarships (5 to this UoA); Doctoral Training Alliance PhD studentships (5 to this UoA); and an annual IHR conference. Dedicated funding is provided to support workshops and meetings with external stakeholders generating collaborative activities with, for example, Alder Hey Children's Hospital (AHCH), Liverpool Heart & Chest Hospital (LHCH), Liverpool Clinical Commissioning Group (LCCG), Liverpool Women's Hospital (LWH), Clatterbridge Cancer Centre (CCC), Public Health Liverpool, University of Liverpool (UoL) and Liverpool School of Tropical Medicine (LSTM).

Unit structure

The IHR provides a platform to integrate interdisciplinary health research across the entire University and drives strategic developments in line with national and international policy by working collaboratively with other Higher Education Institutes (HEIs); the NHS; local communities; external agencies; and industry. This structure enables staff to undertake innovative, flexible, and quality-driven research with an overriding focus to develop novel approaches and practical solutions for therapeutics, healthcare and public health. Within this submission, research is actively carried out within 5 research themes: **Health Promotion**; **Health Science**; **Biomedical Sciences**; and two new themes, **Health Practice** and **Forensic Science**, that were established due to achieving critical mass in these areas. **Health Science** captures the interdisciplinary research across PBS that was previously submitted within individual research groups. The strongly collaborative nature of the IHR results in significant interactions between the members of each theme so Category A and B staff are represented in bold within their primary theme.

Theme 1: Health Promotion

This theme, currently led by **Sumnall**, includes 13 staff from PHI which offers a world class research environment. Since 2014, 3 Professors have been appointed (**Hope; Simkhada; Van Hout**) to provide additional leadership. Researchers tend to collaborate across areas as their expertise is often complementary. Expertise clusters around 4 major domains, but other emerging research areas include sexual health; homeless health; and tobacco, nicotine, and e-cigarettes.

- a) Substance Misuse: (**Atkinson; Gee; Hay; Hope; Jones L; McVeigh; Sumnall; Van Hout**) Research on controlled, prescription, and image and performance enhancing drugs, and alcohol includes: systematic review; policy and practice guidelines development; service and system evaluation, including trials; and estimation of the burden of problem drug use and associated harms. Activities include investigating alcohol marketing; development and evaluation of systems of support for people with co-occurring substance use and mental health needs; injecting drug use and blood borne viruses; sexualised drug use; and (inter)national prevention and harm reduction policy development (Impact Case Study (ICS)1 and ICS2). This group works closely with **Brandt (Health Science)** on risk assessment and legal control of novel substances.
- b) Violence and Adverse Childhood Events (ACES): (**Jones L; Quigg; Timpson; Van Hout**) The World Health Organization (WHO) Collaborating Centre for Violence Prevention is based in PHI. Work includes systematic review and policy and practice guidance development for European and International violence prevention partners. Broader activities involve investigating the extent, nature, risk, and protective factors for violence; programme evaluation; and service review. Exploring the extent, nature and impacts of ACEs across the life course; protective factors; and evidence on prevention is also a significant area of research. Activities include estimation of the burden of ACEs at national population level; systematic review and policy and practice guidelines development; and service and system evaluation (ICS3).
- c) Community-based socioeconomic engagement: (**Porcellato; Timpson**) Research on community-based services; hard to reach and vulnerable populations; and socioeconomic engagement. Socioeconomic approaches are used to develop, understand, and apply best evidence to inform public health service development. This includes applying social value methods to evaluate statutory and non-statutory health services and participatory research to evaluate community-based programmes.
- d) Global Public Health (Low and Middle Income Countries): (**Khatri; Leavey; Quigg; Simkhada; Van Hout**). Multi-disciplinary approach to public health issues in vulnerable populations including health and human rights. Programmes relate to the health of female migrants in Nepal (**Khatri; Simkhada**); prison health standards in Zimbabwe and Malawi (ICS4); prevention and management of HIV, diabetes and hypertension in Uganda and Tanzania (**Van Hout**); and a humanitarian focus on the health of refugee populations in West Bank and Gaza, and Lebanon (**Leavey; Quigg; Van Hout**).

Theme 2: Health Practice

This theme, led by **Jones I** and **Morecroft**, includes 11 staff from NAH and PBS and 33 members of staff undertaking postgraduate study or research development activities. The appointment of 4 Professors, **Fitzsimmons** (2017); **Fleming** (2017); **Lotto A** (2017); and **Jones I** (2016) has transformed the research culture and enabled the engagement of more staff in health practice research. There are 3 broad areas of expertise:

- a) Clinical Pharmacy: (**McCloskey; Morecroft**) The establishment of a collaborative Centre for Pharmacy Innovation (2014, £100K, RLBUHT), to improve how medicines are managed in the NHS, enabled greater interaction with Royal Liverpool and Broadgreen University Hospital NHS Trust (RLBUHT) and Lloyds Pharmacy to deliver impactful research for patient benefit. The recruitment of pharmacists **McCloskey** (2020), **Gitsham** (2016); **Mullen** (2014); and **Shemilt** (2014); and experienced specialist practitioners, **Davies J** (2014); **Traynor** (2014); **Walters** (2014); and **Cutler**

(2009), has established a critical mass for future research opportunities on pharmacy systems and services.

- b) Cardiovascular: (**Jones I; Lotto A; Lotto R; Penson**) Research in Paediatric congenital heart disease focussing on the technical elements of surgical practice and the lived experiences of the child and their family, supports behaviour change for those with coronary heart disease by gaining a better understanding of patient needs. The recruitment of **Lotto R** (2016) and **Lotto A** (2016) strengthened the applied aspects of the surgical management of congenital heart disease and the long-term care of the patients and their family.
- c) International Women's Health: (**Fleming; Maxwell**) Research in midwifery and perinatal health including the mothers and Midwives experience. Programmes include ground-breaking work across 18 European countries to explore healthcare practitioners' exposure to late abortion and Midwives' reason for conscientious objection given the variation in legal frameworks in each nation.

Theme 3: Health Science

Led by **Cronin, Hutcheon** and **Sarker**, this theme includes 29 staff undertaking laboratory-based and/or computational research within 3 PBS research groups and the Centre for Natural Product Discovery (CNPD). The promotion of **Hutcheon** and **Saleem** to Professor strengthened the leadership base.

- a) Formulation & Drug Delivery: (**Al-Kassas; Ehtezazi; Gaskell; Giuntini; Gordon; Hutcheon; Khan; Roberts; Saleem; Seton**) Emphasis is on the design and development of novel drug delivery systems. The recruitment of **Al-Kassas** (2019), **Gordon** (2016), and **Khan** (2016) enhanced the existing capacity for nanoformulation. Significant activities include working with AHCH, on age appropriate medicines, and the pharmaceutical industry (Aerogen; Colorcon®; Quay Pharmaceuticals Ltd).
- b) Medicinal Chemistry and Natural Products: (**Coxon; Evans A; Fatokun; Fielding; Ismail; Leatherbarrow; Lowe; Nakouti; Prieto Garcia; Rahman; Ritchie; Sarker; Sharples; Wainwright**) Medicinal chemistry research is in photodynamic chemistry (**Giuntini; Wainwright**) and peptide chemistry (**Coxon; Leatherbarrow**). The **CNPD** (established 2019) presents an interdisciplinary approach to the discovery and evaluation of natural products for medicinal applications. The recruitment of **Prieto Garcia** (2020), **Fielding** (2017), **Fatokun** (2016), and **Nakouti** (2015) enhanced research capacity. Activities include natural product discovery (**Fielding; Giuntini; Ismail; Prieto Garcia; Sarker**); nutraceuticals (**Rahman; Lowe**); biological studies (**Evans; Fatokun; Nakouti; Ritchie; Sharples**); and formulation (**Ehtezazi; Hutcheon**).
- c) Cheminformatics: (**Albuquerque; Cronin; Enoch; Leach; Madden**) Activities include the application of QSAR and *in silico* models to predict the toxicological properties of chemical, pharmaceutical, and cosmetic compounds (**Cronin, Enoch; Madden**); the study of ligand receptor binding (**Leach**); and properties of supramolecular materials (**Albuquerque**). Since 2014, over £850K EU funding (FP7, IMI and Marie Curie) has led to the development of *in silico* profilers and data resources for industry and regulatory authorities (ICS5).

