Institution: Brunel University London

Unit of Assessment: 24 – Sport and Exercise Sciences, Leisure and Tourism

1. Unit context and structure, research and impact strategy

a. Overview

Sport and Exercise Sciences research at Brunel has a long and rich tradition in promoting social and natural sciences enquiry. Our 200-year-old heritage can be traced back to Borough Road College that was inaugurated in 1798 and stood as the oldest teacher training college in the British Commonwealth. Momentum in research began to gather in the mid-1960s, but the period of greatest progress and dynamic change has been the past two decades since the move of the subject area from Borough Road in Isleworth to Brunel's Uxbridge campus in 2002, and its establishment as Brunel University London's highest quality-ranked research unit in RAE2008 and REF2014. These achievements have resulted from significant and sustained investment in staff appointments and infrastructure during the four RAE/REF assessment periods to support our development as a leading interdisciplinary, research-intensive unit. During this REF cycle, our spectrum of work has been broadened to embrace the impact of sport and exercise on health and well-being.

Our vision is to be a world-leading unit in terms of research excellence, impact and contribution to society through our research in the realm of sport, exercise, health and well-being. We have established networks with stakeholders across policy and practice domains and public engagement is central to our work. Partnership strategies underpin our established interdisciplinary work to address the changing political, economic and social landscape. Such strategic alliances are also relevant to tackling scientific challenges in the areas of human health, well-being and performance. All staff in the natural and social sciences belong to a research centre or a research theme in the University-wide Institute of Environment, Health and Societies: i) the Centre for Human Performance, Exercise and Rehabilitation (CHPER) led by Baltzopoulos and then González-Alonso, ii) the Centre for Cognitive Neuroscience (CCN) led by Williams and then Kumari and iii) the Welfare, Health and Well-Being (WHW) theme led by Kay and then Mansfield. The College of Health and Life Sciences Research Strategy Group (CHLS-RSG), chaired by the Vice-Dean of Research (Victor), and the Institute for Environment, Health and Societies Research Strategy Group (IEHS-RSG), led by the Institute Director (Jobling), provide overarching strategic direction to maximise cross-centre and institute synergies in the subject area. This research structure has created vibrant, impactful, ambitious and diverse research teams across several subject areas. We are accommodated in a single building that contains all Sport, Health and Exercise Sciences academic staff offices, PGR workspaces, laboratories and research support services. The working environment fosters integration and collegiality. The relative proximity facilitates interactions among subdisciplines and provides substantive opportunities for collaboration.

In 2020, Brunel Sport, Health and Exercise Sciences hosts a vibrant and diverse community of 56 researchers that includes three professors, four readers, 19 mid- and early-career lecturers and researchers, two postdoctoral fellows and 28 postgraduate researchers (PGRs). The quality, significance and impact of our work is evidenced by the increased number of outputs from our laboratories and field settings that appear in high-impact outlets since 2014, research income spent (£1.0M in 2006-13; £1.6M in 2013-20) and PhD completions (27 in 2006-13; 30 in 2013-20) as well as our participation in highly influential expert academic, policy and practice networks and scientific committees. These wide-reaching achievements ensure the sustainability of the unit. Within this template, we describe the environment that has nurtured this increase in the scale, quality and impact of our research, as well as our future plans for addressing global challenges in sport, exercise, health and well-being.

b. Research and Impact Strategy

Achievement of strategic aims and evaluation of REF2014 strategy

The main aim of our 2014-20 strategy was to consolidate our position as one of the leading Sport

and Exercise Sciences research units in the UK by achieving progress across five stated objectives: i) focus direction and priorities of research on areas of excellence and expertise, ii) support and further develop the function of our research groupings through strong management structures, iii) foster high-quality international research collaborations, iv) diversify and increase external research income, and v) increase impact and public engagement.

Our efforts to achieve these strategic objectives were facilitated by the University's continued investment in the promotion and recruitment of high-quality staff and the laboratory facilities and systems necessary to support them. This included a critical mass of PGRs and ECRs (see People section) and the promotions to Chair of Mansfield (Sport, Health and Social Sciences) and Karageorghis (Sport and Exercise Psychology; Subject Lead), to Reader of Hills (Social Sciences) and Kippelen (Exercise and Respiratory Physiology) and to Senior Lecturer of Kerner (Social Sciences), Broadbent (Sport and Exercise Psychology), Gibson (Exercise Physiology), Linthorne "(Biomechanics; 1963-2020)" and Mohagheghi (Biomechanics). These developments have taken place in a dynamic and agile environment of career advancement and staff appointments, which are underpinned by achievements under all five strategic research objectives including a ~60% increase in external income and 84% of publications with international collaborators. Our achievement of strong societal impact is demonstrated through our case studies by i) the implementation of evidence-based strategy for designing, delivering and evaluating community sport to improve public health and well-being (led by Mansfield), ii) the significant changes in policy in mixed-gender football (led by Hills) and iii) the development and implementation of culturally sensitive, international safeguards for children in sport (led by Rhind).

Strategy and plans

The subject area's strategy for impact entails engagement with diverse stakeholders from senior international policy makers to practitioners active at the grass-roots level. The strategy is realised through the formation of research-user reference groups, advisory panels that include stakeholders and industrial partners. The subject area has hosted carefully targeted events to promote the impact agenda among specific audiences (see Section 4). The institutional and subject-level impact strategy has maximised the success of the impact case studies in terms of reach and significance. The three case studies demonstrate the effectiveness of our strategy to maximise impact through mapping research to policy priorities and directly engaging with stakeholders in shaping research. Mansfield's relationships with Sport England and the Department of Digital, Culture, Media and Sport (DCMS) have led to a new national strategy and guidance on implementing and evaluating community sport for health and well-being resulting in Sport England allocating 25% of their annual budget to tackling physical inactivity. Hill's established relationship with the English Football Association has in turn led to five changes in national policy and the increase in age limit for mixed-gender football across the age groups under 11 to under 18. In close collaboration with UNICEF, Rhind has developed and implemented the International Safeguards for Children in Sport, which have changed the safeguarding policies and procedures for 125 organisations worldwide and helped to safeguard the 35 million children who access sport through these organisations.

