

Institution: University of Kent
Unit of Assessment: 24: Sport and Exercise Sciences, Leisure and Tourism
<p>1. Unit context and structure, research and impact strategy</p> <p>In the last decade, the School of Sport and Exercise Sciences (SSES) at the University of Kent has emerged as a key centre for sports and exercise science research in the UK. The significant increase in research outputs and research income, as well as a substantial increase in interest from industry, Government, and the public in our research, demonstrates that the strategic decision of the University to invest in the School has paid off. The School was originally founded as the primarily teaching-focused Centre for Sports Studies in 2001. Strategic growth and a specific focus on research activity led to it becoming a School in its own right in 2012. The School now has 12 research-active full-time equivalent staff (FTEs), in addition to 32 postgraduate research (PGR) students. Furthermore, teaching-focused staff have completed PhDs in order to develop and maintain a research-led teaching ethos within the School. The School was submitted to the REF for the first time in 2014, with 11 FTEs contributing to the submission. A key strategic aim of the School was to establish and sustain a world-leading research culture in key areas of strength. These strengths are reflected in the three interdisciplinary research groups that exist in the School: the Endurance Research Group (ERG; core members include Burnley, Davison, Fullerton, Hopker, and Mauger; members from other SSES groups are also highly active within this group, including Dickinson and De Coninck); the Health Research Group (HRG; core members include De Coninck, Dickinson, Hambly, and Peppiatt-Wildman); and the Sports Legacies and Society Research Group (SLSRG; Kohe, Koutrou, and Pappous).</p> <p>Research Structure</p> <p>The School's Education and Research (E&R) staff base is composed of 3 Professors, 3 Readers, 2 Senior Lecturers, and 4 Lecturers. Female staff account for 33% of the headcount, with 1 Professor, 1 Senior Lecturer, and 2 Lecturers being female. The School currently employs 1 early career researcher (ECR) in their first academic role (Fullerton). In addition, we have appointed a total of 8 research associates and assistants on short-term contracts supported by successful grant capture during the REF2021 census period. The School's research is led by the Head of School (Davison), who in turn is advised by the Director of Research and Innovation (Mauger), the Director of Impact and Engagement (Dickinson), and the REF Coordinator (Burnley). This group constitutes the leadership team of the School's Research and Innovation Committee, which is tasked with collectively developing and monitoring the School's research strategy, infrastructure, and facilities in consultation with all research-active staff. The Research and Innovation Committee was formed to ensure representation from each of the School's research groups, plan strategic targeting of grant capture, and ensure coordination of the REF submission. Individual Research Plan discussions with members of staff are led by Mauger and Davison, with support and targets for staff agreed by the Research and Innovation Committee and aligned with the School's Research Strategy.</p> <p>Endurance Research Group (ERG)</p> <p>The Endurance Research Group (ERG) was established as the primary research group of the School in 2011, and has demonstrably conducted world-leading research into the physiology, psychology, and biomechanics of endurance performance (as evidenced by the outcome of REF2014, as well as outputs and impact case studies presented in the present submission). We define endurance broadly as the ability to sustain exercise using primarily oxidative phosphorylation as an energy source, and resist fatigue, in all its forms, in doing so. During the REF2021 census period, the ERG has explored a diverse research agenda, including, <i>inter alia</i>: investigations on muscle torque complexity during fatigue (Burnley); exercise-induced pain (Mauger); mental fatigue, psychological, and training-related interventions to enhance endurance (Marcora, Mauger, Hopker); the use of nutritional supplements to maintain optimal immune system function during endurance exercise (Davison); and respiratory responses to provocative</p>

environments during endurance exercise (Dickinson). This research has led to widespread media coverage and significant research income, outputs, and impacts (see below).

Health Research Group (HRG)

The Health Research Group (HRG) has developed significantly in the last five years. Its researchers focus on investigating a broad range of health- and sports therapy-related research topics including knee injury rehabilitation (Hambly), as well as the role of exercise in the treatment and management of chronic diseases, such as osteoarthritis (Mauger, Davison), Parkinson's disease (Davison), and COPD (Dickinson). The HRG also has specialism in the anatomy and physiology of thoracolumbar fascia in the context of lower back pain (De Coninck). Dickinson has also collaborated with a range of colleagues on a project to measure respiratory function using motion capture in order to identify dysfunctional breathing in health and disease, with implications for both elite athletes and asthma patients.

Sport Legacies and Society Research Group (SLSRG)

The Sport Legacies and Society Research Group (SLSRG) is the newest research group in the School, born of a significant expansion in the School's social science provision both in teaching and research. The SLSRG conducts research on the legacy outcomes of sports mega-events and the portrayal of Paralympic athletes in the media (Pappous). This work has been instrumental in shifting attitudes to Paralympic sport in both the media and society. The SLSRG also conducts sport policy analysis and evaluation, with a focus on programme evaluations, elite sports workers' lives (Koutrou), and the socio-cultural and historical dimensions of sport and leisure industries (Kohe).