Theme 4: Biomedical Science

Led by **Hobbs**, this theme consists of 26 staff taking an integrated approach to the study and application of biological systems. Leadership was strengthened by the recruitment of **McDowell** (Reader, 2020) and the promotion of **Davies** and **Abayomi** to Reader. Recruitment of **Fadel** (2020), **Fawcett** (2020), **Fergani** (2020), **Dykes** (2018), **Diaz** (2017), **Phillips** (2017), **Olorunniji** (2017), and **Hargreaves** (2016) has ensured a critical mass across all areas:

- a) Applied Microbiology: (**Diaz; Evans K; Hobbs; Murphy; Nakouti**) Research on the development of rapid molecular and phenotypic tests for detection of antimicrobial resistance genes in Gram negative bacteria. Activities include the production of natural products from bacteria that have commercial value such as biosurfactants and antibiotics for pharmaceutical and environmental

applications. A novel area of research focuses on manipulating and exploiting biofilms through the application of low-frequency acoustic stimulation to biofilms (**Hobbs; Murphy**).

- b) **Bioanalytical:** (**Dykes; Hargreaves; Phillips; Powell; McDowell**) Research on biomarker identification and validation for diagnosis or prognostic testing in acute cardiology and heart failure (**McDowell**); and, in collaboration with AHCH and LWH, congenital heart disease (**Dykes; Powell**). Studies on coenzyme Q10 metabolism, mitochondrial and oxidative stress induced cellular dysfunction (**Hargreaves**) and lymphoblastic leukaemia (**Phillips**).
- c) **Molecular and Cell Biology:** (**Bryan; Dykes; Fawcett; Fergani; Louhelainen; Olorunniji; Randle; Ross**) Research on a range of projects including: non-coding RNA in dermatological and cardiovascular diseases (**Dykes; Ross**); neuronal mechanisms governing reproductive physiology and behaviour (**Fergani**); drug-induced liver injury (**Randle**); immunology (**Sexton**); biomaterials (**Bryan**) and circadian wound healing (**Fawcett**).
- d) **Nutrition:** (**Abayomi; Davies; Fadel; Lane; PdHeredia; Qi**) Interdisciplinary research including food solutions for nutrition problems; human nutrition and obesity; maternal nutrition; nutraceuticals; and plants. Cardiometabolic risk research in collaboration with **Health Practice (Davies)**

Theme 5: Forensic Science

Led by **Brandt**, this new theme reached a critical mass of 6 staff with the recruitment of **Dawnay** (2015), **Sheppard** (2017), **Assi** (2019), and **Ralebitso-Senior** (2018) and the promotion of **Birkett** and **Brandt** to Reader has provided leadership. A collaborative research portfolio has been developed with law enforcement agencies, forensic practitioners, and environmental partners to provide applied forensic solutions. Multidisciplinary research activities and expertise involving the chemistry and pharmacology of designer drugs of abuse influenced European and Global drug policy **Brandt** (ICS6).

Achievement of Strategic Research Aims 2014-20

The resources provided to establish a more robust IHR structure with a committed leadership, working effectively across all Faculties, has enabled the successful delivery of the aims of the 2014-20 research strategy, as follows:

1. **Strengthen our approach towards the development, translation and impact of high quality inter-disciplinary research concepts, activities and outputs that reflect our expertise and interdisciplinary thinking.** The IHR has been an enabling platform for the cross-fertilisation of inter and multidisciplinary research activities between researchers within UoA3, across LJMU and with external stakeholders. Success is reflected in the increase in staff submitted (36 to 77) and PGR completions during this period (33.5 to 82 (0.97 to 1.13 per FTE)). Outputs were successfully targeted at high impact journals (top 10 percentile) such as Science, Nature Chemistry, Angewante Chemie Int., BMJ Open, Public Health Research, and The Lancet Public Health. Research findings are translated into policy documents, regulatory requirements and legislation, for example, via the European Centre for Disease Prevention and Control (ECDPC); the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA), United States Environmental Protection Agency; European Commission (EC) Joint Research Centre, and the UK Food Standards Agency (FSA) and is further evidenced within the six UoA3 ICS.
2. **Grow our external research funding.** This UoA has realised a total income of £15.4M with a targeted growth in funding from EU government bodies (£3.2M, 20% total income). Income from UKRI Research Councils, The Royal Society and British Academy (£386K) has increased by > 750% compared to REF2014, and Non-EU other has increased from £0.5K to £460K.
3. **Develop key partnerships with academic institutions worldwide, public bodies and industry.** The IHR has built strong relationships with healthcare providers across the Liverpool City Region (LCR). In 2015 we joined Liverpool Health Partners (LHP) and in 2019 became members of the NIHR North West Coast Applied Research Community (NWC-ARC). LJMU was one of 4 founding

partners of the Liverpool Centre for Cardiovascular Science (LCCS), a multidisciplinary research centre established in 2018, We have securing funding in collaboration with industry; for example, an Innovate UK KTP was awarded with Quay Pharmaceuticals Ltd (**Roberts and Al-Kassas**, 2020, £181K). The global nature of our research has increased with new partnerships in Nepal, Palestinian Territories, Jordan, and Sub Saharan Africa (**Van Hout**, H2020, 2018, £4.2M, £98K to LJMU, and **Fleming**, ESRC, 2018, £226K). An increase in international collaboration is further evidenced by the % outputs co-authored by international collaborators increasing over the REF period (**Health Science**, 57 to 79% and **Health Promotion** 20 to 57%).

4. **Promote a thriving, inclusive research culture.** The IHR has over 225 full and associate members from Research Assistant to Professors, across all Faculties. This enables a diverse support network for mentoring; sharing best practice; collaborative workshops; and staff development events such as, 'How to write a systematic review'. We celebrate health research at annual conferences and seminar sessions awarding prizes to staff, students and contract researchers for best presentations and posters. Success is also reflected in an increase in staff undertaking research activities (see section 2 for further detail), and the creation of a **Health Practice** theme and the CNPD.
5. **Enhance our external profile.** Dissemination activities enable our external stakeholders to appreciate the quantity, quality, and diversity of our research. IHR conferences (2017, 2018) showcased our research to over 150 attendees and included keynote speakers and representatives from Liverpool NHS trusts. PHI host an annual Public Health PhD Symposium open to all Public Health students in the UK, and internationally. IHR web pages, including annual reports, are openly available. Staff are regularly invited by national media to comment on topical agendas, for example, substance related issues such as drug deaths, medicinal cannabis, or drugs policy (**Sumnall**). Public engagement, patient participation and outreach activities are embedded in IHR activity and we are members of the LHP Community Information Exchange group.

Key project outcomes

We have successfully delivered on the specific projects identified in REF2014 as being of strategic importance, namely:

- a) Securing 2 further 4-year contracts (2015-19 and 2019-23) for the WHO Collaborating Centre for Violence Prevention work programme.
- b) Completing the STAMPP (NIHR, £1.3m) project which led to two further projects funded by the NIHR (SIPS Jnr High, £856K) and Northern Ireland Public Health Agency (£125K).
- c) Several versions of the OECD QSAR Toolbox have been released, culminating in v4.4 in February 2020, with over 21,000 active users of the Toolbox.
- d) A bid for the MRC VACCINE FAPESP MICA project (£570K, 2017-20) was successful and a patent (WO/2020/099869) filed.

Achievement of Strategic Impact Aims 2014-20

We have successfully delivered on the aims of the 2014-20 impact strategy as follows:

1. **Embed impact at the core of our research activity from conception to translation of impact by identifying, developing, and extending close working relationships with local, national, and international external partners in industry, health trusts and public sector organisations.** Increased external working relationships are evidenced above within Achievement of Research Strategic Aims (number 3). This approach has provided three ICS which directly relate to health policy and practice (ICS1), legislation (ICS6), and regulatory requirements (ICS5). We have worked strategically with external partners such as the EMCDDA (ICS2), Darwen Borough Council (ICS3); and the United Nations Office on Drugs and Crime (UNODC), (ICS6) to address their needs. **Hutcheon** has trained as an Innovation Agency Scout to support researchers to identify and translate research impact at an early stage.

2. **Provide infrastructural support for staff and PGRs engaged in impact focused research and use impact activities to inform the annual personal development and performance review (PDPR) process, the workload allocation model (WAM) and part of the criteria for career progression.** Development of impact was supported by an Impact Officer and dedicated funding (£27.15K). **Brandt and Davies** received LJMU Impact Awards. MRC Pathway to Discovery (P2D) funding (£75K) supported 9 staff to engage with industry. ICS development is provided for within the WAM and engagement with impact monitored via PDPR. Professorship or Readership can be conferred under the criteria of 'making outstanding contributions to the furtherance of Social and Economic Engagement' through commercial enterprise; knowledge exchange; or cultural and professional activities that have a significant positive impact for the University and/or on wider society (Smith, 2017, **Timpson**, 2018).
3. **Place public engagement and the recording of research impact at the core of our scholarly activities and establish a public Engagement and Impact (PEI) Group to link with external agencies to collate and develop a robust framework to capture and monitor the on-going and accumulative impact of our research.** Public engagement and patient and public participation is now considered at the outset of every project so, rather than establish individual PEI groups, activity across the unit is embedded via the IHR. Ventura Ventures (VV) Impact Tracker is used to capture, measure and report impact on a regular basis. Funding specifically for Outreach programmes has been secured by **Seton** (RSC, £150K, 2015-19; Shaping Futures, £160K, 2017-20).