Our strategy for sustained impact includes a framework for our research plans and priority areas to ensure that they continue to support the vitality and sustainability of our unit's impact across all disciplines for the next REF cycle. To enable our vision, the subject area has a 5-year impact strategy that is comprised of five key elements that assure the sustained significance of our work: 1) intellectual themes are mapped to UK and international social and economic priorities (e.g. in relation to the human health and well-being, healthy ageing, and gender/sex differences agendas); 2) input from stakeholders is elicited throughout the research cycle so that beneficiaries' interests directly inform our research agenda; 3) staff actively initiate and participate in collaborations with external researchers in and beyond the UK who are engaged in work of significant and sustained impact in cognate subject areas; 4) special priority and support is given to developing institutional imperative towards global citizenship; 5) all research impacts are promoted through internal and external activities and media coverage that maximise opportunities to broadcast and disseminate research findings to diverse audiences, thus facilitating and extending impact over time (e.g. seminar series and engagement activities).

Future aims and goals and main strategic objectives over the next 5 years

The subject area has a formal research development strategy that guides the activities of the research centres and institutes and is aligned with the Brunel 2030 Research Strategy and Strategic Plan to strengthen its position as a leading interdisciplinary research-intensive university that delivers economic, social and cultural benefit. The main vision guiding the strategic research objectives for the next 5 years is to focus on our areas of research expertise and excellence in human health, well-being and performance, as well as develop a critical mass of talented researchers who will drive further academic innovation, foster pioneering approaches and forge collaborations with international experts.

At the organisational level, we have built on our proven effectiveness in identifying, supporting and developing excellence across all the research activity of staff. This has been achieved through two specialist research centres in the natural sciences and a research institute theme in social sciences. There is thus a robust framework for research capacity-building activities, including staff development/training, access to internal funding for research collaborations and public engagement. The framework makes for a stimulating and vital research environment that enables researchers at all career stages to achieve excellence.

Our future research activity will primarily align with one of the five strategic challenge areas of the University – *'Health': Planetary Health and Human Health and Well-Being Across the Life-Course*. These processes are essential to becoming a world-class centre of excellence in sport and exercise sciences. The resulting important outcomes will continue to have significant impacts in practice, policy and behaviour. Our main strategic objectives to achieve these aims are:

1. Continued focus on priority areas of research in which we have demonstrated excellence coupled with the potential for societal impact;
2. Further develop our research centres and networks to promote leadership, create opportunities for our researchers and enhance the research environment through integrated and purpose-built facilities;
3. Foster high-quality international research collaborations through innovative and pioneering projects in order to enhance our research environment and research quality;
4. Diversify and increase external research income by increasing external grant applications to research councils as well as industrial sectors in the UK, Europe and worldwide;
5. Increase impact and public engagement through continuous consultation/interaction with users and stakeholders.

Initiatives to support interdisciplinary research

The key development in the natural sciences has been the creation in 2015 of two interdisciplinary research centres, the Centre for Human Performance, Exercise and Rehabilitation (CHPER) and Centre for Cognitive Neuroscience (CNN). CHPER brings together strong research groups in physiology and biomechanics from the previous Centre of Sports Medicine and Human Performance in the Division of Sport, Health and Exercise Sciences, Department of Life Sciences, with a number of staff from the Divisions of Physiotherapy and Occupational Therapy in the Department of Clinical Sciences. The research focus is on cardiorespiratory, vascular, neuromuscular and musculoskeletal health across the lifespan, with particular emphasis on how to improve the functioning of these systems to optimise human performance, health and rehabilitation. CCN draws together sport and exercise psychologists, cognitive neuroscientists, clinical neuroscientists, neuropsychologists and psychopharmacologists to carry out cutting-edge research in several interdisciplinary areas, including motor control, decision making, executive control, sports performance, exercise-related affect, vision, language, written expression and social cognition. The subject area contributes to CCN through the sport and exercise psychology research group. The two new research centres have created impetus within the subject area for the further development of state-of-the art sport and exercise physiology, biomechanics and psychology laboratories and the associated infrastructure and systems.

In the social sciences, the key development has been the establishment of the Welfare, Health and Well-Being (WHW) Theme (IEHS) in 2015. The research theme builds on the robust academic

foundations and strong research culture of the Brunel Centre for Sport, Health and Well-Being formed in 2010-11 under the leadership of Kay and the Centre for Youth Sport and Athlete Welfare formed in 2006 under the late Brackenridge's leadership. The wider remit of WHW is to provide a more inclusive 'home' for the range of social science research undertaken in the subject area, and a more appropriate orientation to emerging research and policy agendas. The theme has become recognised within relevant national and international research communities through the contributions of its members to working parties and expert groups (e.g. Mansfield and Kay Sport England Advisory Group on Evidence; Mansfield UEFA Advisory Group Health and Well-Being; Girginov President EASM), its impact on policy and practice (through funding from ESRC, MRC, sportscotland, Sport England, the FA and Macmillan for work on sport, health and well-being), and its commitment to collaborative work with funders and research users.

The research centres and institutes are active in developing collaborations that can contribute to areas that we would like to develop further. The centres have led a series of events in which world authorities along with potential collaborators debate and identify key research priorities and questions. CHPER has identified priority areas and fundamental questions that need to be answered to advance understanding of the functioning of the human body during exercise and environmental stress. The centre has also developed new interventions to improve health, exercise tolerance, rehabilitation and/or treatment of some inactivity-related diseases. Formal collaborative links have been forged with clinicians, permitting the testing of pioneering invasive cardiovascular, respiratory and musculoskeletal research.

The CHPER Physiology group (Gibson, Godfrey, González-Alonso, Kippelen, Romer) is elucidating the red blood cell-mediated mechanisms regulating limb blood-flow during exercise, environmental stress and heat therapy (for the treatment of cardiovascular disorders), as well as the role of muscle mechanisms and breathing in cardiovascular control. Furthermore, the group explores the role of the respiratory system and its mechanical and reflex cardiovascular interactions as significant contributors to oxygen transport and exercise performance limitations in endurance athletes and people with respiratory diseases. The Biomechanics group (Baltzopoulos [2011-16], Korff [2004-16], Horne, Linthorne, Low, Mohagheghi, Shaheen) is using innovative experimental, imaging and modelling techniques that have been pioneered in-house. The techniques are applied to the study of basic mechanisms of muscle-tendon mechanics *in vivo*, joint function and motor performance in healthy, clinical and sports populations. The overarching aim of the group's work is to improve function in people with neurological or musculoskeletal pathologies and identify neuromechanical predisposition to sport injures.

