Institution: Loughborough University

Unit of Assessment: C24 Sport and Exercise Sciences, Leisure and Tourism

1. Unit context and structure, research and impact strategy

Loughborough University has placed Number 1 in the QS world ranking for sport-related subjects for five consecutive years (2017-2021, every year since the category was introduced). The University has made unprecedented investment in Unit activity over the past REF cycle: 39% increase in staff returned, and opening of the **National Centre for Sport and Exercise Medicine** (£23.5M, 2015), the **Institute for Sport Business** on Loughborough's Queen Elizabeth Olympic Park campus (2015) and the **Elite Athlete Centre and Hotel** (£7M, 2018). Our prestigious Research Centres include the NIHR Leicester-Loughborough Diet, Physical Activity and Lifestyle Biomedical Research Unit (2012-2017, £2.2M to Loughborough), succeeded by the **NIHR Leicester Biomedical Research Centre (BRC)** (2017-2022, £1.4M to Loughborough), and the **Peter Harrison Centre for Disability Sport** (£1.2M new awards). Looking to the future, our research collaboration with the £300M **Defence Medical Rehabilitation Centre** and the associated £90M civilian **National Rehabilitation Centre** will reach a new level when the NRC opens in 2024.

1.1 Research structure

The Unit comprises 89 (headcount) staff in the School of Sport, Exercise and Health Sciences (SSEHS, on the Midlands campus) and 8 (headcount) in the Institute of Sport Business (ISB, Skinner leads) at Loughborough University London (LUL). SSEHS and LUL are two of the nine Schools at Loughborough, each led by a Dean and (for research and impact) Associate Deans for Research (ADR) and Enterprise (ADE). SSEHS Dean (Lewis), ADR (Stensel), and ADE (M.King), and, in LUL, ISB Director (Skinner) and ADE (Smith) are all returned to this Unit.

1.1.1 Research Themes

Our wide-ranging expertise encompasses medicine, molecular biology, nutrition, biomechanics, economics, pedagogy, physiology, psychology, sociology and sport management. For research and impact, these disciplines are organised under three broad Themes:

Lifestyle for Health and Wellbeing (Bishop leads, supported by Esliger for impact): exercise as medicine, eating disorders and behaviours, molecular and muscle physiology, and physical activity and sedentary behaviour.

Participation in Sport and Exercise (Downward (SSEHS) and Skinner (LUL) lead, supported by Casey for impact): Factors, structures and processes that motivate, enable, and constrain people's engagements with sport and exercise as part of their daily lives. Sport consumption experiences, sport enterprise performance, and sport's social contribution. Prominent disciplines include sociology and sport management.

Sport Performance (V.Tolfrey leads, supported by Cushion for impact): elite sport, parasport, youth sport, illness/injury prevention and management. Prominent research disciplines include biomechanics and motor control, coaching, disability sport, immune function, physiology and nutrition, sport psychology.

These themes unite communities of practice, facilitating interaction and sharing of ideas through regular meetings and seminars, grant funding workshops, coordinating research bids, PhD student conferences and mentoring/development opportunities.

1.1.2 Interdisciplinary research

Interdisciplinary research is a primary motivator for our diverse staff base. While our Research Themes are fundamentally interdisciplinary, staff can also be members of more than one theme and working across Themes is natural and encouraged.

Interdisciplinary research across Units and Schools is stimulated by the institutional CALIBRE framework (Collective Ambition at Loughborough for Building Research Excellence), which is the research component of the University's Building Excellence strategy. The framework includes the 'Beacon' programme, identifying just five priority research areas of which Sport and Exercise (Harwood leads) is one. Examples of joint projects include Unit staff from SSEHS and LUL working with the School of Social Sciences and Humanities on sport and cultural activities to promote personal and social development of young people (ESRC / DFID; £250k, 2017-19).

The Beacon has also been active under CALIBRE's Adventure Programme which funds mini-Centres for Doctoral Training (CDT):

- The Next Generation Prosthetics mini-CDT (Lewis leads, in collaboration with the Schools of Mechanical, Electrical and Manufacturing Engineering, Science, and Design and Creative Arts) aims to design a fully integrated prostheses enabled by biological feedback via a tissue engineered conduit between the artificial prosthetic and remaining muscle and nerves. This also links to CALIBRE's Health and Wellbeing Global Challenge.
- The Gender and Sport mini-CDT (Witcomb leads, in collaboration with the Schools of Social Sciences and Humanities, and Design and Creative Arts) explores the critical issue of gender diversity in sports participation, from grassroots to elite level.

Interdisciplinary research is further stimulated by Loughborough's Institute of Advanced Studies (IAS) which brings world-leading researchers and research-users to our campuses to participate in themed programmes. International House, home of IAS, provides a welcoming environment on campus for international visitors. As Sport and Exercise Beacon lead, Harwood collaborated with the Transport Technologies Beacon Lead on the 'Motion' theme (2018) launched by an event featuring the Vice-Chair of the British Olympic Association and the Director of Smart Mobility for Ford Europe as keynote speakers.

1.2 Review of objectives and research plans in REF 2014

Strategic research objectives stated in REF2014 were:

- To increase knowledge through world leading research
- To maintain and enhance areas of traditional strength
- To ensure research within the Unit addresses contemporary and emerging challenges

In addition, the following strategic priority areas were identified:

1. Sport performance
2. Injury and rehabilitation
3. Determinants and prevention of chronic diseases of lifestyle
4. Sport policy and management

With the launch of a new University Strategy in 2014, we placed explicit emphasis on excellence (quality) and a much sharper focus on strengths and refreshed priorities. This helped us deliver on our REF2014 objectives and priorities, with the following example achievements:

<u>Priority 1: Sport performance</u>

- A new **Sport Performance Research Theme** was established.
- A **Director of Sport Integration** (Cushion) was appointed to enhance research links and activities between staff, the Sports Development Centre (supporting sport participation at Loughborough up to elite level), and the many sporting organisations on campus.
- £1.8M **industry funding:** With Yakult Honsha (£196k), Gleeson showed that daily ingestion of a probiotic drink reduced plasma cytomegalovirus and Epstein Barr virus antibody concentrations, an effect that can be interpreted as a benefit to overall immune status. With Kyowa Hakko Bio (£148k), Bailey investigated the effects of amino acid supplementation (L-arginine alone and combined L-arginine and L-citrulline) on mitochondrial function and endurance performance, with preliminary findings suggesting a beneficial effect on both. With MAS Holdings (£0.8M), Pain measured female soft tissue deformation during running with marker-based motion tracking so that future support garment design can be based on

dynamic fit and function, while Folland identified the key biomechanical characteristics of economical running as a basis for feedback via wearable technology.

Priority 2: Injury and rehabilitation

- In 2014, the National Centre for Sport and Exercise Medicine (NCSEM) was recognised as an **International Olympic Committee (IOC) Research Centre** for the Prevention of Injury and Protection of Athlete Health. This status was renewed in 2019 for a further 4-years, one of just 11 in the world.
- Peter Harrison Centre (PHC) for Disability Sport work on **Spinal cord injury** was shortlisted for Knowledge Exchange/Transfer Initiative of the Year in the national Times Higher Education awards (2018). The Centre's direct contribution to ParalympicsGB exceeding their Rio 2016 performance goals was recognised by Mitch Hammond, Senior Performance Advisor UK Sport, who acknowledged "the work of the PHC towards assisting sports and athletes achieve what was a truly historic result at the Rio Paralympic Games" and Jonathon Riall, Paratriathlon Head Coach, who praised our "effective and seamless support to athletes in the lead up to the sport's first Paralympic Games in Rio 2016".
- An EPSRC funded (£785k; Lewis) multidisciplinary project (manufacturing engineering, biological science, chemistry) demonstrated **microfabrication of multi-material biological scaffolds** for bioengineered 3D models of the human neuromuscular system, which can be applied to the investigation of neuromuscular physiology and disease.
- This work was facilitated and enhanced by the launch (2016) of our **Defence mini-CDT and our EPSRC CDT in Regenerative Medicine** (both in partnership with the Defence Medical Services).

Priority 3: Determinants and prevention of chronic diseases of lifestyle

- The **opening of the NCSEM** (led by Loughborough, advancing the Exercise as Medicine agenda) enhanced research quality and scale leading to 11 staff now being returned to UoA2 Public Health.
- In the £11.6M NIHR **Leicester BRC**, Unit staff increased knowledge of the role of physical activity for preventing and managing cardiovascular disease, chronic kidney disease, type 2 diabetes, and non-alcoholic fatty liver disease.
- A Heart Research UK study (£145k, Bishop) established the viability of a randomised controlled trial of moderate and higher intensity exercise for **reducing cardiovascular disease risk in kidney transplant recipients**.
- Grants from NIHR (£627k, Clemes) and MRC (£172k, Esliger) showed the benefits of **reducing sedentary behaviour** and increasing physical activity for schoolchildren, truck drivers and older adults. Clemes' '**Structured Health Intervention for Truckers'** project was shortlisted for a Medipex NHS Innovation Award in 2018.