Research and Impact Strategy 2021-26

Over the next 5 years we will **build further upon** our 2014 strategies, utilising the IHR to expand the relationship we have with our stakeholders; deliver more high quality and innovative research in our areas of expertise; advance our emerging areas of research; and demonstrate innovative and practical impact from our activities. We therefore have the following strategic aims for 2021-25:

1. **Place quality at the heart of all our activities; from research planning to output production and impact development.**
We will utilise our success in capacity building; generation of collaborative opportunities; and increase in output quality, to create an agenda that supports excellence from the beginning to end of a project. We will achieve this by revisiting our research design strategies to ensure all research is rigorous; providing mentoring for new researchers; and implementing a peer review process from research design through to publication and impact capture.
2. **Take a more strategic approach to securing competitive research income.**
To increase the number of high value bids we will continue to work closely with, LHP; NWC-ARC; local authorities; the successor to PHE; and international collaborators, to enable greater participation in successful, large, multi-centre funding bids with an increased number of LJMU Principal Investigators. We will build upon our International partnerships and be pro-active in identifying and disseminating funding and event calls in a targeted manner via an IHR bulletin. We will utilise our access to the LHP Single Point of Access to Research and Knowledge (SPARK) to bid for more projects involving clinical trials.
3. **Deliver an environment capable of supporting ambitious new research programmes.** A high-quality physical environment will be maintained to support the delivery of research and enterprise and contemporary infrastructure will be created to support innovative areas of research as they are launched. The IHR will enable a culture that embraces and champions new, interdisciplinary concepts at the forefront of health research.
4. **Co-develop interdisciplinary research agendas with healthcare providers, industry, and the public.** We will expand our external relationships to enhance our response to external initiatives, national and international priorities, and work with partners to ensure we generate impact by implementing and evaluating our research findings in a timely manner. We will capitalise on our

membership of the NWC-ARC, to plan and utilise our research outcomes towards improving the quality, delivery, and efficiency of health outcomes for patients in vulnerable communities.

5. Provide a culture of inclusivity that broadens our horizons, supports researcher development, and celebrates achievements.

We will nurture our existing research values and, to develop vital new expertise, we will recruit internationally leading researchers; grow the number of academic staff, contract researchers, PhD students and Professional Doctorates; and increase our capability in innovative areas of research and impact. We will provide peer support to empower staff to accomplish their ambitions and seek progression towards independent researcher status or promotion to Reader or Professor.

6. Expand the reach and translation of our research.

To enhance the timely implementation of their research, staff will work with Research and Innovation Services (RIS) from the project conception phase and engage with external stakeholders from the earliest stage to capitalise upon opportunities to create and secure the maximum impact from their research. Development programmes will be implemented to enable all researchers to understand impact and to consider the potential intellectual property and commercialisation of their projects.

Research Governance

To ensure best practise, research across the unit is designed and delivered in compliance with rigorous ethical standards. Each research proposal is scrutinised by supervisors and a School Research Ethics Committee (REC) for risk, according to Health Research Authority definitions, prior to submission to the LJMU REC. This process is supported by online training modules and a decision making tool. Upon acceptance, staff are required to add publication details to a Symplectic database and deposit the appropriate version in the LJMU open access repository. For UoA3, 1656 items are currently in the repository, of which 153 are under embargo, and a further 145 are non-journal deposits such as reports. All PGRs are required to deposit their thesis to the repository and are encouraged to make these open access as soon as possible; 82% of all theses deposited are available. Researchers are required to understand working within the limits of the Data Protection Act and General Data Protection Regulation. We adhere to the LJMU policy on Research Data Management and the requirements of funding bodies; so, where required, data management and access plans are submitted and monitored by the funders. These include data sharing statements published with the findings of the research; submission of data to the UK Data Archive or UK Data Service Repository; and applying a creative commons licence to data permitting others to distribute and build upon research in a non-commercial way. PHI has a data sharing protocol, written in accordance with the requirements of the Data Protection Act 1998 and the recommendations of the Caldicott Committee (1997). All data transfer to and from PHI takes place in a secure SSL certified SharePoint environment and abides by the statutory and legal principles which provide the framework for the governance of data exchange.

2. People

Staffing strategy:

Our approach to staffing has been to ensure the vitality and sustainability of our research through the recruitment and retention of high calibre academic staff. The unit staff base is composed of 14 Professors, 17 Readers, 33 established academics and 13 ECRs; more than double the number submitted to REF2014. Retention of staff is high with 60% of staff submitted to REF 2014 still active within the unit. Sustainability is safeguarded by the recruitment of 31 new appointments, including boosting senior leadership with 6 internationally leading Professors, ensuring continuity and development of the next generation of research leaders. Moving forward, FHE are recruiting a Director of NAH and a Director of Research who will be in post early 2021 and will work with

Hutcheon to grow the research staff base, for example, by supporting non-doctoral staff to undertake PhD by publication.

The UoA staffing strategy complies with the University Strategy (2017-22) including measures for encouraging, supporting, and rewarding staff for excellent research. Its implementation is evidenced throughout this UoA where there has been a strategic focus on the recruitment of staff specifically to progress new areas of research, such as: international health (**Fleming; Van Hout**); cardiovascular disease (**Dykes; Jones I; Lotto A; Lotto R; McDowell**); natural products (**Fatokun; Fielding; Prieto Garcia**); and forensic science (**Assi; Ralebitso Snr; Sheppard**), and to expand and broaden existing research areas such as, drug delivery (**Al-Kassa; Gordon; Khan; McCloskey**) and biomedical science (**Bryan; Diaz; Fadel; Fawcett; Fergani; Hargreaves; Olorunniji; Phillips; Qi**). The unit successfully recruited 5 new members of staff via the VC Inspire scheme (**Bryan; Coxon; Lotto R; Queiroz De Albuquerque; Sexton**). Success in our strategy to enrich staff development is evident through the promotion of 3 staff to Professor (**Hutcheon; Morecroft; Saleem**) and 8 to Reader (**Birkett; Enoch; Giuntini; Porcellato; Quigg; Roberts; Smith; Timpson**). As expected, over this period there have also been staff departures for career progression (**Abayomi; Coxon; Leach; Leatherbarrow; McVeigh; Simkhada**). In addition to academic staff, the unit has also supported 33 Research Assistants (RA) and Postdoctoral Research Associates (PDRA). We welcome research visitors as a means of supporting international research collaborations. The unit is supported by the experience of 7 emeritus Professors and 13 visiting/honorary Professors. Since 2014, we have hosted 26 international PDRAs supported by personal funding or fellowships, over 50 visitors (either undertaking research projects or training), and 33 ERASMUS students.

Staff Development

Effective staff support is crucial to the success of the IHR strategy, enabling every individual to realise their potential and achieve progression at all career stages. Research activity is considered annually during a PDPR to discuss individual targets and development needs and by a Faculty panel where staff receive feedback on their research profile resulting in dedicated research time being awarded via the WAM. All staff and PGRs are encouraged to make use of the comprehensive range of LJMU research development activities (for example, ACTivator workshops; library sessions; digital courses; impact development; and wellbeing sessions). Every member of the unit has attended at least one event and there has been an increase in attendance between 2016-20 (from 18 to 77 participants per annum from NAH, PHI and PBS). Staff are supported to undertake external training programmes for example, statistical analysis (**Hay; Sumnall**) and Home Office Project License course (**Dykes**). Leadership development opportunities were taken, for example, Coaching and Mentoring (**Hutcheon; Seton**); ILM level 5 (**Hutcheon; Seton; Ralebitso Snr**); Leadership Matters (**Hutcheon**); and Leadership Foundation for Higher Education course (**Hutcheon; Jones L**). Staff were supported to apply for Research Fellowships enabling them to focus solely on research for a period with provision made to cover teaching and administration. For example, **Fielding** achieved a Leverhulme Fellowship (2019). Within the IHR we take a team approach to overall academic performance, encouraging staff to play to their strengths and celebrating individual success as that of the whole unit. Internal recognition of staff in this submission include, the VC Research Excellence Award (**Saleem**, 2017 and **Coxon**, 2019) and the LJMU Spotlight research award for more radical ideas for ground-breaking research. (**Giuntini** runner up, 2017). Communication is central to our thriving culture and everybody is kept up to date with successes (e.g. publications, grants, awards,) via email, newsletters, social media, interest group meetings and IHR Board minutes. Workshops (14 between 2016-19) and lunch-time seminars provide an opportunity for staff to interact with researchers from multiple disciplines beyond their usual working environment. REF upskilling, for staff on the cusp of being active, was awarded to 9 participants, 3 of whom were submitted (**Khatrri; Maxwell; Ralebitso Sr**).