The CCN Sport and Exercise Psychology group (Bishop, Broadbent, Cocks, Karageorghis, Mullen, Williams [2012-16]) focuses on investigation of the processes and mechanisms underpinning learning, expertise, action and perception to advance understanding and improve the performance and learning of complex, dynamic skills across a range of domains from expert performance in sport to everyday activities such as driving and walking. The group also investigates the application of audio-visual technologies in the context of enhancing exercise-related affect. This tranche of work has behavioural and mechanistic strands. The group has been funded by the BBSRC (Williams; 2012-15) and the ESRC (Karageorghis; 2018-21). Specific objectives of the Sport and Exercise Psychology group are to: i) examine the skills that underpin performance including perceptual-cognitive skills (anticipation and decision making) and motor skills, and the relationship between perception and action, ii) investigate the moderating factors of these skills such as anxiety, pressure, physiological load, age and personality traits; iii) explore how we can enhance the learning of these skills such that they transfer effectively to the real-world environment; iv) investigate the contingencies and mechanisms underlying the application of audio-visual technologies in the exercise domain under the rubric of "exercise hedonics".

The WHW members from the subject area (Bailey, Blair, Hills, Hings, Hunt, Gervis, Girginov, John [2014-20], Kay [2010-19], Kerner, Mansfield, Milner, Rhind [2008-18]) are focused on enhancing the academic quality and significance of our health and well-being research. The group strives to maintain strong policy- and practice relevance as well as espousing a well-defined stakeholder engagement strategy.

Four established areas have momentum and a fifth is earmarked for growth: (i) Health and well-being-related research has expanded rapidly, securing highly competitive funding from research councils, UK government and third-sector organisations for community sport projects involving ESRC-funded PGRs (Mansfield, Hills). This also includes established work on physical activity and chronic disease (Bailey, Mansfield, Hunt), emerging studies of emotional labour and sport/health professional practice (Hings), as well as youth football and mental health (Gervis), for which we have an international reputation and recently attracted ESRC funding for a PGR. (ii) Our safeguarding research is internationally established with research funded to 2016 (Rhind, Kay, Hills), with PGRs completed and ongoing. (iii) Our sport and international development research secured funding for research projects and PGRs and has established an international reputation for understanding the social impact of the Olympic Games (Hills, Girginov). We are initiating a major long-term research agenda across two areas of work (ii and iii) through cross-cultural studies of gender-based violence in European countries (Hills). (iv) Our international reputation for stakeholder engagement has established advanced and applied methodological research focusing on collaborative partnerships, public engagement, and translation and transfer of knowledge for direct socio-cultural and political impact with local, national and international Government and sporting organisations (DCMS, Sport England, FA, IOC; Mansfield, Hills, Girginov). (iv) Our well-established research in the sociology of sport is of high quality and attracts competitive funding for PGRs (ESRC) addressing issues of sport and gender, sport and social justice, sport, community and international development, and the social impact of mega-events (Girginov, Hills, John, Mansfield). (v) Alongside these four established areas, we are developing a fuller programme of research in PE, coaching and pedagogy (Blair, Kerner), with studies on professional practice and learner experiences in school-based learning environments.

Support for an open research environment
Open access to research is of critical importance to maximise the dissemination of the unit's research. We actively encourage all members of staff to share and manage their research data according to the specific requirements in the natural and social sciences. All members of staff deposit their accepted manuscripts in the Brunel's Research Database to make the publications open access via the Brunel University Research Repository. Appropriate consideration of research reproducibility is also actively promoted, encouraging staff and PGRs to make the data that support their research outputs publicly available using Brunel Figshare facilities, which currently contain >220 items.

Supporting a culture of research integrity
Research integrity in our practice, policy and procedures is one of the unit's core values. The unit supports a culture of research integrity by ensuring that all research conducted by its members of staff and PGRs is performed according to the ethical, legal and professional procedures and policies included in the Brunel University London Research Integrity Code. This Code draws together all the University policies regarding research integrity matters. PGRs are required to complete a research integrity online module, prior to applying for ethics approval for their research projects.

2. People

i. Staffing strategy and staff development

The subject area aligns with the University staffing policies that aim to promote world-leading research by providing all staff with high-quality support appropriate for their career stage within an inclusive and collegial research environment. Strategic staff recruitment is core to the subject area's research strategy. The primary research criterion for all academic appointments is 3*/4* research profile/potential appropriate to career stage: (i) All full-time early- and mid-career appointments during the assessment period have contributed to at least one research output (2015 Gibson; 2015 Broadbent; 2015 John; 2017 Kerner; 2018 Hings; 2019 Hunt; 2019 Low; 2020 Bailey; 2020 Mullen); (ii) From 2014 the subject area adopted a strategy for high-performing members of staff to be internally promoted (i.e. six to senior lecturer [30% female], two to reader [100% female] and two to professor [50% female]) and recruit externally outstanding early- and mid-career members of staff of appropriate subject specialism to enhance research capacity in

our areas of expertise. The number of full-time permanent members of staff in the subject area has increased from 24 in 2013 to 26 (77% UK, 12% EU, 8% overseas) in 2020, which has helped consolidate the vitality, diversity, excellence and sustainability of our unit.

Staff retention has been analogous to the sector, with the main reasons for departure being either retirement or career advancement. A number of senior staff that held leadership positions entered retirement and took emeritus positions (e.g. Profs Capel and Brackenridge OBE) whereas others advanced their careers by taking leadership positions in prestigious UK and overseas institutions (e.g. Baltzopoulos, Head of Research Institute for Sport and Exercise Sciences, LJMU; Kay, Head of Sport, University of Stirling; McConnell, Head of Research and Professional Practice, Bournemouth University; Williams, Chair Health, Kinesiology and Recreation, University of Utah). Junior academics and ECRs have also progressed their careers with leadership positions in industry (Korff, Head of R&D, Frog Bikes) or academic positions in high-ranking universities (e.g. Rhind, Reader at Loughborough University; Young, Senior Lecturer at the University of Exeter).