Priority 4: Sport policy and management

- Two ESRC research grants (£582k, Giulianotti) on **Sport for Development and Peace** investigated the role of sport and cultural activities in promoting the personal and social development of young people in eight international locations. Outcomes included an international handbook on Sport for International Development, a seminar at the Commonwealth Secretariat's HQ, and individual reports to NGOs on how to improve Sport for Development and Peace strategies and practices in the field.
- Loughborough's **Collaboration for Sport Integrity** was launched in 2018 with funding from the ESRC to explore past, present, and emerging challenges and their implications for wider understandings of decency and fairness. Key policymakers and stakeholders in the sport industry have contributed – including former MPs and representatives from DCMS, UNICEF, UK Anti-Doping, UK Coaching, and the Commonwealth Secretariat.
- Collaboration between Collison and the UN Office on Drugs and Crime resulted in publication of a 140-page technical guide, '**Preventing Violent Extremism Through Sport**' (2020), a practical toolkit and online learning resources.

In January 2020, an invited International Expert Review Panel comprising distinguished academics from four of the QS top ten universities for sport-related subjects (Birmingham, UK; Ohio State, USA; Toronto, Canada; Queensland, Australia) concluded: "We were unanimously agreed that the maturity of physical infrastructure, the excellence of people, the technologies available and the networks and platforms of and for collaborations are truly impressive, and indeed worthy of QS world ranking #1 within Sport and Exercise Sciences". We will refer to their findings at various points in this statement.

1.3 Enabling and facilitating achievement of impact arising from research

Our impact strategy focuses on six areas: leadership and mentorship, specialist impact support, professional development, funding, partners, and fellowships (study leave):

- **Leadership and mentorship** are provided by senior academic staff including Associate Deans for Enterprise and Impact Leads within our Research Themes. All staff are encouraged to plan for achieving impact through their research. Impact is integral to our Performance and Development Review process (see 2.2).
- **Specialist impact support** is facilitated by a Senior Translational Scientist and four additional translational scientists in SSEHS and, from the University Research and Enterprise Office, specialist advisers on partnership development, intellectual property exploitation and consultancy. Consultancy is conducted through Loughborough University Enterprises Ltd and the Unit has £1.3M income from projects with c.175 organisations since 2015.
- **Professional development** is provided through monthly enterprise clinics and regular enterprise workshops delivered by both internal and external speakers. Examples include 'Fast track the impact of your research' (2017); 'Knowledge Transfer Partnerships' (2018); 'Social Media for Academics' (2018); 'Patient and Public Involvement and Engagement (PPIE)' (2019); 'Partnerships and ways to engage' (2020).
- **Funding** is available from the Higher Education Innovation Fund distributed by Loughborough's Enterprise Projects Group (EPG). Unit staff secured approximately £300k through EPG for 13 projects from 2015-2020. Projects funded include the development of online CPD courses e.g., the Child Feeding Guide, the Professional Certificate for Sports Agents, and Sleepful, an online social network platform for the delivery of a cognitive behaviour therapy treatment programme for insomnia.
- **Partners**. Our unique sport ecosystem includes a host of National Governing Bodies (NGBs), many based in SportPark on the Loughborough University Science and Enterprise Park. This facilitates our partnerships with the English Institute of Sport (EIS), British Athletics, British Swimming, the Amateur Swimming Association, the England and Wales Cricket Board (ECB), Great Britain Wheelchair Basketball, the Lawn Tennis Association, and the Youth Sport Trust.
- **Fellowships** provide academic staff with protected time for up to 12 months (see 2.2).

For the period 2013-18, the Unit was funded by a HEFCE Catalyst grant worth £7M for accelerating impact work on Exercise as Medicine. In addition to capital funding, doctoral scholarships for clinicians and four academic positions, substantial investment was made in translational scientists to drive impactful projects, an e-learning specialist to develop CPD resources, and dedicated marketing and PR support.

Impact work is frequently shortlisted for University Enterprise Awards. Walking Works Wonders, a programme encouraging exercise in the workplace, was an 'impact' winner in 2015. A 'partnership finalist' award in 2019 celebrated a 15-year collaboration with the ECB facilitating wide-ranging changes spanning bowling, batting, pitch length, and protective equipment. Exercise Guidelines for Adults with Spinal Cord Injury was shortlisted for an 'impact' award in 2019.

1.3.1 How the selected impact case studies relate to our approach to achieving impact

All impact case studies (ICSs) have benefited from the leadership, specialist support, training and internal funding. The unifying characteristic of our ICSs, however, has been the pivotal role

of partnerships, particularly with those located at SportPark. King's case studies on **cricket fast bowlers** and **cricket pitch lengths** have benefited from a vibrant and enduring partnership with the ECB and its National Cricket Performance Centre on our Midlands campus. Harwood's case study with **parents and children in national and international tennis** benefited from his longstanding partnership with the Lawn Tennis Association, as well as the award of a University Fellowship which provided him with dedicated time for this ICS and the ICS on **psychological development of athletes in youth and para-football**. In another productive partnership, the Youth Sport Trust have collaborated with Harris and Cale over many years on **physical education policy**. V.Tolfrey's case study on **Parasport** again exemplifies collaboration with campus partners in SportPark including UK Sport and British Triathlon. Loughborough has sought to establish itself as the pre-eminent university in the world for para and disability sport. In 2019, Nik Diaper was appointed Head of Para Sport at Loughborough, the first role of its kind within higher education. V.Tolfrey's impact work has benefited from collaboration with Diaper (previously with the EIS). Finally, Bradbury's case study on **BAME coaches** is based on his strong partnerships with organisations further afield: The Football Association and the Football Against Racism in Europe Network.

1.4 Research and impact objectives and plans for the next five years

Our ambition is to deliver paradigm shifting research that informs and changes practice in areas related to sport, exercise and health sciences around the world. Our research and impact future plans have been developed through our Research Themes and validated by our International Review Panel (2020). They are presented by Research Theme.

Priority 1: Lifestyle for Health and Wellbeing

Our collaborative work within three major national centres will form the core of our plan for this Theme.

- Extend and expand collaborations with the **Leicester BRC** examining physiological and metabolic health outcomes. We will work to secure renewed NIHR funding for 2022-27. The future will see increased focus on impact by integrating exercise into chronic disease rehabilitation and management programmes/strategies. This work will complement our new **Centre for Lifestyle Medicine and Behaviour (CLiMB)**. Supported by a £2.2M NIHR programme grant (2019-24), CLiMB (focusing on behaviour change) will identify and evaluate innovative health behaviour interventions and policies to prevent and treat chronic diseases.
- Through **NCSEM**, facilitate greater interaction between clinicians and academics, greater incorporation of exercise into treatment strategies, and greater integration of our **biosciences** work in molecular biology and cellular physiology. Capabilities will be enhanced by Excellence100 appointments including Davies, whose work (supported by a 2019 Academy of Medical Sciences Springboard Award, £100k) will improve understanding of how tissues within the musculoskeletal system communicate and regenerate.
- The **Defence and National Rehabilitation Centre (DNRC)** programme comprises the National Rehabilitation Centre (NRC, £90M) and the Defence Medical Rehabilitation Centre (DMRC, £300M), recently opened just outside Loughborough. We will work with DNRC and partners to scope out Education and Training provision and Research and Innovation strategy, to deliver a step-change in rehabilitation patient outcomes nationally and internationally. This work will be complemented by grant funding such as the recently awarded Versus Arthritis Foundation Fellowship (Skarabot, £279k, 2021-24) to inform rehabilitation strategies for knee osteoarthritis.

Priority 2: Participation in Sport and Exercise

We aim to enhance participation in all sectors of society to improve health, wellbeing, and socio-economic outcomes, notably in marginalised and underrepresented groups. For example:

- Critical analyses of the political, economic, social, and cultural issues in the development and sport sector will include assessing the **social return on investment in grassroots sport** nationally, in Europe and beyond, in both formal competitive sport and charitable provision for disadvantaged communities. This priority will include the work of Excellence100

appointment, Pullen, under her AHRC award focusing on gender and disability stigma in the dialogue around sport.

- We will explore contemporary issues concerning: **sport integrity** e.g., corruption and good governance; child protection; professional sport as a site for implementing health, social, economic, and environmentally sensitive changes in behaviour; and extension of these **social benefits to socially excluded groups** e.g., BAME, disability and LGBT+ communities, and vulnerable young people (e.g., those in care).
- With strong support from the UK's UNESCO Office, we have applied to host a **UNESCO Chair in Sport, Physical Activity and Education for Development**. The Chair will undertake research, enterprise activity, and advisory work on policy and practice, particularly in collaboration with colleagues in the 'global South', in the areas of sport, physical activity and education. It will build on our global reputation and engage over 20 academic staff across the University.

Priority 3: Sport Performance

We aim to improve performance in sport at all levels and in all segments of the population. This will include enhancing collaborations with Loughborough's Sports Development Centre (responsible for sport participation on campus from recreational to elite level) and NGBs based on campus. For example:

- **Optimising athlete performance.** A new focus will be applied environmental physiology, for training and competing in extremes of heat, humidity and/or hypoxia, using the hypobaric bedrooms in the new **Elite Athlete Centre and Hotel**. This will draw on the expertise of Excellence100 appointment L.Taylor who was part of an international collaboration (involving ten countries) at the 2019 IAAF Doha World Championships demonstrating the importance of body temperature management and body cooling interventions prior to prolonged endurance events in the heat.
- We will engage with **AI, data analytics and machine learning** expertise on campus to provide novel insights into sport performance that can inform policy and practice. This will utilise the University's High Performance Computing facility.
- Studies on participation of transgender (intersex, trans, non-binary) people in sport were initiated by our **Gender and Sport mini-CDT** (10 staff, 6 PhD students, 2018-23) and will begin to influence policy in this sensitive area and promote inclusivity.