Impact is embedded within the unit with the provision of Researcher Development Workshops supporting knowledge transfer and impact generation (Building Blocks of Impact; Influencing Government Policy Through Research; Exploring Stakeholder Engagement). The Impact officer provides training in the use of the VV impact tracker, with additional 1-2-1 meetings, to support the development of impact from specific projects. Impact advice and updates are also included in School forums and away days. Appointment of joint LJMU/NHS posts (**Lotto A**; Aragon Cuevas; Hughes), 9 teacher practitioners linked with local healthcare organisations, and 52 honorary lecturers, encourages engagement with external healthcare professionals and enriches consideration of research translation at all stages. For example, Wright, seconded from RLBUHT to the Pharmacy Innovation Centre, is leading a project with NHS England and North West AHSN on the evaluation of the 'Transfer of Care Around Medicines' Programme implemented across Cheshire and Merseyside. This has provided evidence of the impact on improving patient safety after hospital discharge and, as a result, a new service is being introduced to encourage community pharmacists to follow up patients referred via this system.

New staff are assigned to a research theme and encouraged to work collaboratively. The IHR facilitates opportunities to engage with researchers across LJMU and encourages early and mid-career researchers to work alongside established researchers in different subject areas to develop their own research ideas, apply their expertise to interdisciplinary research activity, and help with introductions to key external collaborators and agencies.

ECR support is provided across teaching and research activity. All new staff are initially allocated low teaching and administrative loads to enable them to develop their research and establish personal research teams. ECRs are assigned mentors who help them define a learning and development plan. In FHE, this process is formalised by the Faculty Research and Knowledge Exchange Committee. ECR support for income generation is described in section 3.

Non-Doctoral level staff are supported to undertake PhDs. Since 2014, 8 members of staff have completed a PhD, 5 have completed a PhD by published work and 8 are in the process of undertaking a PhD. Staff who have previously achieved PhD by publication provide workshops to share experiences and offer guidance. In PHI, ECRs tend to be appointed as RAs or PDRAs working on particular projects rather than independent lecturer-equivalent roles and therefore have specific development needs addressed by the Researcher Development Concordat (2019). **Timpson** is the academic lead for the Researcher Development Concordat and the minutes of the steering group are circulated. We implements the principles set out in this institutional Concordat in relation to providing an inclusive, supportive, fulfilling work environment and the development of research contract staff and PDRAs is delivered in accordance with this. **Ralebitso Snr** is a member of the team developing resources in alignment with this Concordat on 'Upskilling Research Supervisors, Principal Investigators and Senior Academic Staff on EDI issues as related to Research Students'.

Training, supervision, and support mechanisms for postgraduate research (PGR) students

PGR students are crucial to the vibrant research culture within the IHR and make a huge contribution to the achievement of our strategic aims. Consequently, we seek to recruit a diverse community of excellent students. PhD recruitment and completions are buoyant with 82 PhDs conferred since 2014 (a growth of over 100%) and numbers continue to increase with NAH growing from 0 to 21 students. Home/EU funded studentships include Marie Sokolowski-Curie Action/COFUND DTA3; Industry-funded; Faculty ECR studentships (10); VC awards (5); matched funding with Industry (Orchid Cellmark; Medichemica Ltd); and IHR studentships (13). The unit successfully recruits International students from, for example, South Africa; Egypt; Saudi Arabia; Nepal; and Libya, supported by University sponsorships; ERASMUS Plus; Egyptian Dual Channel Scheme; or

personal funding. They have the opportunity to undertake pre-sessional English language programmes. PhD vacancies are advertised on the LJMU vacancies page and FindAPhD.com and shortlisting and interviews conducted according to LJMU policies.

PGR Support

Support for PGRs is overseen by the Doctoral Academy, Faculty Research Degrees Committee (FRDC) and supervisory teams. Robust procedures to monitor and support PGRs during their studies are managed using E-Doc, an online management system for PGR students where training activities, progress reports and supervisory meetings (at least 10 per annum) are recorded and approved. On FRDC, each School is represented by at least one staff and one student member who facilitate communication, feedback, and the sharing of good practice. To achieve consistency in the PGR/PD experiences, Faculty Handbooks detailing the regulations, codes of conduct and roles and responsibilities for staff and PGR/PDs are provided and there are dedicated PGR Community sites for all PGR queries.

PGR Development

Upon starting, a varied development programme is available to all PGRs and a local School induction and a Health and Safety induction provided. The Doctoral Academy arrange various events and activities to support PGR and Professional Doctorate candidates including research skills (such as using Endnote, research design, impact etc.); the PhD process, (transfer, viva); next steps (writing grant applications and funding); and the 3is initial teacher practice programme training which enables them to teach on the undergraduate programmes. They have access to the Vitae programme and external courses are supported where required; for example, a travel grant to attend BACPR education day; training at the EC Joint Research Centre; CEM microwave peptide synthesis training; and Introduction to Systematic Review and Meta-Analysis by Johns Hopkins University. In PHI, all PGRs have attended at least one externally run methodological training workshop relevant to their programme of research. Our PGRs have been successful in obtaining external funding to support their studies, for example, from the Society for the Study of Addiction scholarship; Cumberland Lodge Scholarship; Aerosol Society award; and Sir Richard Stapley Educational Trust grant. PGRs are encouraged to visit European Universities via the ERASMUS scheme to learn new techniques and establish partnerships between the academic partners (Istanbul University, Turkey; Trinity College Dublin, Ireland). An abundance of opportunities are available for PGRs to gain confidence in presenting their research to a wide audience and broaden their horizons by networking with researchers in different fields. Events include the annual FHE and FSC Research Days, University Research Day, the IHR Conference, Research Cafes, 3 Minute Thesis and lunchtime staff/student seminar series. Several PGRs from this unit have been awarded prizes for outstanding student oral and poster presentations at Faculty and IHR events. Students are also encouraged to present their findings at national and international conferences and the Doctoral Academy has a limited fund available for help with expenses for students presenting oral papers. Our PGRs have been successful in obtaining external bursaries to attend conferences (Nutrition Society, Federation of European Nutrition Societies, European Congress on Obesity, SSA travel, International NPS conference, Congress of the European Society for Photobiology) and have also hosted student conferences, for example a 'Metabolic Day' held at LJMU. PGRs are encouraged to publish their research throughout their studies and have co-authored many papers submitted to this UoA.

Support for, and Promotion of, Equality, Diversity, and Inclusivity (EDI)

Each Faculty has an Equality, Diversity, and Inclusivity (EDI) working group to promote, embed and celebrate a culture of EDI with respect to protected characteristics. EDI issues are a standing item on the monthly FRC agendas. PHI and PBS are currently preparing an AdvanceHE Athena SWAN bronze application with effective and active self-assessment teams (**McCloskey; McDowell;**

Porcellato; Ralebitso Snr; Sarker; Timpson) and NAH will do so in 2021 following a review of the process (**Maxwell**). There are currently 4 women Professors in the unit (29% of all Professors) and 61% of ECRs are women; on average women have submitted the same proportion of outputs as men. Clear mechanisms exist to support promotion for women and inspirational role models, for example, members of the Women Professors Network (**Fitzsimmons; Fleming; Hutcheon; Van Hout**) and the Woman's Academic network (chaired by **Abayomi** and **Hutcheon**, 2016-18), provide peer support. The Leadership Development Foundation co-ordinates mentorship, by senior colleagues (men and women), for women academics at all levels of their career stage but with a focus on progression from Senior Lecturer to Reader and Reader to Professor. Female members of staff are supported to complete the Aurora leadership development programme (**Giuntini; Hutcheon; Lees; Porcellato; Quigg; Seton**) and some have gone on to support the national programme as a mentor (**Hutcheon; Porcellato**). **Timpson** is a member of the LJMU Athena Swan Working Group and is supporting the EDI team to develop EDI discussion-based training. The unit is represented on the StellarHE Programme for BAME Staff (**Fatokun; Ismail**) and the LJMU BAME Network (**Ehtezazi; Ralebitso Snr**). Staff in the unit also sit on the LJMU Dis-Ability staff network and the LJMU Together (LGBTIQ+) Network. **Ross** was part of the 2020 LJMU and John Moores Student Union Black Lives Matter (BLM) Consultation and helped inform the design of the LJMU BLM website. He is also part of the LJMU Working Group for the Equality and Human Rights Commission Report on 'Tackling Racial Harassment: Universities Challenged'. Staff in the unit have attended various EDI workshops and events, including, Unconscious Bias; Transgender Awareness; Race Equality; RESPECT; Disability Support Training; LGBTQ+ History Month; and World Mental Health Day. Across the unit there is a commitment to equality within all groups and all IHR events are organised with consideration for those with caring responsibility and those from culturally diverse backgrounds. We ensure that meetings are held within the working day (09.30 to 16.30) to enable all staff, regardless of personal responsibilities, to attend. Shortlisting and selection are conducted in accordance with LJMU policies on EDI, recruitment activity is supported by a dedicated member of staff from Human Resources, and all panel members must undertake training. Any applicant declaring a disability is automatically offered an interview if they meet the selection criteria. When considering promotions, staff are asked to highlight EDI issues that they would like to have taken into consideration.