Support for early-career researchers and development at all stages of research careers
The subject area's support framework for ECRs aligns with the principles of the Concordat to Support the Career Development of Researchers. Newly appointed lecturers and researchers are assigned a mentor, have reduced teaching and administrative responsibilities, and can receive University funding through the Brunel Research Initiative and Enterprise Fund (BRIEF) in accord with a policy to provide optimal support for their research. The research mentoring scheme includes yearly meetings for each researcher with the director of their research institute theme/centre (González-Alonso, Kumari or Mansfield). Individual Research Plans, introduced for all staff at the beginning of the REF2014 cycle, are reviewed by the Research Institute Theme Leaders and Centre Directors and form part of the staff annual performance development reviews. Our Research Institute and Centres offer a wealth of subject-specific activities for staff and PGRs organised on a weekly, monthly or termly basis, including joint events (e.g. cross-disciplinary seminars) to bring all staff together and encourage interdisciplinary approaches to sport, health and exercise-related issues. Specialist speakers are invited to deliver additional sessions addressing overarching issues such as research impact or grant capture.

The subject area actively promotes a collaborative and supportive approach to research activities. Annual performance targets for professors and readers include requirements to collaborate with junior colleagues for research outputs and funding bids. ECRs with limited prior research experience have been supported in the writing of peer-reviewed outputs and funding bids as well as supervision of PGRs. Several of the subject area's early-career staff have benefited from the University's strong central support for staff development in research. Gibson, Broadbent, Kerner, Cocks and Hings received £15k in 2016/17, 2019/20 or 2020/21 from BRIEF to develop their respective research programmes.

Gibson used the funding to investigate the role of heat shock proteins in the molecular pathways underlying skeletal muscle vascular and metabolic responses to passive heating. Broadbent used his BRIEF funding to elucidate the impact of contextual priors and anxiety on performance effectiveness and processing efficiency in relation to anticipatory judgements. John has undertaken a systematic analysis of the impact of local authority outdoor gyms in London parks located in socially deprived areas. Cocks is examining the impact of cognitive demand on maladaptive stepping behaviours that may increase the chances of falling in older adults. Kerner has developed a physical education-based curriculum to support positive body image and mental health in children and adolescents. Lastly, Hings will develop and evaluate an educational intervention to promote knowledge and skills in relation to emotional labour, professional practice, and mental health in the allied health professions.

Following a recent maternity leave, Shaheen received the Athena SWAN Research Award in 2019-20 (£11k) to create an open-source database of upper-limb and shoulder movement for clinical utility, and thus help her establish this line of research at Brunel. The subject area has also benefited from University provision for research leave to support research development and enable staff to achieve impact from their research (Hills, Karageorghis, Romer). Leave is used

according to individual and research centre or institute theme priorities to support individual output, impact case study, grant development, KTP and the furtherance of academic collaborations (e.g. Hills finalised content and evidence for her impact case study whereas Karageorghis and Romer undertook collaborative research projects at the laboratories of Prof Ekkekakis at Iowa State University, USA, and Prof Sheel at the University of British Columbia, Canada, respectively). The subject area recognises and rewards staff for carrying out research and achieving impact by protecting time for research and supporting them through the academic promotions process. For example, all lecturers who started their academic lifecycle 4-5 years ago and met their research and teaching targets have been promoted to Senior Lecturer (e.g. Kerner, Broadbent, Gibson). Moreover, Prof Mansfield has received the Brunel Research Policy Impact Award for her work on community sport.

ii. Research students:

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Registered students	**27**	**25**	**22**	**19**	**24**	**18**	**20**
Percent Female	**26%**	**28%**	**32%**	**32%**	**46%**	**56%**	**65%**

Recruitment of PGR students
The subject area has a long tradition of postgraduate scholarship and regards PGRs as central to the vitality and sustainability of our academic community. Under our enhanced research structure, we have strengthened this core area of work. We have been proactive in recruiting PGRs that specifically support work around staff and research groupings' core themes. We have increased supervisory capacity through new appointments and appropriate staff.

From 2013 to 2020, there were 30 PhD completions, and our current PGR population has increased to 28. Two additional PhD degrees (Barratt, Travers) were awarded after completing data collection in collaborating international institutions and were not included in the 30 awards return in the REF4a form. There was also a clear increase in the quality of applicants, attracted by the increased profile of our team of researchers and the vibrant research environment. Moreover, there has been a significant advancement in the number of high-quality female PGRs, increasing from 26% to 65% over the REF period. Other demographic characteristics have remained as White (83-100%), with no known disability (82-91%) and from the UK and EU (70-94%).

Recent graduates show an upward trend in the quality of research outputs undertaken in our laboratories and field settings. Graduates have proceeded to prestigious postdoctoral fellowships at national and overseas institutions (e.g. University College London, University of Exeter, University of São Paulo, University of California) or have taken lectureships at UK and overseas institutions (e.g. Sheffield Hallam University, Singapore Sports School, Roehampton University, Kingston University London, Universidade Federal do Rio Grande do Sul, Northumbria University, Bradford Teaching Hospitals NHS Foundation Trust).

During the assessment period, **12 postdoctoral researchers** from across all research teams (Kalsi [2008-14]; Waugh [2011-14]; Johnston [2011-2015]; Young [2013-15]; Gonzales [2013-2016]; Simpson [2014]; Noorkoiv [2015-18]; Watanabe [2016-18]; D'Innocenzo [2018]; Gray [2019-20]; Kuan [2019-20]; Mouchlianitis [2020-2021]), **23 research assistants** (hired once or more times for 3 months – 2 years) and **2 overseas doctoral interns** (University of British Columbia, Springfield College, USA) have substantially contributed to the vitality and sustainability of our research environment through their support of PGRs, day-to-day management of the research laboratories, data collection, analysis and stakeholder engagement in externally funded social science research, organisation of seminars and writing of scientific papers and grant proposals.