1.5 Open research environment

The University has been a pioneer of the **'Open Agenda'**, actively supporting Repositories for text-based outputs (since 2005) and data (since 2015), working beyond funder (including REF2021) open access requirements. Our landmark **Open Research Position Statement** committed to depositing from 2020 the full-text of 100% of our primary research outputs in our now unified **Research Repository**. The Unit has met its target by depositing 100% of 2020 journal articles. Over just the past year, Unit outputs in the Research Repository have generated over 800,000 views and over 300,000 downloads. Our commitment to open data is exemplified by the International Children's Accelerometry Database – a unique global dataset supporting physical activity research in children (2019 CALIBRE Open Research Awards finalist, Esliger).

1.6 A culture of research integrity

The University's Ethical Policy Framework is the foundation of the Unit's culture of research integrity. Research leaders are accountable for ensuring adherence to this Framework in respect of the nature, conduct, dissemination and foreseeable end-use of research and the behaviour of researchers. They are responsible for conducting ethics checks on all proposed projects and obtaining necessary approvals via dedicated Ethics sub-committees (human participants, human tissue) or from the main Ethics Committee (philanthropic funding, military applications, animal testing, all other issues). Potentially controversial research projects receive additional scrutiny, initially by the Pro Vice-Chancellor (Research), e.g., James' work with Bridge Farm Nurseries on cannabidiol to modify energy balance and exercise performance and recovery.

Unit staff are integral to the University's endeavours, chairing the Human Participants Sub-Committee (Mastana 2012-19, Lindley 2019-). The Unit also employs a Regulatory and Compliance Manager who is responsible for supporting the work of the Human Participants Sub-Committee and ensuring compliance with all Human Tissue Authority (HTA) regulated activity as well as data protection.

2. People

2.1 Staffing and recruitment policy

All academic staff contribute to teaching, research and enterprise activities. We expect and incentivise collegiality from the earliest career stages and, as careers develop, we expect broader leadership contributions. Academic staff have open-ended contracts, while research staff are normally on fixed-term contracts related to projects in line with sector norms.

Since REF2014, the University approach to recruiting excellent staff at all career stages, from postdoctoral and early career researchers (ECRs) through mid-career and senior roles, has radically changed, driven by the University Strategy and beginning with the 'Excellence100' campaign in which we recruited 20 new academic staff members, a **Vice-Chancellor's Research Fellow** (Markey) - five-year ECR posts - and three **Doctoral Prize Fellows** (Gallichio, Skarabot and Rimington) - two-year posts for outstanding researchers less than two years post-PhD.

Building on Excellence100, recruitment to established posts is now conducted through biannual recruitment rounds, managed centrally but with significant School input, rather than piecemeal replacement hires. With excellence as the primary criterion, these rounds promote improved succession planning, deliver better international recruitment and improve diversity. Overall, Unit FTE has increased by 26.8 (almost 40%) to 94.9FTE (41% reporting female gender, 71% reporting white ethnicity) including 8FTE to create ISB, with two external professorial appointments to provide leadership. The profile is now: 18 professors, 8 readers, 33 senior lecturers, 34 lecturers, 3 Research Associates / Fellows and one Clinical Academic Assistant.

Part-time working is welcome and six academic staff work part-time (2M/4F). For example, Bishop has worked part-time for 15 years during which she has progressed from Lecturer to Professor, supported by protected time for research and participation on the Aurora leadership programme.

On our staffing and recruitment policy, the International Expert Review Panel concluded: "The size, scope and quality of (the growing) faculty is impressive and the dividends in the form of broad recognition internationally are now being reaped, not only in areas of performance enhancement and sports policy, but increasingly in addressing exercise, physical activity and health agenda, across the lifespan and within different populations".

Succession planning is a regular consideration at School Leadership Team meetings. A variety of positions provide developmental opportunities, e.g., Research Theme leads, Director of Doctoral Programmes (DDP), each with deputies, that prepare Unit staff for more senior roles. Our strategy is for high retention rates and a high proportion of research leaders to be homegrown (including the ADR and ADE). For example, 12 professorial staff departures since REF2014 (mainly retirements) have been replaced by 11 internal promotions (including the ADR and ADE) and 2 new recruits.

2.2 Staff development strategy

Loughborough's Organisational Development offers a wide spectrum of training opportunities and support for staff at all career stages. Courses range from earliest stages (Welcome to Loughborough) through essential training (Information security training, Unconscious Bias) to training for staff becoming senior managers (Coaching conversations for managers, Recruitment and selection). All staff involved in research and impact can access comprehensive training and

development, especially technical staff, several of whom have engaged in the Midlands Innovation TALENT programme to support Higher Education technicians. Staff can access budgets to support research consumables, conference attendance and travel, with priority given to early career staff.

All academics are expected to obtain **Fellowship of the Higher Education Academy** (FHEA). For new lecturers, this is integral to their dedicated development programme. More experienced colleagues are supported through our `Recognition of Experienced Practitioners' scheme.

2.2.1 Mentoring
Mentoring is offered to all staff, with training provided by the University. The Leicester BRC also offers mentorship training. Over the last 3 years, 52 academic, research and technical staff across all grades (33F/19M) received mentorship, delivered by 41 academic staff (22F/19M) primarily at Reader or Professor level. The programme supports diverse outcomes such as promotions, development of major grant bids, significant publications, and fellowship applications.

2.2.2. Support and integration of early career researchers into the Unit's research culture
Following the principles of the *Concordat to Support the Career Development of Researchers,* the University provides structured support to postdoctoral researchers for career progression and development, including preparation of applications for funding. This was recognised by the European Commission's HR Excellence in Research Award (since 2010, renewed after external review every 4 years). This includes 'Recognition of Teaching for Researchers (ROTOR)' and 'Associate Teaching Pathway' programmes which allow postdoctoral researchers to achieve Associate/FHEA status. Workshops (e.g., grant funding, fellowships, building networks) are provided for all staff, including postdocs.

During the REF period, the Unit employed 173 research staff i.e., research assistants / associates, translational scientists and Excellence100 Fellows, including 36 currently in post. Research staff are fully embedded in our Research Themes. They attend School seminars, Athena Swan events, social events and a wide variety of training activities. Postdoctoral researchers bring new ideas and contribute to the conceptualisation and writing of research grants, organise and conduct research studies, assist with supervision of doctoral researchers, present data during research talks and public lectures, develop new research methods and techniques, and organise research and impact days. In doing so, they enrich research culture and academic vitality. 12 of our postdocs took permanent academic posts at Loughborough (11 SSEHS, 1 LUL), including 3 (of 4) of the Excellence100 Research Fellows.

2.2.3 New Lecturers' Programme (NLP)
All new lecturers are guided by an experienced and trained academic colleague who acts as Adviser. NLP (formerly academic probation) was substantially revised in 2017 and includes the full spectrum of research and impact activity (publication, funding applications, collaboration, public engagement, non-academic partnerships). New lecturers have a reduced workload in teaching and administration (33, 50 and 67% of School norms in consecutive years), which enables the establishment of a full academic profile in research, teaching and impact at a manageable pace. In addition to an extensive training programme leading to FHEA, the New Lecturer meets four times annually with their Adviser though many more informal meetings are the norm. New Lecturers are allocated a University-funded PhD studentship within their first two years, for co-supervision with an experienced colleague. Supervision is a requirement to pass the programme, alongside a minimum expectation on research output production, and the submission of at least one substantial grant application. During the assessment period, 33 staff competed NLP and 12 have subsequently been promoted. 10 staff are currently completing NLP.

2.2.4 Mid-career and senior staff
Regular career progression events are provided on 'route to senior lecturer / professor' etc. and Deans hold one-to-one meetings with staff who have been in their grade for at least three years to discuss targeted support to develop potential for promotion. CALIBRE's Research Leaders Programme emphasises leadership broadly, beyond traditional Associate / Dean roles. Folland attended this programme, implementing a restructure of the School's Research Themes and M.King (now ADE) also attended, focusing on Loughborough's international strategy. Both were subsequently promoted from reader to professor.

2.2.5 Performance and Development Review (PDR), reward and promotion
All post-probationary staff have an annual **PDR**. This University scheme was totally updated in 2017. A supportive one-to-one discussion between the reviewee and a trained reviewer reflects on achievements over the past year and agrees performance and developmental objectives across the full range of activities including CALIBRE-aligned goals for research and impact activity. New PDR is a transparent way to recognise performance exceeding expectations with additional financial **reward**, overseen by a Senior Review Group. The new scheme has particularly benefitted our technicians and research staff for whom a rigorous developmental discussion was previously sporadic and consideration for reward a rarity. In 2019, 34% of academic staff, 34% of postdoctoral researchers, and 35% of technicians in the Unit were identified as 'exceeding expectations' and considered for reward.

PDR also identifies promotion candidates. In SSEHS, the Human Resources Advisory Group advises the Dean on promotion cases and proactively engages with staff. In 2016, the University revised the criteria for **academic promotion** (Senior Lecturer and Reader / Professor), to ensure that the research components align with the University Strategy and CALIBRE. Evidence for cases can be based on research, teaching, enterprise (impact) or any combination to encourage balanced portfolios of work. Promotion panels consider statements from applicants describing how personal circumstances, such as caring responsibilities, may have affected their profile. Since 2014, Unit staff received 47 promotions (21F/26M) comprising 23 to Senior Lecturer, 13 to Reader, 11 to Professor.