3. Income, infrastructure, and Facilities

Income Generation and Support

Our 2014-20 income strategy (Section 1, strategic aim 2) supports high quality research activities that, working directly with external stakeholders, translate to changes in therapeutic approaches, practice, or policy. The unit achieved a total of over £15M external income, including over £9M from UK central government bodies/Local Authorities; health; and hospital authorities, and the QR allocation for UoA3 (£4M) was dispersed to Faculties and Schools. We realised targeted growth in funding from EU government bodies (£3.1M, 20% total income); a 750% increase in funding from UKRI, The Royal Society, British Academy (£386K); and an increase in Non-EU other (from £0.5K to £460K). Research across the unit is funded externally from a diverse portfolio of sources including, EU; MRC; ERDF; Innovate UK; NIHR-HTA; NIHR-PH; and WHO. The University has invested in the new GaP (Grants and Projects) system to allow users to easily determine costings via a more efficient process that supports a collaborative approach towards compiling project proposals. Generating and identifying new ideas and opportunities is the key to the future strength of our research, so the IHR works closely with RIS to horizon scan and circulate national and international funding initiatives to diversify our funding portfolio. **Hutcheon** and research group leaders connect with LHP, NWC-ARC and other local partners to identify potential multi-centre collaborative bids and facilitate the construction of interdisciplinary teams to prepare them.

International income generation is supported by using internal UK Global Challenge Research Funding (GCRF) to facilitate the generation of feasibility data and development of relationships between international research teams enabling publications and further bids to be produced. For example, **Fielding** obtained three separate internal GCRF grants (£13K, £12.7K, £8K) which led to a successful Leverhulme Fellowship bid (2019-2020, £412K) and funding from the São Paulo Research Foundation (2019, £3K) for a one-year PhD student visit; **Fleming** was awarded an internal GCRF grant (£6K) for the validation of the Edinburgh Postnatal Depression Scale (EPDS) in Uganda which cemented a relationship with the Aga Khan University who are looking to enable staff to undertake PhDs with LJMU.

The critical mass of contract researchers in **Health Promotion** provides capacity for senior academic staff to develop large-scale grant applications, nurture collaborative partnerships, and enable a swift and agile response to funding opportunities. Prominent funding sources include: ERASMUS + Sport (**Sumnall**, 2018-2020, £350K); Irish Health Research Board (**Jones L**; **Sumnall**, 2015-16, £47K); NICE (**Jones L**; **Sumnall**, 2015-16 £60K); Alcohol Research UK (**Jones L**, 2012-14, £300K); EC: Joint Action on Reducing Alcohol Related Harm (**Jones L**, 2014-16, £1.3M; £25K to LJMU); Public Health England (**Jones L**, 2014-16, £39K); EC (**Quigg**, 2016-19, £445K, £85K to LJMU and 2016-18, £420K, £85K to LJMU); Public Health England (**Quigg**, 2015-17, £87K); MRC (**Van Hout**, AHRC 2017, £170K); EU H2020 (**Van Hout**, 2018, £3.64M, £85.5 to LJMU). Whereas there has been a strong track record of successful income generation in other themes, research income in **Health Practice** grew from zero (2008-13) to £194K (2019/20) due to the recruitment of ambitious senior staff who secured large, prestigious grants: ESRC (**Fleming**, 2018, £226K) and **Fitzsimmons** and Smith: Interreg Europe Health Innovation Experimental Landscape through Policy Improvement (HELIUM, 2016-20, £243k); EDRF Health Enterprise Hub Innovation Exchange (HEHIE, 2016-19 £273K); and EDRF Health Matters (2019-21, £668K). **Health Science** staff successfully secured funding from a range of sources; UKRI (**Hutcheon**, 2017, Innovate UK, £97K; **Saleem**, 2017, MRC, £570K); Royal Society (**Giuntini**, 2018, £15K). Major income sources in **Biomedical Science** include, MoD (**Hobbs**, **Murphy**, **Nakouti**, 2019-21, £185K); Newlife Foundation pump priming award (**Dykes**, 2017-19, £11k); BHF Oxford CRE pump priming award (**Dykes**, 2015, £13k); British Skin Foundation (**Ross**, 2015-19, 4 grants, total £110,000); Leverhulme trust project grant (**Davies**, 2016, £127k); LCCG Research Capability Fund (£27K, 2019) to obtain feasibility data for NIHR bid (**Davies**).

ECR-specific support

ECRs and RAs are encouraged and supported in income generation activities. This takes the form of participation in grant training (bid writing workshops, training on costing grants, understanding the grant funding landscape); appropriate contributions to grant applications; and being named as Co-Is (where appropriate). To support ECRs, FHE have a Research and Enterprise funding stream and FSC has a competitive funding stream for research support and PGR studentships (10 between 2014-20), and £10K Seedcorn Funding to establish a research base and preliminary data (**Dykes**, **Gordon**). Success of the ECR support schemes is evidenced by, for example, **Saleem**, who was awarded Faculty ECR funding for a PGR studentship (2011-14) on the pulmonary delivery of nanocarrier systems for protection against pneumococcal disease. This initiated collaborations with LSTM and Instituto Butantan, Brazil and resulted in 3 publications; a patent (WO/2020/099869); a successful MRC grant (2017-20, £570K); a visit to Instituto Butantan, funded by a BactiVac Catalyst Training award (£4,707); a new collaboration with Aerogen Ltd supported by an MRC Industry Engagement Fund (2018, £1,500); and promotion to Professor (2019). **Randle** used her Faculty ECR fellowship (£4270, 2016) to establish a collaboration on drug-induced liver injury models with researchers at Universities of Groningen and Kansas. This led to new collaborations with the UoL and Aintree Hospital to adapt this model to identify druggable targets and the award of an honorary senior lectureship at the UoL. ECRs have been encouraged to access internal GCRF funding to

develop international partnerships. For example, **Phillips** obtained funding in 2019 (£2.7K) to work with Cairo University in Egypt and in 2020 (£8.6K) to work with partners in South African on the microbiome and childhood leukaemia. ECRs have also been successfully supported to apply for relevant external start-up schemes, for example, an ESRC new investigator grant (**Atkinson**, 2020 £239K); and an EPSRC First Grant Scheme (**Coxon**, 2018, £101K).

Support for Impact Generation

Each ICS has been developed using VV Impact Tracker which enabled staff to collate and share streams of evidence over time, ensuring all parties were kept up to date and helping to direct future work as the research evolved and diversified. The authors of ICS were supported by the Impact Officer and internal funding (QR and Research England Strategic Priorities Funding £28.15K) was used to enhance the development of impact towards REF Impact case studies (**Brandt; Davies; McVeigh; Quigg; Sumnall**) and rewards for excellent impact (**Brandt; Davies**).

A growth in impact has been realised via greater engagement with external users of our research. Researchers regularly attend seminars and workshops with external speakers (for example, LHP; Clinical Research Network; LGGC; Innovation Agency) who provide an external perspective on current and potential healthcare activities that can lead to relevant, impactful outcomes (locally and nationally) and how this feeds into new policies, the development of healthcare models, and changing clinical practice etc. For example, the EATright project (**Davies**), a collaboration between Liverpool City Council and Liverpool PCT (now LCCG) to encourage reformulation of fast food with less fat and salt, produced a 'healthier takeaway scheme'; evidence based interventions and influenced various local authority health policies (Leeds, London, Southwark, Wisconsin, USA). Another example is working as part of a consortium (LJMU, UoL, PHE and Mast Diagnostics) a prototype machine for the testing of swab and urine samples was developed for the detection of STIs (**Hobbs**). To conduct this work £1.6M was secured from Innovate UK. As a part of this study a non-automated test kit with identical chemistry was produced and is manufactured in Liverpool and commercially available through Mast Diagnostics. An important example of support for impact was the successful MRC P2D bid (£75K) to hold a Liverpool 'Open Door' Innovation Showcase Event with BioNow, support an IHR Industry Event (**Hutcheon**), and host an IHR Cardiovascular Health collaborative workshop. Funding was also used to support staff (**Coxon; Fatokun; Leach; Murphy; Olorunniji; Powell; Ross; Saleem**) to visit or undertake a collaborative feasibility study with industry (Aerogen; Astra Zeneca; Biohealing Technologies; IntelliHep; Cambridge Research Biochemicals; ClyZ Laboratories; Ingenza Ltd.). This resulted in collaboration with Aerogen on the MRC VACCINE FAPESP MICA grant (**Saleem**) and publication of a high-quality paper (**Olorunniji**). As a member of Bionow (a membership organisation that supports business growth, competitiveness, and innovation within the biomedical and life science sectors across Northern England) we use their B2B website and events (BioFocus; BioCap; BioInfect) to network. After showcasing her research via this platform, **Hutcheon** established a relationship with Alchemy Pharmatech towards co-developing a nasal delivery system for Migraine therapy.