Evidence of studentships from major funding bodies
The prestigious ESRC-funded Grand Union Doctoral Training Programme (ESRC GUDTP), a partnership that involves Brunel University London, Oxford University and the Open University has led to excellence and innovation in social science research training in a bespoke Health and Well-Being pathway (led by Mansfield). Since 2016, the programme has supported five PGRs at Brunel (Chowdhury, Wray, de Vos, Cook, Pickford). The high quality of these PGRs has led to additional funding being awarded in a highly competitive cross-institution schemes (The Incubator Award – Chowdhury) and the delivery of four-day research schools each year for advanced qualitative methods. Recruitment of PGRs through our ESRC GUDTP represents a core aim for widening participation in relation to career stage and partnership experience, age, gender and ethnic background. The GUDTP enables those awarded and other PGRs in the Health and Well-Being pathway to apply for ESRC postdoctoral fellowship funding and our first two applications will take place in 2021. These collaborative and interdisciplinary projects with Oxford University and Sport England will extend and enhance our work on community sport, women, international development and public health.

To enhance the multidisciplinary culture over the REF period, the University and the College have supported excellent candidates with either an *Isambard Kingdom Brunel Research Scholarship* or a *College PhD Bursary* (Tiller, Simpson, D'Innocenzo, Hall, Jones, Fasbender, McDermott, Burnett, Gredin, Marshall, Illidi, Castro, Crawley, Smith). Excellence in the subject area has also received recognition through the award of a studentship on community physical activity and well-being in nuclear test veterans through the Centre for Health Effects of Radiological and Chemical Agents (Prescott) and international studentships from: i) the *Brazilian Ministry of Education Science Without Borders* PhD programme (Bigliassi, Wilhem, de Aguiar Greca), ii) the *Portuguese Foundation for Research and Technology* (Vargas) and iii) the *International Inspiration Charity* (Owusu-Sekyere).

Our PGRs have been highly successful during the REF period in obtaining internal and external recognition for their high-quality research. Thirteen PhD students have received the Vice-Chancellor's Travel Prize, which supports conference attendance and are competitively awarded each year (e.g. Tiller and Simpson [2014]; D'Innocenzo, Gredin and Hall [2015]; Bigliassi, Ellmers and Wilhelm [2016]; de Aguiar Greca, Hall, Ellmers and Bigliassi [2017]; Marshall [2019]). Moreover, Trangmar, Chiesa, Jones, Bigliassi and Wittels received a Vice-Chancellor's Doctoral Research Prize in 2014, 2018 and 2020 whereas Tiller, Ellmers and Marshall won the Brunel University London Research Student Conference Prize in 2014 and 2016. Bigliassi also received the Brunel Graduate Association Prize in 2018. In 2019, Smith was awarded a Brunel University London public engagement grant to support stakeholder engagement and impact activities and most recently a British Sociological Association PGR conference prize and the Maureen Harrington Award (Leisure Studies Association) for ongoing work on coproduction and participatory research. In 2020, Wittels also received a University public engagement award for work on addressing physical activity, diet and health issues with women living in deprived areas. Most recently (2020), Smith was awarded the prestigious national Cumberland Lodge Scholarship for her work on youth migration and leisure. Lastly, Trangmar and Bigliassi won an equal 5th Young Investigators Award at the 2015 and 2017 ECSS Annual meeting, respectively. In addition to the Vice-Chancellor's Travel Prize, the College has a Research Fund to support PGR students who do not have conference funding through the terms of their studentship. This requires the submission of an online application detailing how the funds will help to develop their careers.

Monitoring and supporting PGR students
The Brunel Graduate School (see institutional-level environment statement) and the College provide strong support to the unit's PGRs. The College PGR Office organises a tri-annual induction programme that includes a comprehensive programme of talks on the Code of Practice for Research Degrees, Research Ethics and Integrity Code, Health and Safety Rules and Regulations, organisation and scope of the Graduate School, Library Resources, Union of Brunel Students and planning for the PhD. The quality of supervision is enhanced through the policy of appointing a supervisory team. This can only be led by a staff member who has already overseen a successful completion (Principal Supervisor); the second supervisor may be less experienced.

An independent research advisor with expertise in a different research area is also part of the supervisory team and has the task of supporting the career development of the PGR. The robust process provides broader support for PGRs and facilitates staff development.

The well-being of PGR and staff can be germane to the vitality and sustainability of the research unit. The University offers support to researchers and staff with mental health conditions (e.g. depression, anxiety or eating disorders) through a team of counsellors and mental health advisers. Furthermore, researchers and staff with a disability, a long-term medical condition or a specific learning difficulty, such as dyslexia, are supported by advisers from the Disability and Dyslexia Team.

Development of PGR skills and preparation for future careers
PGRs make an outstanding contribution to the research culture of the subject area and are treated as junior members of staff. Their offices are located adjacent to staff offices, which ensures daily interaction and complete immersion in the research environment. Specific collaboration and integration activities include:

- Co-authoring research outputs – a large proportion of research papers produced by Sport, Health and Exercise Sciences staff during the present cycle were co-authored/first-authored by PGRs;
- Collaboration on funding bids – experienced PGRs have contributed significantly to the preparation of funding proposals and have been named as co-applicants;
- Appointment to current funded projects – PGRs are frequently employed to undertake fieldwork and data processing;
- Participation in local/national/international conferences and specialist workshops hosted by the subject area, College and University.