Equality, Diversity, and Inclusion (EDI) considerations are prominent in PDR and Reward including within reviewer training (e.g., unconscious bias). EDI monitoring is routine for promotion and a standing item on School committee agendas.

2.2.6 Research and impact leave
Leave is available in the form of School and University Fellowships, providing up to 12 months outside regular workload to pursue agreed programmes. Submissions are often a consequence of PDR discussions and diversity is routinely monitored. Since 2014, three Unit staff received School Fellowships (2F/1M) and two received University Fellowships (1F/1M):

- Hogervorst collaborated with Alzheimer's Research UK on lifestyle change for reducing dementia risk.
- Varela-Silva received Bill and Melinda Gates Foundation funding to lead a project examining healthy birth, growth and development in children and adolescents in Guatemala.
- Harwood worked on parenting in youth sport and the psychosocial development of young athletes, supporting two impact case studies. His work led to two sets of strategic partnerships: firstly, with the International Tennis Federation and Lawn Tennis Association and secondly with multiple Icelandic organisations (Reykjavik University and the Icelandic Football Association, National Olympic and Sports Association, National Youth Association, and Gymnastics Federation).
- Sandford shared her British Academy funded 'Right to Be Active' research (examining the sport/physical activity experiences of looked-after children) with various stakeholders e.g., care experienced youth, practitioners, charities, NGBs, local authority staff and foster carers. She was invited to present the research at the All-Party Parliamentary Group for looked after children and care leavers (2019) and engaged with key organisations e.g., Become, StreetGames, Public Health England and Ofsted.

- Jowett based herself at UK Sport and worked with the Head of Coaching Development and the UK Sport team of coach developers, developing the 'Women in High Performance Coaching' programme (with the aim to increase female coaches' representation to 25% (from 10%) in the 2024 Olympic and Paralympics Games). As a result, Jowett was nominated for UK Sport's Victor Awards in 2020.

2.3 Postgraduate Research (PGR) Students
A key ambition over the past decade has been to enhance the research environment for PGR students. PGR processes and procedures are centrally coordinated by the Doctoral College and delivered in Schools by the Director of Doctoral Programmes (DDP) and ADR. PGR students actively contribute to development of their own community. Each School has elected PGR representatives who meet regularly. An overall lead, the Doctoral Researcher President, sits on both the Doctoral College Sub-Committee and the University Research Committee ensuring the views of PGR students are represented at institutional level. As well as engaging with PGR reps, participation in the Postgraduate Research Experience Survey (PRES) and the Doctoral College Wellbeing Survey ensure our decisions are based on the real experiences of our community. The Unit awarded 217 PhD degrees, averaging 31/year, almost 10% up on REF2014.

2.3.1 Funding
The School attracts funding to maintain its PGR population (over 200 including part-time students) via University scholarships (33%), partner organisations including NIHR and UKRI (36%), and high-quality self-funded students (31%).

The Doctoral College is responsible for an annual strategic investment exceeding £9M in scholarships across all Schools. Schools are responsible for the strategic distribution of these scholarships to priority areas and with general aims of facilitating interdisciplinary collaboration and ensuring that ECRs gain experience in PGR supervision. CALIBRE's Adventure programme supports mini-CDTs on a competitive basis and the Unit has been successful in securing mini-CDTs in Next Generation Prosthetics, and Gender and Sport.

External funding is secured by working in partnership with a wide array of organisations and involves a combination of fully funded and match-funded studentships. Examples of funders include Addenbrooke's Charitable Trust, Badminton World Federation, Bradford Institute for Health Research, Commonwealth Scholarship Commission, Defence Medical Services, ECB, EIS, Kids Run Free, National Autistic Society, Saudi Arabian Government, Sporting Communities, St Andrews Healthcare, Taiwan Ministry of Education, UK Athletics, UK Sport, University of Kelaniya, University of Malta and World Tennis Federation.

Funding is also provided via the NIHR Leicester BRC, the Versus Arthritis Centre for Sport, Exercise and Osteoarthritis, the Peter Harrison Centre for Disability Sport, the NCSEM and our EPSRC/MRC Centre for Doctoral Training in Regenerative Medicine. Loughborough is also one of the six universities which comprise the Midlands Graduate School ESRC Doctoral Training Partnership in which 'Sport and Exercise' is a dedicated pathway, established by the Unit in 2017. The Unit also leads a British Council scheme with historically disadvantaged universities in South Africa.

2.3.2 Recruitment
Studentships are advertised on our website and social media channels, and on sites such as jobs.ac.uk and FindaPhD.com. Studentships are awarded competitively after advertisement and an interview selection process. Individual applicants with self-funding or holding a personal scholarship are encouraged to apply and develop proposals with potential academic supervisors. In recent years, to promote recruitment of self-funded students and those holding personal scholarships, pre-formed, but unfunded, PhD projects have been advertised. A minimum upper second-class first degree in a relevant field is required but many incoming students have Master's degrees. International students are required to have a minimum IELTS score of 6.5 overall.

Typically, 45 PGR students are recruited each year, of which roughly 25% are from outside the UK/EU. Across the REF period, ratios have been 41/59 identifying as female/male, reaching 51/49 F/M in 2019-20, with 63% identifying as white.

2.3.3 Monitoring and support mechanisms
New PGR students complete a range of formal and social induction activities. These include separate induction meetings, with the supervisors (two supervisors per student), with the DDP and with the Doctoral College. They are allocated a 'buddy', an existing PGR student, who acts as an ongoing mentor. PGR students are assigned to a Research Theme and have an initial tutorial with a Deputy DDP to provide an independent point of contact for advice. Students have at least one formal meeting with their supervisors each month to track progress and engagement. Records of these meetings are maintained by our electronic system, Co-Tutor. Additional meetings are held when necessary.

The progress of all new students is reviewed at 6-months and then annually based on submission of a report and subsequent review meeting. The 6-month review is conducted by a Deputy DDP. Annual reviews are conducted by an Independent Reviewer. Progress boards are held quarterly, chaired by the DDP. Records of PGR progress boards are maintained centrally, re-registration requires a satisfactory review outcome. Supporting PGRs to submit within their funded period is a high priority.

Research students can take a leave of absence for various reasons e.g., sickness, parental responsibilities, caring responsibilities.

2.3.4 Skills Development
From its 'Graduate House' home, which provides social and workspace for PGR students, the Doctoral College offers over 200 events annually, from induction and international orientations to transferable skills and employability training to meet the requirements of the Vitae Researcher Development Framework. Major events include the annual research conference and summer showcase, and the 'Café Academique' forum to debate emerging research ideas. Further specialist support is available from the Mathematics Learning Support Centre, English Language Support Centre, Student Advice Centre, and the Careers Network.

Within the Unit, PGR students have copious opportunities for training, skills development and networking via the Research Themes. Students have opportunities to present their work including poster (year 2) and oral (year 3) presentations. The Leicester BRC, via the Academic and Clinical Excellence Group, provides PGRs with additional bi-monthly bespoke training in health research (e.g., PPIE, Good Clinical Practice) and opportunities to present and learn via student-led seminars. Students are encouraged to submit their work for presentation at external conferences with travel and accommodation budgets provided for all students. Additional funding is available for research consumables and training. Students are invited to monthly networking coffee mornings with leading research staff. PGR reps are provided with a budget to organise social and networking activities. Training and support of PGR students within Schools is managed by the PGR sub-committee chaired by the DDP. In the Postgraduate Research Experience Survey 2019, overall satisfaction of Unit PGR students was 83%, above the national average for all subjects and for Sports Science.

2.4 Equality, Diversity and Inclusion (EDI)
EDI is integral to the Unit's staffing and recruitment policy and succession planning. Recruitment advertisements use positive role models and promote family friendly policies including part-time working. All interviewers undertake mandatory training including unconscious bias, and single gender panels are not permitted.

We are committed to addressing BAME, disability and gender inequalities in science and improving career progression for those with all protected characteristics. SSEHS attained the **Athena SWAN Silver Award** in 2012 (renewed in 2016 and again in 2020). Staff achievements

are recognised through annual Athena Swan Awards with categories such as Inspirational Leadership, Emerging Leader, Supporting Positive Developments, Research Assistant / Associate / Fellow of the Year. Two female academics are sponsored biennially to attend the AdvanceHE Aurora leadership programme. Since 2014, the proportion of female staff at Reader level has increased from 31% to 50% and at Professor level from 19% to 39%. Our ethnic demographic remains predominantly white which we will continue to address through our positive action plan.

Flexible and remote working is supported, subject to agreement with the Dean, to promote and support wellbeing, as it has been for many years. Key meetings are scheduled 10am-4pm to support caring responsibilities. Lecture capture is used for training and staff meetings for staff unable to attend. Remote working is facilitated via the VPN (with secure multifactor authentication) that provides access to all University online resources. Our supporting infrastructure has eased the transition to effective home working during the COVID-19 pandemic during which we have seen just how effective flexible and remote working can be.

Colleagues preparing for **maternity or adoption leave** are supported to attend classes and appointments. University funding is available to cover colleagues taking family leave, and those on leave can take up to ten *Keeping-in-Touch days* to attend meetings or important events during their leave. Towards the end of any long-term leave periods, including sick leave, staff are offered a phased return to work or a flexible return with, whenever possible, workload adjustments during the first 12 months. Funding is available **for staff with caring responsibilities** to cover e.g., the travel and accommodation costs of their children where national/international conference attendance would be otherwise difficult.