Infrastructure & Facilities

The IHR is a virtual infrastructure that provides support, facilitation, and a formal route to internal and external collaboration. The management, review, and identification of infrastructure needs are the responsibility of the host Faculties and are shared between different schools. Infrastructure and facilities vary considerably across this UoA given the different staffing, operational and research facilities required by the different themes. Infrastructure needs are reviewed regularly by Faculty Pro-VCs (who sit on the IHR Executive Board); Operations Managers; senior staff; and the FRCs, providing the opportunity to discuss and approve strategic plans for development, staffing requirements relating to new income streams and opportunities for cross-Faculty sharing of resources. QR spending plans are mapped to the current strategy and reviewed regularly by School

Directors, the Associate Dean for Research, and the Faculty PVC. Research capital requirements are prioritised by School Directors (QR and RCIF). The outcome is the provision of an infrastructure that supports the delivery of research and enterprise, maximising efficiency and quality of grants/tenders submitted and increasing the support available post award. For example, the current FHE Research Strategy required increased infrastructure support, so a research support manager was appointed to increase support for the delivery of research and enterprise, maximising efficiency and quality of grants/tenders submitted and increasing post award support.

Dedicated computing space and communication services are essential facilities for **Health Promotion** and **Health Practice** research. Within the Centre for Collaborative Innovation in Dementia (CCID), a European accredited living lab was created (£1M) to support participatory research with vulnerable groups such as dementia sufferers. This has enabled collaboration with LCR partners to co-create health innovations and solutions, underpinned by the HELIUM project (Interreg Europe, £243K) and the Health Enterprise Hub Innovation Exchange (HEHIE, ERDF, £272K). In response to an increase in numbers, PGRs, PDRAs and Fellows were provided with new designated office space to support a culture of research and better enable peer support. A simulated endoscopy lab was built to research and teach clinical endoscopy (£280K) and this is supported by a visiting Professor who is a consultant epidemiologist at RLBUHT (O'Toole). The Analytical Resource Centre enables PHI to offer the highest standards of information governance and the capacity to deliver complex analyses of large and multiple datasets. Access to a number of associated monitoring and intelligence systems which together with systematic evidence reviews, provide a comprehensive library of public health data sources. Going forward to 2026, FHE will complete its campus restructure (total cost £33M). New facilities will include a Clinical Simulation Facility to enable researchers to develop a greater understanding of clinical learning and will bring together clinicians and academics within a new research area supported by the recruitment of a Professor in this field (2021). Audio and video recording equipment will enable the observation of simulated clinical practice to facilitate research which aims to better understand how clinicians make decisions.

Researchers in **Health, Biomedical and Forensic science** have access to chemical, pharmaceutical and life science research laboratories maintained by Faculty Senior Research Officers who also provide training and expertise when required. Our research capability has increased via the utilisation of HEFCE STEM funding (£11.8M) towards the development of expansive new Science and Engineering research facilities including renovations comprising refurbished laboratory space and fume hoods. The installation of a 600MHz NMR has supported PGRs and PDRAs to undertake advanced organic chemistry projects; and funding to be secured (Leverhulme Fellowship, **Fielding**; Royal Society Newton-Bhabha Fellowship, **Giuntini**). The introduction of capability in texture analysis, peptide synthesis, microwave synthesis and microfluidics has facilitated increased activity in peptide synthesis and formulation resulting in successful EPSRC, Innovate UK, MRC Industry Engagement, and Royal Society bids. The plant science facilities have been upgraded and a greenhouse established to support plant medicine and science. Facilities within the Life Sciences Building include molecular genetics laboratories, animal cell tissue culture suites and facilities to support stem cell research which are continually updated with reinvestment in, for example, a new freezer management system. The imaging unit is equipped for a wide range of microscopy and contains SEM, TEM and confocal microscopes and a support unit houses rodent-breeding colonies and holding facilities for non-mammalian vertebrates. Computational Chemistry researchers have a dedicated laboratory with individual workspaces and access to current software for molecular modelling, toxicity prediction and Quantitative Structure Activity Relationships that has enabled 13 successful new bids since 2014 (over £1.4M). Our research capability has been enhanced via a memorandum of understanding with the UoL Technology Directorate that offers flexible access to world class equipment and expertise. An internal FSC budget (£50K) was made available for access to these facilities to underpin high quality

research outputs and incorporation of costings into funding bids. For example, **Ralebitso Snr** accessed facilities in the Centre for Genomic Research to acquire ECR feasibility data for a bid submitted to Qiagen Microbiome Award (2018) and **Saleem** collaborated with members of the technical Directorate on Cancer research bids. We have access to LHP SPARK for support with joint NHS projects in terms of research development, sponsorship, set-up and governance and a designated Clinical Trials Unit. SPARK has supported, for example, a successful bid for detecting AF in supermarket customers (**Jones I**, BMS, 2019, £210K).

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

Collaboration and Partnerships

The IHR strategy promotes interdisciplinary collaborations within and across fields such as physical and natural science; public health; healthcare; psychology; art & design; law; business; sports science; and engineering & technology. For example, internal collaborations exist between nurses (**Jones; Lotto R**); pharmacists (**Penson**); nutritionists (**Davies, PdHeredia**); and SES (UoA24 on cardiovascular, rehabilitation, and nutrition projects and between PHI (**Timpson; Quigg; Porcellato**); NAH (**Fleming; Maxwell; Van Miert**); psychology (UoA4); SES (UoA24 and Art & Design (UoA32) on children's health research and social innovation projects. The outcome of one internal collaboration on International Women's Health, between **Van Hout** and Kewley (Psychology, UoA4), is evidenced within ICS6. The IHR cross-Faculty PhD studentship scheme recommends inclusion of external collaborators. In 2019 a studentship was earmarked for each of the new centres; LCCS (**Dykes; Lotto A; Powell** with Alder Hey) and Liverpool Centre for Alcohol Research (**Sumnall**; Tod, FSC; Goodwin, UoL) to create momentum for our collaborative partnerships. The Liverpool Health Commission is an independent panel established by LJMU, with the first area of investigation led by **Fleming** on the first 1,000 days of life with a particular focus on marginalised populations including commissioners from: The Women's Organisation; Sefton Women's and Children's Aid; LWH and AHCH.

Membership of steering groups and committees enables input into the research direction and priorities of, for example, the LCR/LEP Health and Life Science Board (Pro-VC FHE); Council of Deans for Health (NAH director); and LHP, NWC-ARC and LGGC (**Hutcheon**). Collaborations with local, national, and international researchers; stakeholders; beneficiaries; and users are essential for the delivery of realistic solutions to health-related problems. For example, the WHO Collaborating Centre for Violence Prevention is a four-year international work programme, led by **Quigg**, to promote and implement a public health approach to violence prevention. This has enabled the generation of additional income (£384K) to support this work and the production of 4 high quality outputs including: an update of Violence Info; a WHO state of the art document on adverse childhood experiences; and a WHO fact sheet and journal article on interpersonal violence and the sustainable development goals. Publication with international collaborators increased between 2014 and 2020, with 79%, 57%, 46% of papers from PBS, PHI and NAH respectively, co-authored with international partners in 2020.