Regular research seminars hosted by the research institutes and research centres are scheduled to present and receive feedback from their peers and staff in a friendly/supportive environment. PGRs are represented on the Student Experience Committee of the College. Their contributions have made positive changes to the University's Code of Practice for Research Degrees.

iii. Equality and diversity
The subject area is actively promoting equality, diversity and inclusion in all its research activities, which is reflected in the submission of 100% of the academic staff. We ensure that staff and students follow the appropriate academic standards and have equality of opportunity to participate in research. The equality implications of the Concordat to Support the Career Development of Researchers, the Athena SWAN and the Gender Equality Charter are also promoted and implemented at subject area level. The unit's submission (all FTEs in the unit have permanent contracts) shows a balance in the proportion of research outputs across the three **unit's research groupings** (2.4 - 2.8 average outputs used per FTE in CHPER [10 FTEs], WHW [10 FTEs] and CCN [6 FTE]s), **gender** (34% outputs used from female staff, who constitute 39% of all staff), **age** (all age groups within 5% of the proportion of the population submitted < 30 yr 3%, 30-39 yr 33%, 40-49 yr 18%, 50-59 yr 39%, 60-69 yr 9%), **ethnicity** (85% staff are white, used outputs 87%) and **declared disability** (disability declared staff 4%, used outputs 3%). Our Equality Impact Assessment indicates that the research outputs are a well-balanced representation of the protected characteristics and contractual positions of staff. All our research is conducted in human participants, their tissue samples or their data. We therefore make sure through our rigorous online ethics processes that there is equality of opportunity for all to participate and that no group with protected characteristics is excluded, unless there is a sound research (or scientific) reason to exclude them.

Support for equalities and diversity and maintenance of standards of research quality and integrity
All work in the subject area is permeated by a strong equality and diversity agenda. To maintain good practice, Equality, Diversity and Inclusion is a standing item on the agenda of the subject area's monthly meetings, as well as the Department and College Management Board meetings. Several specific measures are in place in the subject area to support early-career development and progression. These include a policy of recruiting ECRs that dovetails with a promotion

initiative. The subject area also supports flexible and remote working policies. These allow staff to request a combination of home and on-campus working in order to balance their professional commitments with other priorities, such as childcare. These policies also facilitate the return of staff and PGRs from a period of leave/abeyance (including parental leave) or ill health. PGRs are permitted a period of abeyance in extenuating circumstances (e.g. illness, family crisis, unforeseeable problems) or in situations of maternity/paternity. Periods of abeyance do not count towards the maximum period of study. The University and the Department of Life Sciences, where our subject area resides, have achieved an Athena SWAN Bronze Award for the efforts to promote equal opportunities for women in science-related subjects. High standards of research quality and integrity are maintained through formal and informal mechanisms for scrutiny:

- We foster a supportive research environment to nurture confident but self-critical researchers. All grant applications are reviewed internally by at least two internal independent reviewers. A specialist advisory group from CHLS-RSG and IEHS-RSG members provides advice and assistance to junior members of staff and helps them to develop high-quality funding proposals. Regular research institute and centre seminars and meetings facilitate the provision of feedback and advice from more experienced members.
- Ethical standards are enforced through the College and University Research Ethics Committees, which implement a well-honed online process of ethical approval. A Health and Safety Officer works closely with the College's Research Ethics Committee (e.g. with obligatory risk assessments for all research projects).
- We benefit from our experience in leading research in challenging areas including work with children, victims of abuse, vulnerable people and in culturally sensitive contexts. The subject area also provides a specialist programme of postgraduate student training related to ethical issues in sport research, reinforcing the PGR ethics education offered by the Brunel Graduate School.

3. Income, infrastructure and facilities

Levels of research income exceed the previous REF cycle by ~60% and include grants from ESRC, Football Association, IOC, International Inspiration Foundation, Caribbean Sport and Development Agency, England Rugby, The Royal National Orthopaedic Hospital, The Physiological Society, Rugby Football Union, Macmillan Cancer Support, Cancer Research UK, Pace Tune LLC, Street League, West Ham FC, Badminton World Federation, Medical Research Council, Street Games, Diabetes UK and recently ERASMUS+ programme. The level of research income generated by the subject area and the experiences/outcomes of PGRs are regularly monitored via the CHLS-RSG and IEHS-RSG.

Strategy for generating research income

In line with the Research Councils and Brunel's increased emphasis on interdisciplinarity and impact, The Division of Sport, Health and Exercise Sciences is embedded in the Department of Life Sciences and College of Health and Life Sciences. This organisational structure enables cross-fertilisation of ideas as well as theoretical and methodological synergies (through capacity building/training workshops, seminars and grant writing activities) with Psychology, Biosciences, Environmental Sciences and Clinical Sciences. This interdisciplinary structure has yielded an increased critical mass and funding applications in human health, well-being and performance with significant success in highly competitive and prestigious funding calls.

For instance, collaboration with staff in the Department of Clinical Sciences has resulted in successful project grants bringing together researchers from 1) social sciences in sport, health and well-being to generate, translate and disseminate best evidence to lead policy and practice on community sport for health and well-being enhancement (the Sport England Health and Sport Engagement Project [Mansfield, Kay, Fox-Rushby, Anokye; £353k] and the ESRC What Works for Well-Being strategy project [Victor, Mansfield, Kay, Meads, Longworth; £198k and Mansfield, Victor; £76k]; total income £628k), 2) social sciences and biomechanics to assess participants' experiences, challenges, benefits and the risk of injury in mixed-gender football (the FA Mixed Gender, Risk and Health Project [Hills, £120k]) and 3) biomechanics and physiotherapy (Ryan, Korff, Kilbride, Baltzopoulos) to characterise and gain mechanistic insight of the impact of strength

training in adolescents with cerebral palsy (STAR project supported by children's charity Action Medical Research and the Chartered Society of Physiotherapy Charitable Trust; total income £250k).

Organisational structure supporting research and impact
The Welfare, Health and Well-Being theme and the Centre for Human Performance, Exercise and Rehabilitation and the Centre for Cognitive Neuroscience and their partnerships provide the organisational structure supporting research that has led to the delivery of socio-economic impact.

Dedicated facilities with state-of-the-art equipment for delivering high-level collaborative activities (e.g. workshops, town-hall meetings, sandpits, public engagement events) can be accessed by social science researchers and are located both within the Department building and with shared access across the University. This includes access to digital media recording/editing services, design/print facilities and interview/focus group rooms. The infrastructure and our established approach to internal and external collaborative partnerships have enabled our success in highly competitive research funding and the development of the submitted impact case studies. It has also facilitated projects examining socio-cultural and political issues and the impact of sport on health and well-being. These were completed in partnership with national and international organisations, such as the DCMS, Sport England, StreetGames, the FA, the IOC, Macmillan Cancer Support, Diabetes UK and ERASMUS+ partners. Moreover, public and citizen groups have been studied. These facilities and infrastructure together with the expertise gained in the REF2014 cycle in relation to the unit's world leading research in child and athlete welfare and sport and international development have been used to support our current impact case studies. The same strategy whereby the current case study holders mentor future ones will be utilised in the next REF cycle.