Loughborough University's Equal Opportunities Code of Practice provides explicit focus on **supporting staff with protected characteristics** so that they can achieve their potential while at the same time ensuring their well-being. A Reader within the Unit who is registered as blind has been proactively supported to ensure that appropriate technology is in place for him to undertake his role. EDI data on funding applications and successes is monitored so that strategies can be adopted to counter any trends indicating that groups with protected characteristics are disadvantaged.

All Schools have **Wellbeing Advisors** who can be contacted by staff and PGR students for support and our Employee Assistance Programme operates a 24/7 confidential helpline.

2.5 Equality and diversity issues in the construction of the REF submission
The University Research Committee created **the REF Code of Practice (CoP) Working Group** in October 2018 with diverse membership. All submission preparations were conducted in accordance with the CoP and subject to Equality Impact Assessments. Our Unit submission team comprised four men and two women. All members underwent REF-specific Equality and Diversity training.

Forty Unit academics (24M/16F) contributed to the **peer review of outputs**. Our outputs selection and assessment processes were in line with Loughborough's Responsible Metrics Policy. To ensure fair, consistent and transparent selection, we identified outputs that convey the most original, significant and rigorous work produced by the School's current or former staff. Our School submission was subject to Equality Impact Assessments, considering gender, maternity leave, ethnicity and ECR status, which revealed no bias.

3. Income, infrastructure and facilities

3.1 Research funding strategies
The delivery of our strategic research objectives at the level of ambition we set for ourselves could not be achieved without significant research funding. ADR and ADE coordinate the funding strategy in which Research Themes identify funding priorities. Research grant applications are

peer reviewed internally by a colleague with relevant expertise and by the ADR to ensure they are of the highest quality prior to submission. Our Centres are also fundamental to our strategy, acting as focal points for attracting research and impact funding.

Since 2014, the Unit has generated over £18M in research funding. This has come from a wide variety of sources including research councils (£1.8M, 10%), UK based charities (£4.8M, 27%), UK Central Government (£4.7M, 26%), UK industry (£2.5M, 14%), EU (£1M, 5%), and various non-EU sources (£3.3M, 18%). This includes 4 research councils (EPSRC, ESRC, MRC and AHRC) and national governing bodies of sport. We place particular emphasis on developing and maintaining relationships with governing bodies of sport and this is facilitated by collaborations with organisations on our campus at SportPark. Partnerships with industry are facilitated by the Unit's ADRs and ADEs who ensure a coordinated approach in response to partnership requests from industry or Unit-led overtures to potential industry partners. Our links with charities have been facilitated and strengthened with in kind support to projects from our Research Centres.

In **Sport Performance**, we used our extensive partnerships with sporting organisations and national governing bodies to secure funding from multiple organisations e.g., ECB, EIS, Football Association. In disability sport, we continued our established partnership with the Peter Harrison Foundation (£1.2M since 2014, V.Tolfrey) and consequently were able to attract funding from a wider variety of Paralympic sports organisations e.g., British Triathlon, GB Wheelchair Rugby. **High quality outputs** included a *Neurology* paper (2017) on exercise guidelines for spinal cord injury. Our sport and exercise nutrition research attracted funding mainly from industry, to examine how nutrition influences performance and health. Examples include research on novel amino acid mixtures to optimise the composition of sports drinks (Entrinsic Beverage Company LLC, £575k, PI James), sleep architecture in athletes (Rousselot BV, £207k, PI Clifford), dietary nitrate supplementation and resistance exercise performance (Herbalife Europe Ltd, £181k, PI Bailey), and the potential of cannabidiol to modify energy balance and exercise performance and recovery (Bridge Farm Nurseries, £149k, PI James).

Our **Lifestyle for Health and Wellbeing** Theme was very focussed on the rehabilitation agenda and secured funding from the research councils and a variety of charities. EPSRC funding supported work in molecular biology, including proof of concept work using our newly acquired MRI scanner, while MRC awards funded interventions to decrease sedentary behaviour in young adults at risk of type 2 diabetes and inactive older adults. Our partnership with the Defence Medical Services and the translational potential of our expertise in Exercise as Medicine resulted in novel and impactful projects funded by the NIHR and various UK charities focusing on chronic disease including the British Heart Foundation and Diabetes UK. Our new **Centre for Lifestyle Medicine and Behaviour (CLiMB)** is supported by a programme grant (NIHR, £2.2M, 2019-24, Co-I Elsiger) titled 'Snacktivity to promote physical activity and reduce future risk of disease in the population'. Focusing on behaviour change strategies, CLiMB will allow us to implement findings from some of our charity funded work. For example, J.King (Diabetes UK, £15k, 2018-20) initiated new activity in non-alcoholic fatty liver disease (NAFLD) with ongoing work investigating the effects of exercise on hepatokines and potential links between NAFLD and type 2 diabetes. Additional NIHR funding (Clemes, £627k, 2017-20) allowed us to investigate the clinical and cost effectiveness of a Structured Health Intervention For Truckers (The SHIFT Study).

Under the **Participation in Sport and Exercise** Theme, researchers received ESRC support for work in Sport, Development and Peace as well as work promoting independence in people with dementia. For example, Giulianotti obtained two **major ESRC research grants** in the field of 'Sport for Development and Peace':

- 'Sport for a Better World? A Social Scientific Investigation of the Sport for Development and Peace Sector' (2014-17, £332k)
- 'New Development Frontiers? The Role of Youth, Sport and Cultural Interventions', (2017-19, £250k)

The projects investigated the role of sport in promoting the personal and social development of young people in eight countries (Cape Verde, Jamaica, Kosovo, Nepal, Rwanda, Sri Lanka, Timor Leste, Zambia). Project outcomes included hosting the first multi-stakeholder Sport for Development and Peace events in three nations, which privileged the voices of marginalised young people, advising national governments on developing youth and sport strategies, and delivering reports to NGOs with recommendations on improving strategies and practices. The projects were supported and guided by major stakeholders (e.g., Commonwealth Secretariat, UN Office of Sport for Development and Peace, and national ministries). With her AHRC funding, (£199k, 2020), Pullen is addressing 'Gendered representations of disability: Equality, empowerment and marginalisation in Paralympic media'.

Theme members were also funded by various charities with a common goal of improving life for marginalised groups e.g., the role of sport for preventing youth crime (StreetGames), exercise and sleep as medicine in a secure mental health setting (St Andrews Healthcare), increasing engagement with physical education in primary school children (Youth Sport Trust), and representation of ethnic minorities and women in leadership and coaching positions in football (Football Association). Downward's funding from the Health Foundation (£200k, 2018-19) initiated a two-year longitudinal study of how a person's health can affect their economic outcomes (e.g., job satisfaction, income and perspective on their own financial situation) and their social outcomes (e.g., their relationship with their partner and perceptions of their own neighbourhood). The findings will help policymakers, from areas such as the NHS and the Government, implement future strategies.

The funding portfolio includes the **prestigious** £11.6M NIHR Leicester BRC (2017-2022, £1.4M to the Unit) which is a **consortium** endeavour with Leicester's Hospitals and University of Leicester. The Centre has three main themes including Lifestyle for which Stensel is BRC Lead. This award continued a collaboration initiated as the Leicester-Loughborough Biomedical Research Unit (BRU; 2012-17). Together, the BRU and BRC have produced **high quality outputs and impact** involving collaboration with clinicians to integrate exercise and physical activity behaviours into prevention and management strategies for chronic diseases. Examples include:

- *Journal of the American Society of Nephrology* (2014) – compelling evidence that walking exercise is safe with regard to immune and inflammatory responses and has the potential to be an effective anti-inflammatory therapy in pre-dialysis chronic kidney disease (CKD). This informed the development of Renal Association Guidelines on Exercise and Lifestyle for people with CKD to be published in 2021.
- *Diabetes Care* (2017) – demonstrating improved glycaemic control after walking and standing interventions in postmenopausal women at increased risk of developing diabetes due to impaired glucose tolerance.

3.2 Organisational infrastructure supporting research and impact

The Research and Enterprise Office (REO) supports our research and impact ambitions by alerting Unit staff to funding opportunities, guiding development of applications, supporting costing, developing collaboration agreements, protecting IP and know-how, and providing legal advice. **Research Development Managers** (RDM) work particularly closely with staff, directly assisting with drafts of applications, preparing letters of support, and liaising with the funder, supporting large awards like the NIHR programme grant `Snacktivity' but also smaller but still important submissions such as the Rank Prize (£20k, 2017) awarded to Martin investigating amino acid metabolism in ageing muscle cells and a Thalidomide Trust Award (£61k, 2019) to Papathomas for research promoting physical activity in thalidomide survivors. The REO also provides targeted skills training to aid **Researcher Development**, particularly by supporting three CALIBRE elements: the **Research Leaders** programme, the **Doctoral College** and the **Institute of Advanced Studies**. The Research Leaders programme provides extensive support for Research Fellowship applicants, including interview preparation and a mock panel; Skarabot's successful Versus Arthritis Foundation Fellowship ('Arthrogenic muscle inhibition and impaired function in knee osteoarthritis', £279k) starts shortly.

The support of **Partnership Development Managers** from REO has been critical for our impact work, while the REO **Commercialisation Team** has also facilitated impact work such as Jowett's Tandem relationship tool (assessing the effectiveness of coach / athlete relationships), Cushion's Coach Analysis Intervention System (an online platform enabling coaches to analyse their coaching behaviour), Plateau's disordered eating in athletes online course (used by Scottish Athletics and Mental health charities including Mind), and Yilmaz's Professional Certificate for Sports Agents programme (which has included work with FIFA). The REO **Quality and Visibility** team have spearheaded our drive to increase open access publishing and responsible use of metrics, to enhance the quality and visibility of our work. The **Legal Services** team have provided support that has been particularly important for industrially funded research.