Health Promotion staff also collaborate with national and international bodies and international coordinating bodies (for example: Public Health England; The Home Office; EMC; WHO; United Nations Office on Drugs and Crime; and Irish Health Research Board) to support policy and practice development. Examples of funded work include: the development of quality standards in drug demand reduction for the EC; development of international standards in prison health for UNODC; and evidence reviews to support development of the Irish National Drugs Strategy. Further collaborations were facilitated by the establishment of research networks co-founded by PHI, such as the Drugs North West Research Network (launched 2018) and the Image and Performance Enhancing Drugs Research Network. During the disruption of the pandemic, **Van Hout** used internal GCRF funding (£18.8K) to work with Middle East and North Africa agencies and the United Nations

on a project 'Understanding and responding to substance use and abuse in Palestinian refugee camps during COVID-19 in Lebanon' resulting in 2 reports published on the Middle East and North Africa Harm Reduction Association (MENAHRRA) website. International Women's Health research relies on global partnerships, for example, as part of an AHRC-MRC Global Public Health Partnership (2017, £170K), **Van Hout** collaborated with the University of Zambia, University of Malawi and UNODC on the prevention of mother-child HIV transmission and promoting health services for women prisoners.

Working with partners across the LCR, including HEIs; NHS trusts; and healthcare agencies, is crucial to the achievement of high quality and impactful research within **Health Practice**. One example of success is an IHR facilitated workshop (2016) that brought together cardiovascular researchers from UoA3 and SPS with key NHS clinicians to generate new project ideas. This resulted in the formation of the LCCS in 2018, governed by a multi-disciplinary steering group consisting of colleagues from all 4 founding partners: LJMU, UoL, LHP and LHCH. The LCCS has over a 100 members (29 from LJMU, 14 from UoA3), and since its launch, there have been 314 outputs from LJMU members (81 from UoA3), and 6 PhD students. LJMU members of LCCS have submitted 30 bids and been awarded 5 projects (£591K to LJMU, £398 to UoA3).

Staff in **Health Science** and **Biomedical Science** have strong collaborations with industrial partners, for example, with Unilever Safety and Environmental Assurance Centre to develop computational profilers to group compounds on the basis of molecular initiating events relevant to toxicity. This partnership began in 2015 (funded PhD studentship), was extended with further funding in 2018 and will continued from 2021 (**Cronin**). A new area of research, focused on manipulating and exploiting biofilms for biomedical and industrial applications, was initiated in collaboration with Croda Biotechnology (**Hobbs; Murphy**). Subsequent use of P2D funds (£5K) and a Newton Mobility Grant (Royal Society 2019-20, £9,500) extended this project to include collaboration with **Nakouti**, and institutions in both the UK (University of Sheffield) and abroad (Chulalongkorn University, Thailand and Nirma University, India). More recently funding from the MOD Defence and Security Accelerator has been secured (2019-21, £185K). Staff have pursued world leading research with partners across the globe. For example, targeting funding such as FAPESP, INSERM and CAPES, to undertake a series of collaborative projects with partners in Brazil including bilateral exchange visits with: University of São Paulo and Nove de Julho University (**Wainwright**); Federal University of ABC, São Paulo (**Giuntini**); Institute Butantan (**Saleem**); and São Paulo State University (**Fielding; Wainwright**), resulting in co-authorship of over 25 papers.

Forensic Science staff collaborate with law enforcement agencies (Cheshire Police, Merseyside Police, City of London Police), forensic practitioners (Eurofins Forensic Ltd), industry partners (Qiagen, Bruker, Perkin Elmer, Agilent), and other groups (London Zoo, Natural History Museum, London). A collaboration between **Birkett**, Cellmark Forensic Services (match funded PGR studentship, £30K), the Merseyside Police firearms unit, Helston Forensics, and local recreational shooting clubs resulted in a publication that was one of the most downloaded papers in the Journal of Forensic Sciences (2019).

Contribution to Key Research Users and Beneficiaries

In recognition of their expertise, staff have been invited to steer national and international health agendas as evidenced by their participation in a range of committees and advisory groups, including the following:

Staff in **Health Promotion** act as expert advisors to a number of international organisations, including the UN Office on Drugs and Crime (**Hay; Sumnall; Van Hout,**); ECDPC (**Hope**) and EMCDDA (**Atkinson; Hay; Hope; McVeigh; Sumnall; van Hout**). **Hope** is on the International Advisory group for the SPHERE-C Project, funded by the ECDC and the Robert Koch Institute, and the advisory panel for the update of the ECDC / EMCDDA guidance related to infections among people who inject drugs. **Sumnall** was Board member and President of the European Society for

Prevention Research; member of the Advisory Council on the Misuse of Drugs which helps to set UK drugs policy (2011-19); sat on the development group for the United Nations Office on Drugs and Crime/WHO International Prevention standards group, which produced standards in drug prevention for UN Member States (2013 and 2020); and sat on the NICE guidelines development committee that produced national guidance on targeted drug prevention in vulnerable young people (2017). **Quigg** is a member of various UK-based Violence Reduction Unit steering groups focused on strategy development, programme evaluation, research, and advocacy (e.g. Merseyside Violence Reduction Partnership steering group; Greater Manchester Violence Reduction Unit research steering group). She also facilitates stakeholder engagement events (e.g. 150 multi-agency partners across Wales) providing expertise in a public health approach to violence prevention and feeding into the development of regional/national policies and strategic approaches, and programme delivery. Staff in PHI regularly work with local and national bodies (Home Office, Department of Health, NHS, PHE, PHW, charities) to support policy and practice development. For example, PHI have been commissioned by the Cheshire and Merseyside Public Health Collaborative to provide evidence to support activities on behalf of local directors of public health. **Van Hout** provided expert consultation to UNODC leading to input on a variety reports, technical guidance and policy including: input into UNODC criminal justice technical guidance on gender-based violence against women in the context of COVID-19; input into a series of new Bills gazetted to the South African Parliament regarding Criminal Matters; Domestic Violence; Sexual Violence; Cannabis for Private Consumption; input into a technical guidance document on HIV ensuring access to measures for the prevention of mother-to-child transmission of HIV in prisons (ICS6). **Health Practice** staff sit on Hospital trust boards (Council for Governors at LHCH; Board of Governors at the RLBUHT) and external NHS and professional committees: for example, British Association for Nursing in Cardiovascular Care-Research committee and Council of Deans for Health Research Steering Group (**Jones I**). **Maxwell** is a WHO Technical Advisor for the PHE Collaboration Centre (CC) focusing on maternity and infant care and **Van Miert** was a member of the NICE guideline development group for bronchiolitis (published 2015). A systematic review of the Drucebo effect in statin therapy has been cited in an ESC Position Paper, by the Canadian Consensus Working Group; and is included in European Headache Federation recommendations (**Penson**).

Staff in **Health Science** have a long-term collaboration with AHCH and **Hutcheon, Morecroft**, and Ford (Emeritus Professor) sit on the Paediatrics Medicine Research Unit (PMRU) Board; with **Saleem, Roberts** and **McCloskey** on the PMRU Science Board. This collaboration resulted in the publication of the Manipulation Of Drugs Required In Children (MODRIC) guidelines accessible to all healthcare professionals (published 2013, updated 2017) that have been translated into Norwegian and Portuguese. **Cronin** is a member of a Project Monitoring Team for the European Chemical Industry Council; an International Working Group to develop "In silico toxicology protocols" funded by the US National Institute of Environmental Health Sciences of the National Institutes of Health; the International Life Sciences Institute Europe Expert Group; and an invited panel member at the United States Environmental Protection Agency FIFRA Scientific Advisory Panel meeting (2014). **Madden** was an invited expert for the Medicines and Healthcare Products Regulatory Agency; EC's Joint Research Centre and EC's Scientific Committee on Consumer Safety; EC's Scientific Committee on Consumer Safety; UK Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT); and the UK FSA. Staff in **Forensic Science** provide advice on drug identification and the latest developments on the designer drug mark to, for example, Cheshire police (**Brandt**). **Brandt** is an Expert Advisor to the WHO Expert Committee on Drug Dependence including the preparation of critical review reports used to make recommendations to the UN Secretary-General on the need for and level of international control of these substances. He is also an extended Member of the EMCDDA Scientific Committee, for whom he has developed risk profile assessments and technical reports of new psychoactive substances that have been identified

to cause significant threats to public health. **Assi** has worked with Bournemouth Street Support and UK charities (YMCA, HumanKind, Salvation Army, the Big Issue) to evaluate the use of new psychoactive substances among the homeless population (2018-2020).

Contribution to the Economy

Our links with industry and other stakeholders have enabled innovation, opportunities and solutions resulting in economic impact. A key example is the co-creation of health related innovations and solutions with LCR citizens; the business sector; other academics; and commissioners and providers of services (**Fitzsimmons**, Smith). Underpinned by HELIUM, this venture involved working with over 80 SMEs directly (and supporting a further 20) to co-create a number of innovations. For example, working jointly with Damibu, a Liverpool SME, and the National Museums Liverpool, House of Memories led to the co-creation and continuing development of the internationally launched *My House of Memories* app. Additionally, during the HEHIE project, the total state aid support delivered in the form of research and development activities was equivalent to £33K. A regional stakeholder group consisting of LCR health and social care partner organisations was established to analyse the current ESIF policy instrument and a number of good practices (innovations) within the LCR were identified and disseminated through the Interreg Europe good practice platform. Learning from these activities resulted in working with regional partners to secure the Liverpool Health Matters project that will significantly increase LCR's capacity to support local SMEs while at the same time driving economic and business growth.