The further development of state-of-the-art facilities in the Department of Life Sciences (including laboratories for biomechanics, psychology/motor control and invasive human cardiovascular and respiratory work) facilitate collaboration with other world-class Brunel research centres and institute themes. The infrastructure at our disposal through local collaborations and the access to patients and clinicians through the new Brunel Medical School and the Brunel Partners Academic Centre for Life Sciences (a pioneering partnership involving Brunel University London, the Hillingdon Hospital NHS Foundation Trust and the Central and North West London NHS Foundation Trust) allow us to pursue an ambitious, innovative and structured research strategy in line with the remit of the UK Research Councils and Charities. This enables exploration of basic mechanisms pertaining to physiological, psychological and biomechanical function and their impact in health and disease. Multiple research techniques, approaches and models can be employed from the human organism as a whole to organ, tissue, cellular and molecular levels. These include the 3T real time, high resolution functional magnetic resonance imaging (*f*MRI) unit shared with the Royal Holloway University for psychophysiological research and intravital microscopy and animal facilities for *in vivo* investigation of microcirculatory blood flow regulation studies.

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

Our commitment to the sustained support for research collaborations, the development of relationships with key research users and beneficiaries and the continuous improvement of our methodological and theoretical approaches have allowed us to make important contributions to the research base, economy and wider society during the period 2014–20.

High-quality research collaborations, networks and partnerships
The subject area has strong links with local, national and international governing bodies of sport, hospitals and professional sports clubs, though which research is developed, conducted, translated and disseminated and impact is achieved. Notably, the subject area staff and PGRs have collaborated extensively with governing bodies of sport. Examples include: 1) the work by Girginov committed Routledge to a sustained Olympic-related publication programme. The impact of the LOCOG knowledge transfer project has resulted in the engagement of the Sochi 2014

Winter Olympic Games Organising Committee in supporting a similar project. Recently, Girginov and collaborating partners have been awarded ERASMUS+ funding to form sport managers and leaders' employability across Europe (€370k) and develop an interactive online tool to enable them to balance the societal benefits of sport with economic reality (€400k). These projects will likely have a large impact in the sector; 2) Mansfield has promoted the sport and public health and well-being agenda through the development of evidence-led policy recommendations on the role of community sport in public health and well-being in partnership with the DCMS and Sport England; 3) Hills, John and Mansfield's research–practice partnerships with the FA have informed the development of sustainable programmes to engage inactive young women, disadvantaged young people and inactive people across the life-course in sport, and to use sport to facilitate the employability of young people; 4) Rhind, Hills and Kay have carried out the international multidisciplinary primary and secondary research into developing and implementing culturally sensitive International Safeguards for Children in Sport in collaboration with UNICEF and 125 organisations worldwide. The Brunel International Research Network for Athlete Welfare (BIRNAW) founded in 2010 to foster international collaboration comprises > 50 active researchers in 16 countries and offers a strategic network for ongoing work on safeguarding and gender-based violence; 5) Gibson has conducted research on the physiological adaptations to exercise heat acclimation and is advising the English Institute for Sport on heat alleviation strategies for athletic performance for the Tokyo Olympic and Paralympic Games; and 6) González-Alonso, in collaboration with the Gatorade Sports Science Institute, USA, and the Aspetar Orthopaedic and Sports Medicine Hospital, Qatar, has conducted research on the impact of hydration on physiological function and fatigue mechanisms, that have contributed to the development of practical hydration solutions for sports.

The research outputs reveal a steady rise in the number of collaborations with highly ranked universities. Eighty-four percent of our research outputs are published with international collaborators and leading UK universities (e.g. British Columbia, Copenhagen, Iowa State, Karolinska Institute, Sydney, Utah, Southern Queensland, Oxford, Imperial College London, UCL, Loughborough, and University of Bath). The international research profile of researchers in Sport, Health and Exercise Sciences is also acknowledged through keynote or invited presentations to international conferences, contributions to many professional, scientific, governing body and clinical meetings, workshops and symposia and key international collaborations. For example, González-Alonso has a long-standing research collaboration with the University of Copenhagen and Rigshospitalet that concerns integrative physiology of exercise, resulting in multiple world-leading research outputs, including work with Prof Secher on the function of the human brain, heart and skeletal muscle during exercise. Romer has an ongoing collaboration with the University of British Columbia, Vancouver (Prof Sheel) following a one-term research leave in 2013-14. The visit led to the creation of training opportunities for research students and the establishment of experimental protocols for studies at Brunel. These interactions with academics and research students culminated in grant capture (Canadian Lung Association) and seven world-leading or internationally excellent research outputs in the current REF cycle. Romer has also collaborated with Prof Goosey-Tolfrey, Loughborough University, in research addressing the respiratory system limitations to exercise performance in athletes with spinal cord injury. For the last decade, Kippelen has collaborated with Prof Anderson, Sydney Medical School, University of Sydney and Prof Dahlén from the Experimental Asthma and Allergy Research, Karolinska Institutet, Sweden, in projects investigating the mechanisms and biomarkers of exercise-induced bronchoconstriction. Godfrey has worked with Prof Quinlivan at the MRC Centre for Neuromuscular Diseases, UCL, in projects investigating the influence of physical activity on McArdle disease. Shaheen has ongoing collaborations with Prof Bull and Dr Kedgley from Imperial College London and Dr Catalfamo from the National University of Entre Ríos, Argentina, to investigate the role of structural and movement variability in joint function. Mohagheghi has collaborated and published with Prof Baltzopoulos now at LJMU. In CCN, Karageorghis has published regularly with Prof Terry from the University of Southern Queensland, Australia, Prof Ekkekakis from Iowa State University, USA, Prof Hutchinson from Springfield College (MA), USA and Prof Delevoye-Turrell from the University of Lille, France, whereas Bishop has collaborated extensively with Prof Williams, now at the University of Utah, USA.