In SSEHS, the **Technical Resources Manager** is supported by a Senior Technician who assists with management of the technical team and ensures health, safety and environmental compliance including equipment maintenance. The Team has six areas of focus: Biochemistry, Exercise Physiology, Physiology, Biological Sciences, Biomechanics and Motor Control, and Sports Science and Psychology. An additional Technical Officer leads on Electronics support.

Among 40 administrative staff supporting the Unit are a **Regulatory and Compliance Manager,** who coordinates ethical approval processes, HTA activities and data protection, a **Regulatory and Safety (Biological and Chemistry) Administrator,** who conducts HTA audits for traceability and consent, and oversees administration of Standard Operating Procedures and risk assessments, and an **Ethics, Regulatory and Compliance Administrator** who assists with the processing of ethical approval applications.

3.3 Operational and scholarly infrastructure supporting research and impact
Abundant infrastructure supports our research and impact work from test tube to trackside and bench to bedside. This includes facilities for cell work in laboratories to whole body research in our plentiful sports amenities, in local schools and in clinical wards, encompassing our Midlands and London campuses as well as shared facilities with partners in the Leicester BRC, the DNRC and beyond. The uniqueness and quality of our facilities was acknowledged by the International Expert Review Panel who noted "the scale of infrastructure and … the agenda they lead are truly world-class".

Laboratory space and equipment. 94 research laboratories on our Midlands campus (covering 4246m^2) support work in the Lifestyle for Health and Wellbeing and Sport Performance Themes. Work in cell and molecular biology is resourced by six analytical laboratories (for protein, DNA and clinical chemistry needs), three cell culture laboratories, a biochemistry laboratory and a molecular biology laboratory. These are equipped with tissue culture and cryostorage facilities, a real time PCR system, a HPLC system, a flow cytometer, and an automated benchtop clinical chemistry analyser. These facilities support work of staff seeking to better understand acute and chronic responses to exercise at a molecular level with a view to optimising performance, recovery, and rehabilitation processes.

For physiology and nutrition work, we have seven exercise physiology laboratories, a nutrition laboratory, three research kitchens, a nutrition cubicle and two nutrition observation rooms. These support our collaborations with the food and nutrition industry seeking to better understand interactions between exercise and appetite with a view to ameliorating obesity. Crucial to this work is assessment of body composition which is enabled by two anthropometric / body composition laboratories, an immersion tank for underwater weighing, a COSMED Bod Pod body composition analyser, and a DEXA scanner. In addition, our 3T MRI scanner has enabled the development of new (to Loughborough) techniques e.g., for accurately quantifying visceral adipose tissue and for assessing central (brain) appetite responses using the BOLD (blood oxygenation level dependent) technique. The Unit also houses four climatic chambers for research investigating exercise responses in the heat, cold and at simulated high altitude.

Our biomechanics and motor control researchers have access to a wide range of software, equipment, and facilities to allow a broad range of experimental and theoretical research. These include three biomechanics laboratories containing eight force plates, four Vicon motion analysis systems (totalling over 60 cameras – both fixed and mobile systems), a Computer Assisted Rehabilitation Environment balance platform, numerous high-speed cameras, wireless electromyography systems, accelerometers and inertial measurement units. For theoretical research, staff can access Loughborough's High-Performance Computing facility to enhance computer modelling techniques and capacity for assessing activities including cricket fast bowling, triple jump, gymnastics high bar, springboard diving, para long jump, sprinting, drop jumping, and gymnastic vaulting.

Further facilities include two paediatric exercise physiology laboratories, three muscle function laboratories for assessment of neuromuscular performance, two wearables laboratories housing a wide range of physical activity tracking devices and a Polar team pro GPS player tracking system, an invasive procedures laboratory for muscle and fat biopsies, a sleep laboratory equipped with polysomnography technology, an extensively equipped Parasport laboratory including a large wheelchair specific treadmill and Vicon motion analysis system, and three psychology laboratories.

Since 2014 approximately £3.3M has been spent on new equipment with notable purchases including MRI and DEXA scanners, a motion analysis system, a high-speed force treadmill, an eye tracking system, a bench top clinical chemistry analyser and mass spectrometry facilities.

Unit staff can draw on the country's largest concentration of world-class **sporting facilities** and sports performers from recreational level to Olympic Gold medallists and World Champions, all based at Loughborough. Facilities include:

- Two state-of-the-art gyms for strength and conditioning research.
- The Seb Coe High Performance Athletics Centre (with integrated force plate), Paula Radcliffe Athletics Track and Steve Backley National Throws Centre, for research in athletics.
- A 50-metre swimming pool with instrumented starting blocks and camera system.
- The National Cricket Performance Centre, with integrated force plate and video analysis system for performance and injury research.
- The Loughborough University Stadium e.g., for GPS work during competitive football.
- The Tennis Centre (home to the Lawn Tennis Association National Academy and Tennis Leicestershire) facilitating psychology work with coaches and parents.
- The Gymnastics Centre with integrated force plate, Vicon motion analysis and video systems for performance and injury research.
- The Badminton Centre (e.g., for Badminton World Federation funded research on the jump smash).
- The Netball Centre, the Sir David Wallace Sports Hall, and an abundance of pitches for rugby, hockey, cricket and football.

The University's newly opened (2018) £7M **Elite Athlete Centre and Hotel** provides training camp and catering facilities for all athletes including those with disabilities. Twenty rooms have climate control able to provide altitude conditions up to 5000m, enabling athletes to "sleep high and train low". The Centre includes specialist nutrition and recovery rooms. This facility provides an ideal opportunity for sport science academics to work with the Sports Development Centre, sport governing bodies and elite sports competitors to generate unique research into the potential benefits of chronic periods of exposure to high altitude environments. Potential benefits to be investigated include improved performance (particularly in endurance sports), accelerated rehabilitation from injury and potential health benefits (e.g., for weight control).

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

Our most significant research and impact activities have flourished through collaborations with world-leading Universities and end-user partners from the worlds of sport, exercise and health. These collaborations are facilitated by dedicated support, from our Senior Translation Scientist and Research Development Manager, by networking (sandpit) events, by inviting external speakers to present and interact with staff during research theme meetings, and by availability of pump-priming funds.

4.1 Research collaborations, networks and partnerships

At the heart of our academic partnerships lies the **NCSEM-East Midlands** (Lewis (Dean) is Director). With Nottingham and Leicester Universities, University Hospitals of Leicester NHS Trust and Nottingham University Hospitals NHS Trust, we are committed to education and the translation of research to accelerate improvement to the nation's health and wellbeing. Six clinical PhD fellowships have been awarded to support NCSEM-East Midlands. For example, Dr Graham-Brown's Fellowship allowed Bishop and Stensel to work with immunologists and clinicians at the University of Leicester (Profs Burton, McCann and Smith) demonstrating the potential of physical activity to improve cardiac function (findings in press with *Kidney International*). NCSEM is the foundation on which our participation in the **Leicester / Loughborough BRC** is built, as well as further collaborations regionally, nationally and internationally. Nationally, NCSEM-East Midlands is part of NCSEM-England, with additional hubs in London and Sheffield, which advises government and provides educational and clinical services. Internationally, NCSEM is an **International Olympic Committee (IOC) Research Centre** for the Prevention of Injury and Protection of Athlete Health (renewed in 2019 for a further 4-years, one of just 11 IOC Centres worldwide), linking the Unit to an international network of experts in sports injury and disease prevention and financial support.

Regionally, NCSEM underpins our engagement with **Midlands Innovation Health** (MIH) which is focussed on a regional health and life sciences strategy. MIH is an initiative of the **Midlands Innovation (MI)** partnership comprising the 8 research-intensive universities in the Midlands: Aston, Birmingham, Cranfield, Keele, Leicester, Loughborough, Nottingham, and Warwick. The Unit is engaged in a range of MI projects including equipment sharing (e.g., accessing specialist microscopy facilities at University of Nottingham), the TALENT programme to raise the profile of HE technicians, and the MI Commercialisation of Research Accelerator, which gave an IP exploitation grant (2019) to develop online training for coaches addressing disordered eating in athletes. MIH facilitated the Midlands response to COVID-19 described in the report 'Mobilising Research Excellence in the Midlands to Tackle COVID-19' (authored with Midlands Health Alliance and Medilink Midlands). MIH is supported by the Midlands Engine and works closely with the **Midlands Health Alliance** which coordinates collaboration between the Midland's NIHR BRCs and enables our researchers to access clinical spaces in Leicester and Nottingham.

Nationally, we anticipate significant growth in our partnership with the **Defence and National Rehabilitation Centre (DNRC)** in the areas of injury prevention and management, musculoskeletal rehabilitation, concussion and the impact of exercise on immune function and infection risk. After signing an MoU with Defence Medical Services (2016) and with their recent opening, the National Rehabilitation Centre (NRC) announced (February 2020) Loughborough and University of Nottingham as leads of the **NRC Academic Partnership (NCAP)**, comprising over 20 universities.

Linked with the NRC agenda, the **Versus Arthritis Centre for Sport, Exercise and Osteoarthritis Research** (£5M, 2013-23) is a Unit collaboration with Nottingham University Hospitals NHS Trust (lead) and the Universities of Nottingham, Oxford, Southampton, Bath, and Leeds. Its remit extends from elite athletes (long-term impact on joints) to the prevention and care of osteoarthritis in the general population of recreational athletes and exercisers.