The LCR Industrial Strategy specifically highlights the impact of substance use, violence, and injury on the local economy, and how individual and regional prosperity can be improved by addressing these factors. Local stakeholders use PHI data to better understand local populations and the size of the challenges they face, and to directly improve policy and practice responses. PHI research plays an important part in helping the City Region achieve the ambitions of the Strategy. For example, working extensively with Merseyside Police in assessing assault presentations to A&E departments, in order to reduce the incidence of knife crime involving young people across the region. Data collated has been used to target hotspots, allocate resources for prevention, and to identify the demographics of both victims and perpetrators.

Contribution to Wider Society

Health Promotion contributes to the development of public health policy and practice, influencing national and international public health strategies across a range of key programmes and research is tailored to the needs of the services and organisations that commission and deliver health and wellbeing services. An upstream approach is used to engage with communities and groups who are often most affected by health inequalities. The social and economic focus of this work supports community assets, groups, and organisations to generate income to support sustained delivery and growth, thus maximising the impact they have for the communities they support. The societal impact of ACEs is evidenced in ICS3 (**Quigg**). The evidence on the acute impacts on child health has been used by global experts to advocate for prevention strategies (e.g. WHO; Centre for Disease Control) and led to impacts for services and the public. For example, the implementation of Embrace led to more school children self-referring for support, staff seeking advice and sharing best practice, and greater personal support for staff. **Sumnall** regularly engages with local and national media to discuss topics related to substance use, and in particular, public health impacts, and changes in law and policy. The development of new methods to capture personal reminiscences of growing up in post-war Merseyside resulted in a public exhibition at the Museum of Liverpool Life (**Leavey**). Similarly, art exhibitions have arisen from the work of **Atkinson** on the interaction of young women with the nighttime economy as part of the Liverpool Light Night programme. According to a staff survey conducted as part of the PHI Athena SWAN application preparation, 41% of staff across all grades and 75% of PGR reported participating in volunteering or charity work outside of their role. A number

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of staff also do voluntary work within the local community related to their research interest (e.g. Childline, initiatives addressing homelessness, menstrual poverty).

Researchers in **Health Practice** have delivered a number of outreach events including AF screening in the local community which has led to a Bristol Myers Squibb funded project (SHOPS-AF) using sensor technology in the handles of supermarket trolleys to detect AF with follow up from the in-store pharmacist.

Staff in **Health Science** and **Biomedical Science** support a range of activities to promote science to school aged children, addressing educational inequality and promoting the talent pipeline for health-related careers. For example, each year there has been a presence at The Big Bang North West science fair (**Randle, Seton, PdHeredia**) and staff work closely with for example, Girlguiding, a Corporate Honorary Fellow and in 2019, over 300 girls aged 5-18 and 80 supporters attended a LJMU STEM event (**Randle**). The Chemistry For All project operates within local schools and has led to a series of recommendations for schools from the RSC and additional projects (Funded by Shaping Futures, (**Seton**, £160K).

Indicators of Wider Influence, Contribution to, and recognition by the Research Base

The unit embraces a culture of open access publication and data sharing. Green open access is enabled via the LJMU open access repository. Gold open access deals from publishers are utilised (Royal Society of Chemistry, Springer, Wiley) and, in some cases, staff can apply for gold open access where this is not covered by grant awards, particularly to support co-authorship with a charity/NGO or lower/middle income country collaborator. Dissemination of research through conference and scholarly society attendance, including Board memberships are largely funded through the travel components of grants or via internal funding based on researcher development goals and potential significant benefits with respect to collaborative grants.

Invited keynotes include the 18th International Conference on (Q)SAR in Environmental and Health Sciences (**Cronin**, Slovenia, 2018); 38th Annual Conference of the West African Society for Pharmacology (**Fatokun**, Nigeria, 2015); 7th International Interdisciplinary Scientific Conference “Society, Health, Welfare” (**Fleming**, Latvia 2018); WHO 8th Milestone of a Global Campaign for Violence Prevention ministerial meeting (**Quigg**, Canada, 2017); International Conference on Vaccines and Immunology (**Saleem**, Netherlands, 2018); United National Commission on Narcotic Drugs (**Sumnall**, Austria, 2015). **Conference organisations** include: 24th, 25th and 26th International Harm Reduction Conference (**Hope**, 2015-19); International Conference on (Q)SAR in Environmental and Health Sciences (**Cronin**, Slovenia, 2018); UK and Ireland Controlled Release Society Annual Workshop and Symposium (**Gordon**, UK, 2019); Congress of the European Society for Photobiology (**Giuntini**, EU, 2017-19); and Pharmaceuticals and Drug Delivery Systems (**Hutcheon**, EU, 2017-18). All staff undertake peer review for journals and many hold **editorial Board membership** including Editor-in-chief, ATLA – Alternatives to Laboratory Animals (**Madden**); Editor-in-Chief, Phytochemical Analysis (**Sarker**); Editor in Chief, Journal of Ethnicity in Substance Abuse (**Van Hout**); Co-Editor in Chief, Computational Toxicology (**Cronin**); Co-Editor in Chief, Computational Toxicology (**Cronin**); Editor, British Journal of Clinical Pharmacology (**Penson**); Editor, International of Biochemistry & Physiology (**Sarker**); Editor, Dyes and Pigments (**Wainwright**); Associate Editor, Drug Testing and Analysis (**Brandt**); Associate Editor; Drug Development and Industrial Pharmacy (**Saleem**); Commissioning of 3 special issues of Drug Testing and Analysis (**Brandt**, 2014-17); Guest Editor; International Journal of Drug Policy themed collections (**Hope**, **Sumnall**); Special Issue editor, BioMed Research International Environmental Biotechnology (**Ralebitso Snr**); Special Issue Editor, MDPI Pharmaceuticals (**Saleem**); Guest editor, Frontiers of Nutrition (**PdHeredia**); and Guest Editor, Computational Toxicology (**Madden**). **Scientific committee membership** includes: Association for Cardiovascular Nursing and Allied Professionals Scientific Committee (**Jones I**); Heart UK Medical, Scientific and Research Committee

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(**Penson**); International Lipid Expert Panel (**Penson**); NW Regional Steering Group Royal Society of Chemistry (**Seton**); and Ambassador of the British Pharmacological Society (**Fatokun**).

Fellowships awarded include European Society of Cardiology Fellowship (**Penson**) and Florence Nightingale Fellowship (**Lotto R**).

Membership of **peer review bodies** includes Vice Chair of the Life Sciences Panel, RIS/ITN Horizon 2020 (**Van Hout**); member of the UKRI Future Leader Fellowships peer review college (**Hutcheon**); member of the peer review college of Shota Rustaveli National Science Foundation (**Sarker**); member of the French Institute National du Cancer funding board (**Sumnall**); and expert review panel member Canadian Institutes of Health Research and Member of the North West Regional Advisory Committee for the NIHR Research for Patient Benefit Programme (**Fitzsimmons**). Most staff review for national funding bodies, for example, NERC; NIHR; UKRI; Leverhulme Trust; Wellcome Trust; British Academy; The Royal Society, Pharmacy Research UK; Cancer Research UK; and the British Heart Foundation. Examples of International reviewing activities are: The Cyprus Research Promotion Foundation (**Cronin**; **Saleem**; **Sarker**); US FDA Office of Women's Health, Czech Science Foundation, and Auckland Medical Research Foundation (**Cronin**); L'Agence nationale de la recherche (**Madden**); Czech Science Foundation and Social Sciences and Humanities Research Council of Canada 2019 Insight Grants (**Fitzsimmons**); Health and Medical Research Fund from The Government of the Hong Kong Special Administrative Region (**Saleem**, **Sarker**); The South African Medical Research Council, South Africa (**Sarker**); French National Institute of Health and Medical Research (**Sumnall**); and Health Systems Network, WHO -Europe and Research Foundation - Flanders Belgium (**Van Hout**).

Training courses that have been delivered include for the European Chemicals Agency, (**Cronin**, Finland); Korean Cosmetics Industry Institute, Seoul, (**Cronin**, S Korea); Postgraduate Summer School of Photobiology (**Giuntini**, Italy). British Council (**Fatokun**, Brazil, Thailand, China, Kazakhstan, Indonesia, and Ghana); 5th Global Symposium on Health Systems Research (**Khatri**); and Alvertox Academy (**Madden**, Italy).