Contributions to the economy and society

The main beneficiaries and audiences for Sport, Health and Exercise Sciences research include sports governing bodies (e.g. the IOC, Sport England, DCMS, Sport England, Streetgames, the FA), sports industry; government agencies at local and transnational level; children in sport; athletes, coaches, and practitioners; older adults; charitable organisations; the commercial sector; professional associations related; the Olympic movement; international sporting bodies; the NHS; and the general exercising public. By way of illustration of the aforementioned beneficiaries/audiences, the director of WHW (Kay and then Mansfield) along with other members have fulfilled advisory roles in national and international settings (e.g. sportscotland, the IOC, Sport England, DCMS, UEFA).

The subject area has developed ties with the sports industry that have enabled the research and development of new technology. Examples include: 1) Karageorghis' work on the effects of music in physical activity has been heavily leveraged by multinational companies to support the marketing of music albums (e.g. with Ministry of Sound), mobile phones (e.g. with Sony Ericsson), MP3 players (e.g. with Nike) and mass-participation events (e.g., with IMG); 2) Korff's work with the PhD student Karl Grainer on bicycle setup in children has been heavily leveraged by Frog Bikes, the UK's leading children's bicycle manufacturer. Specifically, this work has informed the design of children's bicycle frame geometry as well as a unique children's bike fitting tool (FrogFit); 3) Girginov run a series of Brunel-funded research seminars with Sport England, Mintel (Market Research Group) with collaborators from George Washington University (USA) and published a systematic review on the role of wearables for promoting social interactions. This forms the basis for ongoing research on how to better use wearables to encourage social interactions, which are critical for changing people's attitudes and behaviours.

Sport and Exercise Sciences research has had beneficial impacts for a wide range of vulnerable or minority groups. Examples include: 1) Rhind's development of the International Safeguards for Children in Sport and the culturally sensitive implementation guides, changed the safeguarding policies and procedures of the 125 organisations worldwide and policy goals of the Commonwealth Secretariat and the United Nations, helping safeguard the 35 million children who access sport through these organisations; 2) Sociological interdisciplinary work by Hills, Horne and Baltzopoulos for the Football Association (FA) addressed the issue of gender segregation/inclusion in youth football. On the bases of the research, the FA changed national policy regarding the age limit for mixed-gender football for the age groups under 11 to under 18; 3) Mansfield has promoted the sport and public health and well-being agenda through the development of evidence-led policy recommendations on the role of community sport in public health and well-being in partnership with the DCMS and Sport England.

Contribution to the sustainability of the discipline

The subject area has organised a number of national and international conferences. In 2018, Mansfield chaired the organising committee of the inaugural Well-Being in the UK conference attracting circa 200 delegates to Brunel University London and a further 200 engaging through the live stream. Delegates represented academia, policy and practice interest in the areas of culture and sport, work, and communities. In 2015, Girginov organised an international conference at Brunel on leveraging the Olympic Games. WHW hosts regular seminar series through central University support for knowledge exchange including national seminars on public engagement, and digital wearable technologies attracting academic and policy experts. In 2020, PGRs in the social sciences organised and hosted the British Sociological Association Sociology of Sport Study Group conference for postgraduate research. In 2020, Hills coordinated an International Conference on Safeguarding Children for 300 delegates at Brunel, in partnership with Keeping Children Safe.

Notable contributions to the research base

The unit has made notable contributions to a variety of fields of sport and exercise sciences: i) circulatory limitations to exercise and blood flow regulation during hyperthermia and exercise (González-Alonso), ii) respiratory limitations to exercise and pulmonary sex differences (Romer), iii) pulmonary function with systemic and airway dehydration (Kippelen), iv) perceptual-cognitive

skills in expert performance (Bishop and Broadbent), v) influence of psychological factors on fall risk in older adults (Cocks), vi) impact of hedonistic (pleasure-oriented) approaches on exercise experience to promote long-term exercise adherence (Karageorghis), viii) anxiety and attentional focus (Mullen), ix) sports (throwing) performance (Linthorne), x) musculoskeletal *in vivo* function and biomechanics (Mohagheghi), xi) sport and the public health and well-being (Mansfield, Hills, John), xii) safeguarding children in sport (Rhind, Hills, Kay), xiii) sport international development: Olympic Studies development of the Olympics knowledge legacy (Girginov).

Indicators of wider influence and contributions to professional associations and learned societies
Numerous members of Sport, Health and Exercise Sciences serve on the editorial boards of international journals. Girginov, President of the EASM, *International Journal of Sport Policy and Politics* and *European Sports Management Quarterly* editorial board member, Editor of Routledge Major Work series titled *Olympic Studies*. González-Alonso, member of the ECSS Scientific Committee (2016-), *European Journal of Applied Physiology* advisory board member, invited speaker at the Gatorade Sports Science Institute (GSSI) Expert Panel meeting (2017). Mansfield, Managing Editor, *Annals of Leisure Studies*; editorial board, *Leisure Studies Journal* (2012-), *Qualitative Research in Sport, Exercise and Health* (2013-) and *International Journal for the Sociology of Sport*. Romer (editorial board member, *European Journal of Sport Science* (2014-); Associate Editor, *Applied Physiology, Nutrition and Metabolism* (2014-); Karageorghis (Sport and Exercise Psychology editorial board member, *Journal of Science and Medicine in Sport*, 2009-; EB member, *Journal of Sports Sciences*, 2006-); Linthorne, editorial board member, *Sport Biomechanics*. Kippelen, Member of UK Anti-Doping Respiratory Steering Group (2018-). Karageorghis is one of only two British sport scientists to have led two BASES Expert Statements. The first, titled “The BASES Expert Statement on the Use of Music in Exercise”, has been the most viewed of all BASES Expert Statements during the REF census period while the second, titled “The BASES Expert Statement on the Use of Music for Movement among People with Parkinson’s”, was published in February 2020. Three researchers (Godfrey, Karageorghis, Romer) are fellows of BASES. Romer is a fellow of The Physiological Society, González-Alonso a fellow of the ECSS and Bishop and Karageorghis associate fellows of the BPS. Our strategy is that more members of staff work closely with relevant learned societies to increase the impact and external recognition of their research.