Partnership in the Leicester BRC also networks the Unit nationally, within the **NIHR Diet, Activity and Research Translation (DART) Collaboration** of 10 BRCs across England including Bristol, Cambridge, Guy's & St Thomas, Imperial, Leicester, Manchester, Newcastle, Oxford, Southampton and UCLH. The DART collaboration (Stensel is a lead member) enhances the effectiveness of research conducted across the country in diet, nutrition, physical activity and sedentary behaviours. It has enabled the Unit to integrate its expertise in physical activity into multiple collaborative projects with clinicians, e.g., behaviour change techniques to improve dietary, physical activity and sedentary behaviours in families at increased risk of cardiovascular disease due to familial hypercholesterolaemia (published in BMJ Open, 2020, with Bristol).

Our longstanding **Peter Harrison Centre (PHC) for Disability Sport** (V.Tolfrey leads) is also a magnet for international research collaborations. New initiatives have been launched with the University of Queensland on Para sport classification (e.g., wheelchair tennis and basketball impairment criteria) to ensure compliance with the International Paralympic Committee's (IPC) Athlete Classification Code, with Harvard Medical School on spinal cord injury (SCI), and with University of British Columbia on exercise necessary to improve fitness and cardiometabolic health in adults with SCI. The Centre has hosted several esteemed visiting professors including Profs Martin Ginis (University of British Columbia), MacDonald (McMaster University) and van der Woude (Groningen University).

Loughborough's Institute of Advanced Studies also supports collaborations, bringing world-leading researchers to our campuses to participate in themed programmes:

- Professor David Bishop from the Institute of Health and Sport at Victoria University, Australia was hosted for a Cycling Science Symposium organised by Ferguson (2019).
- Professor Lee Thompson (Waseda University, Japan) and Professor Susan Brownell (University of Missouri, USA) attended an IAS 'Sport and the Nation' event organised by Bairner (2018).

While international collaborations like these are routine for individual academics, our Research Centres are the cornerstones of our major collaborations and so we have focussed on these in this subsection.

4.1.1 Key Research Users and Beneficiaries

The Midlands campus is home to the largest concentration of sports governing bodies anywhere in the world, bringing a priceless benefit to our research and impact activity matched by the direct benefit to the partners themselves. Most are located on Loughborough University Science and Enterprise Park in **SportPark,** accommodating 15 sports organisations such as British Swimming (supporting Fletcher's work on the psychology of performance excellence), the ECB (supporting M.King's impact work with cricket), Activity Alliance (formerly English Federation of Disability Sport), British Wheelchair Basketball and British Triathlon (supporting V.Tolfrey's impact work with Parasport), England Squash, the Institute of Sport and Recreation Management, the Institute of Swimming, Leicester-Shire & Rutland Sport, UK Sport, Volleyball England (supporting Cushion's coach education work), and the Youth Sport Trust (supporting the physical education impact work of Harris and Cale). SportPark will shortly undergo a £6M expansion that will see UK Anti-Doping join its unique community. Loughborough is also home to the **British Athletics National Performance Institute** (supporting Bailey's research focusing on physiological and nutritional interventions to enhance track and field performance). The International Expert Review Panel concluded that our research and impact activity "is facilitated by powerful support from the hosting of NGBs (of significance), Sporting Agencies and Centres on campus".

Of the many collaborations, the area of disability sport is the one to have grown the most since 2014. The PHC is recognised by the parasport community as a worldwide centre of excellence, working with stakeholders such as the EIS, UK Sport, International Paralympic Committee, rehabilitation scientists at national spinal injury units (e.g., Stoke Mandeville), and organisations running international parasport events such as the International Triathlon Union, the International Wheelchair Rugby Federation and the International Wheelchair Tennis Federation. Chelsea

Warr, (former) Director of Performance at UK Sport commented, "new knowledge emerging from the Centre's vast research engine is always effectively translated and disseminated".

Individual Unit staff are trusted partners for a wide variety of sporting bodies, influencing their policy and practice while using insight gained to add to the Unit research environment. Examples include:

- Cope was a consultant to the **Premier League** (2014), reviewing and evaluating the School Sport PE programme, and the **Professional Footballers' Association** (2020), redeveloping the UEFA B (basic) Football Coaching course (mandatory qualification to coach in male professional football).
- Mears' work on risk factors for exercise-associated hyponatremia (abnormally low blood sodium levels) supported the guidelines of the **International Institute of Race Medicine.**
- Barker is National Lead Sport Psychologist for Para Football with the **Football Association**.
- Harwood conducts parent education work for the **International Tennis Federation** – 2300 parents across 137 nations took its e-learning modules – and is a Player Development Advisory Panel Member for the **Women's Tennis Association**.
- ISB works with **Chelsea Football Academy** (training methodologies to reduce injury in elite footballers) and technology company PC23 who are developing a talent identification application called 'AIScout'.
- ISB is also working with the **Oman Olympic Committee** to develop the National Sport Strategy.

Our honorary academic (25) and clinical (16) appointments are further important facilitators of collaboration. For example:

- Honorary Clinical Professor Peirce is Medical Director for the ECB and co-supervises PGR work on vertebral adaptation and lumbar stress fracture in elite fast bowlers, and bone development in adolescent cricketers.
- Honorary Clinical Professor Singh is Head of Pulmonary and Cardiac Rehabilitation at University Hospitals of Leicester NHS Trust and collaborates with Unit staff in cardiopulmonary rehabilitation for people with Chronic Obstructive Pulmonary Disease (COPD).
- Visiting Fellow Girardi is Research Manager at St Andrew's Healthcare and facilitates work implementing physical activity interventions in secure mental health settings.

4.1.2 Wider Contributions to the Economy and Society

Over **20,000 patients**, from those with chronic conditions to elite athletes, have been treated at Loughborough's NCSEM and offered exercise as an effective clinical alternative. Over 630 research informed **Continuing Professional Development** sessions have been delivered to a wide range of practitioners, clinicians, academics, and allied health professionals. For example, **'Exercise as Medicine' seminars** (delivered by academics) were provided for GPs and health care professionals across two days covering weight management, glucose regulation, cardiovascular disease risk, healthy ageing, mental health (depression and anxiety), cancer survivorship, motivation and adherence to physical activity, and the role of technology in supporting healthy lifestyle behaviours. Since 2014, the NCSEM has provided over **50 public lectures** on topics related to sport, exercise and health. After moving to online seminars due to COVID-19, lectures have attracted almost 1800 live attendees with over 1100 subsequent views to date.

Staff are also engaged with relevant educational organisations:

- Giulianotti is a member of the scientific advisory group for Play International and the Swiss Academy for Development, using sport and play to empower **disadvantaged children and young people** to become healthy, educated and employed.
- Cale has influenced **physical education provision in schools** through multiple roles (National Physical Education Expert Group, former Chair of the Association for Physical Education).

- Coates has worked with a variety of organisations (e.g., Cambridgeshire County Council, Derbyshire County Council, Nottinghamshire and Leicestershire Forest Education Network) evidencing the benefits of **Forest Schools**.

4.1.3 Engaging with Diverse Communities and Publics
Our public lecture series has covered diverse topics from 'Sleep and Metabolic Health' to 'Social Determinants of Health'. In 2020, lectures focused on exercise, immune function, obesity, and COVID-19. Campaigns are run highlighting academic research e.g., Mental Health Awareness, Parents in Sport Week and Health Habits. The NCSEM hosts an outreach and engagement programme involving community stakeholders and a PPIE group. ISB has established a sport technology accelerator for SMEs that seek to identify technology solutions for sport and physical activity challenges; organisations working in sport analytics, eSports, broadcast technology, fitness, smart stadium, and fan engagement have participated.

There are many examples of impactful contributions to **sports organisations** such as the incorporation of material into strategy documents and coaching manuals (psychological development of athletes in youth and para-football, cricket fast bowlers, cricket pitch lengths, BAME coaches), policy changes (para sport, physical education policy) and presentations to representatives from UEFA, national federations and national governing bodies (BAME coaches). Support for the development of these resources has been provided in the form of funding, intellectual input from our translational scientists and technical support from e-learning specialists.

Staff are also engaged in grassroots organisations related to their academic disciplines. For example, Holley is a member of the East Midlands Hungry for Change Group investigating community solutions to **food poverty**. She also works with StreetGames Fit and Fed project providing holiday clubs to youth in disadvantaged communities, seeking to tackle inactivity, hunger and isolation.

4.2 Contribution to the sustainability of the discipline
The Unit encourages such contributions. Numerous staff hold **fellowships**, including Academy of Social Sciences (Giulianotti), American College of Sports Medicine (Folland, L.Taylor), Association of Applied Sport Psychology (Harwood), BASES (Harwood, Spray, K.Tolfrey, V.Tolfrey), European College of Sports Science (L.Taylor), Hong Kong Association of Sports Medicine and Sports Science (Fong), Human Biology Association (Verala-Sliva), International Society of Biomechanics in Sports (Fong, M.King), Norbert Elias Foundation (Malcolm), North American Society for the Sociology of Sport (Malcolm), Royal Society of Arts (Giulianotti, Varela-Silva), Royal Society of Biology (Folland).

Several staff hold **prominent roles in national and international associations**. Downward is President of the European Sports Economics Association. Garcia is Executive Director of the Association for the Study of Sport and the European Union. Lewis is President of the Tissue and Cell Engineering Society. K.Tolfrey was the British Association for Sport and Exercise Sciences (BASES) chair (2015-18).

Unit staff make extensive contributions to **shaping debate** across discipline areas. The NCSEM has organised and hosted national conferences in 2015, 2017 and 2019 (the latter two in collaboration with the Faculty of Sport and Exercise Medicine UK). Plateau and Stensel organised an MRC funded UK Hot Topics Workshop in 2020 bringing together over 60 delegates from academia, the public sector and industry to scope out research priorities around physical activity, appetite regulation and obesity.

Several Unit staff hold **visiting professorships** or act in **advisory roles** within the discipline: Bairner is a member of the Advisory Committee of the Department of Kinesiology (Physical Education) at Seoul National University (appointed 2020) and Stensel was Chairperson of the Visiting Committee for Sports Science and Physical Education at the Chinese University of Hong

Kong (2017). Giulianotti is Visiting Professor at the University of South-Eastern Norway and Seoul National University. Skinner is a Visiting Professor at the Russian International Olympic University, at Beijing Sport University and Ulster University. Smith is Professorial Fellow at the Centre for Sport and Social Justice, RMIT and Visiting Professor at the Centre for Sport and Social Impact, La Trobe University.

Unit staff are heavily engaged in bodies committed to **national and international priorities** around safeguarding, integrity, and sport as a lever for social change:

- Rhind is Sport Safeguarding Forum lead and Co-Chair of the Research Evidence Working Group associated with the **International Safeguards for Children in Sport** (working with UK Sport, Sport England, DCMS, NSPCC, Police, and NHS).
- Yilmaz was an invited speaker at **Time for Europe to Stand Against Child Trafficking in Sport** (European Parliament, Brussels, 2018).
- Manoli is an Academic Expert on the European Commission Expert Group on Sport Integrity (her 'Mapping **Corruption in Sport**' report is the official policy recommendation to EU member states).
- Skinner has conducted policy work for the World **Anti-Doping** Agency.
- Collison is a United Nations invited expert advising on sport as an educational tool to tackle **violent extremism**.

4.3 Indicators of wider influence

In line with strategy commitments to world leading research addressing contemporary and emerging challenges, Unit staff are encouraged to engage in external activities. Their influence and recognition are evidenced here through their work for grant review committees, advisory boards and working groups, their roles as conference chairs and invited speakers, awards received and editorial roles held.

Virtually all staff act as reviewers for funding bodies, with many serving on national and international **grant review committees** e.g., Blagrove (Chair of Research Grants Panel, UK Strength and Conditioning Association), Cale (Education Panel for the Hong Kong Research Assessment Exercise 2020), Downward (UEFA Research Grants Committee), Fullgrabe (PhD studentship review panel for Action on Hearing Loss, UK), Garcia (Football Against Racism in Europe panel), Giulianotti (ESRC College of Reviewers, GCRF Peer Review College), Hogervorst (Alzheimer's Research UK grant panel), Leicht (Spinal Cord Injury Research Board), Markey (Early Career UKRI International Development Peer Review College Member), Pain (Finnish Research Council of Biosciences, Health and Environment), Papathomas (Health Research Board, Ireland) and Skinner (Swiss National Science Foundation).

Unit staff have accepted **invitations to join advisory boards and working groups**, particularly in promotion of physical activity and for sports governing bodies:

- Bishop: Scientific Advisory Board of the Transplantoux Society (encouraging exercise as medicine in transplant recipients).
- J.King: Nuffield Health Scientific Advisory Board.
- Stensel: British Nutrition Foundation Scientific Advisory Board.
- Stevinson: Macmillan Cancer Support Physical Activity Expert Advisory Panel.
- Clemes: Sedentary Behaviour Expert Working Group for the 2018/19 UK Chief Medical Officers' Physical Activity Guidelines Review.
- Stevinson: Contributor to the 'Movement for Movement' curriculum on physical activity and health for UK medical schools.
- M.King: Injury Prevention Working Group of the Badminton World Federation and the Bowling Legality Group of the International Cricket Council.
- Jowett: Sport England Task Force on Diversity in Sport, and UK Sport as a Coach Developer Consultant and leader of "Women in High Performance Coaching" Project.
- V.Tolfrey: IPC Classification committee member.

Staff acting in **conference chair roles** include:

- Giulianotti: Multiple chair roles including Head of Scientific Committee of the International Symposium, *Sport for a Better World? A social scientific investigation into the Sport for Development and Peace Sector*, Commonwealth Secretariat, 2017.
- M.King: Chairperson, XVI International Symposium on Computer Simulation in Biomechanics, Australia, 2017; Chairperson, 6th World Congress of Science and Medicine in Cricket, Loughborough, 2019.
- Maidment: Academic Lead, 2018-20, for the British Academy of Audiology Annual Conference.
- Malcolm: Chair of the Scientific Committee for 2020 European Association for the Sociology of Sport conference (postponed).
- Pain: 10th International Symposium on Computer Science in Sport, Loughborough, 2015
- Skinner: European Association for Sport Management, 2020.

In addition, several staff have been members of the BASES annual conference Scientific Programme Committee (e.g., Harwood, I.Taylor, Stensel).

Unit staff have given over 300 **invited talks** worldwide. Examples include Bailey (8th International Conference on Sports and Exercise Science Annual Conference, Bangkok, 2018), Bairner (International Joint Conference on Physical Activity, Exercise Science and Sport Sociology, Taiwan, 2015), Blagrove (Royal Society of Medicine, London, 2020), Bishop (International Transplantoux Symposium, Leuven, 2020), Cale (British Educational Research Association, Manchester, 2019), Cushion (International Council for Coach Excellence Global Conference, Tokyo, 2020), Downward (Sport Forum – International Scientific Conference, National Olympic Committee of Lithuania, 2019), Folland (UK Strength & Conditioning Association Conference, Hinckley, 2017), Fong (Royal Society of Medicine – Sports Injuries and Sports Orthopaedics Meeting, London, 2018), Giulianotti (University Day of the German Society of Sport Science, Berlin, 2019), Jackson (United States Olympic Committee, Utah, 2018), Kinnafick (BASES, Liverpool, 2017), James (Royal Society of Medicine Rio 2016 Olympic Games conference, London, 2016), J.King (British Association for the Study of Liver Disease, London, 2018), M.King (The Royal Philosophical Society of Glasgow, Strathclyde, 2020), Leicht (Korean Paralympic Committee Sports Science International Seminar, Seoul, 2019), Malcolm (World Congress of Sociology of Sport, Otago, 2019), Papathomas (European Network of Young Specialists in Sport Psychology 14th Annual Conference, Zagreb, 2018), Smith (World Science Festival Brisbane, 2016), Stensel (European Congress on Obesity Annual Conference, Glasgow, 2019) and L.Taylor (Brazilian Olympic Committee International Sports Science Seminar, Rio De Janeiro, 2019).

Notable awards include: Harwood (Distinguished Contribution to Sport and Exercise Psychology Award by the British Psychological Society, 2018) and V.Tolfrey (IPC Paralympic Scientific Award in recognition of her outstanding contribution to the field of sport for people with an impairment, 2017). Conference **awards** include:

- Clifford: (BASES Early Career Research Award, 2019).
- Clemes: PGR student awards, Ewan Macdonald Prize for the best poster at the Occupational Health Conference, Bristol, 2019, Outstanding Poster of Physiotherapy UK Prize, Birmingham, 2019.
- James: PGR student prizes at the American College of Sports Medicine 2015 and European College of Sports Sciences 2018 annual conferences.
- Maidment: British Society of Audiology Jos Millar Shield, 2018.
- Leicht: Readers' Choice Award for best review paper of 2018 in *Spinal Cord*.

Collectively, Unit staff have **editorial roles** with over 80 journals. 32 staff are Editorial Board Members (some for multiple journals), 24 are Associate Editors, five have Editor-in-Chief (EIC) roles and one is an Executive Editor (EE). In these latter roles, the influence of Unit staff is clearly visible:

- As EE (since 2019) for *Journal of Sport Sciences (Social and Behavioural Sciences),* **Jackson** introduced initiatives (special issue topics, topical article highlights, identifying areas for invited reviews, appointment of a social media editor) that have increased downloads (+68%) and CiteScore (+72%).
- As EIC (since 2018) for *International Review for the Sociology of Sport*, **Malcolm** has extended the international scope of the editorial board and appointed a new reviews editor. Increases in submissions, downloads, citations and impact factor have followed.
- **Fong** is EIC for *Sports Biomechanics* (since 2014). He has expanded the journal's focus to encompass sport injury and medicine in addition to the previous focus on sports skills and techniques. He has enlarged the editorial team and instigated a double-blind peer review process. This journal has experienced a four-fold increase in submissions, a doubling of downloads and improved journal metrics.
- **Downward** is EIC (since 2018) for *European Sport Management Quarterly*. He set an explicit goal (achieved in 2020) for gender balance among associate editors and board members.
- **Giulianotti** is the joint founding editor of *Frontiers in Sports and Active Living* (launched 2020), which encompasses a wide spectrum of social and natural sciences related to sport, leisure, and active living. Giulianotti led creation of the journal's social science sections, appointed the section editors and jointly authored the journal's foundational 'Grand Challenge' statement.

These roles show Unit staff playing leading roles in shaping the debate and direction within Sport and Exercise Science.