Our three research groups hold regular meetings with members to share updates on research activity, provide support and feedback on current and future research projects, and plan for collaborative activity between members. These meetings are also attended by postdoctoral researchers and postgraduate research students. Through this, the three groups provide a research culture that develops the School's early career researchers, enhances the quality of research activity, and facilitates a strategic approach to future projects. The groups' collective activities have been fundamental in establishing the School's research at an international level, and have directly supported events such as the Endurance Research Conference and the international symposium at the Kent-Paris Research Institute, 'From London 2012 to Paris 2024: Lessons learned from research into the social legacies of the Olympic and Paralympic games'.

Research Strategy

Our research strategy for 2014-18 was designed to increase and sustain our research activity on all fronts, to build on the research reputation of the ERG, to increase research capacity in the social sciences and health areas, and to increase external research funding. Our research strategy for 2018-23 further builds on this.

We have substantially increased our research activity since the last REF census period as follows: In the REF2014 census period, the School published 49 outputs in total, whereas during the current census period the School has published more than 320 outputs, or ~3.3 per FTE per annum. Our research reputation has been enhanced by proactive public engagement activities (such as print and broadcast media work) and expert input to national and international consumers of research such as the UK Parliament and the World Anti-Doping Agency (see impact case study 1), as well as key contributions to the research discipline, notably the Endurance Research Conference held in Medway in September 2015. We have expanded our research in social sciences with the appointment of two new research-active staff in this area, who focus on the volunteering experience during and after sports mega-events (Koutrou) and the working practices of sports professionals and sports organisation and politics generally (Kohe).

Our research income for the REF2021 period has increased more than fourfold in comparison with that for the REF2014 census period (see section 3). This success has been achieved partly through the strategic appointment of staff with expertise that aligns with our research groups, the allocation of University-funded PhD studentships to research areas with strong funding/output

potential and to early career staff to support diversification of staff submitting research grant applications, and the support of individual staff through individualised research plans.

Collectively, these points demonstrate that the School's research strategy has facilitated research output, reputation, and income not only to continue growing, but to accelerate during the current REF census period.

Research Strategy 2018-23

The School is building on the successes and sustained growth of the last decade into the 2020s and beyond. To that end, the School has refreshed its research strategy to help achieve the following strategic objectives:

Promote and coordinate collaborations in health-related research

This strategic objective is being met, operationally, by staff coordinating across the University (the Schools of Biosciences, Pharmacy, Psychology, the Centre for Health Services Studies, and the Kent and Medway Medical School) and with external partners (local Health Trusts, CCGs, and the Medway Working Age Group and Medway Neurological Network), as an example of how to broaden our areas of activity, identify novel areas of collaborative research potential, and develop the required research networks. Funding targets for these collaborations include, *inter alia*, Research for Patient Benefit as well as the NIHR, Research Councils, and opportunities with CGRF and the Royal Society Newton Fund.

This collaborative and multi-disciplinary research activity will be facilitated by one of the University's recently announced Signature Research Themes: Future Human. Future Human takes a multi-disciplinary approach to exploring the use of science and technology for human enhancement in order to understand the opportunities, limits, challenges, and risks of using scientific and technological advancement to restore or improve performance and function. This recently developed theme (established in 2020) will be an important driver of School research and collaboration, both internally and externally. The University provides strategic investment for this Signature Research Theme, through appointment of academic leadership of it (1.0 FTE shared across three University staff), two PhD studentships per annum, and a capital fund (£50k per annum). The Future Human Signature Research Theme incorporates much of the research activity in the School's three research groups, and was devised and is led by an SSES academic (Mauger).

Increase capacity for biological research projects

In order to apply competitively for UKRI funding streams, the School recognised the importance of broadening the skill set of its researchers to include analysis of key biomarkers that fluctuate during performance/rehabilitation, as well as identifying new biomarkers in the course of this research. The School successfully bid for University capital investment (over £230k) to invest in new biological wet lab space and the equipment needed to provide significantly increased on-site capacity to perform molecular biology/biochemical analysis of participant/patient samples. This space was completed in June 2020 and will enable us to collaborate with schools internally (listed above) as well as forming networks with translational physiologists and clinicians working nationally and internationally in areas of chronic disease such as stroke, Parkinson's disease, diabetes, and cancer.

Increase the number of research-active staff

Achieving our research aims will require longer-term investment in the recruitment of additional members of research-active staff with expertise in exercise biology for health (with specialisms in genetic, molecular, and cellular-level work), as well as enhancing research activity within the current staff base. The latter will be achieved by continuing to set ambitious research targets for staff and, crucially, supporting our early career researchers in meeting the required targets by peer mentoring and changes to their workload allocation. For example, new lecturing staff are given a lighter teaching load in their first two years of employment so that they can seed their postdoctoral research objectives. The increased research activity will be sustained through the capture of

research grants and the recruitment of PGR students and research associate staff. Staff will continue to be encouraged and supported to play an active role in wider research networks to ensure all research activity is disseminated nationally and internationally. This will help to raise the profile of the School's research and foster interdisciplinary collaborations and cross-institutional funding applications.

Sustain the worldwide recognition of the Endurance Research Group

The ERG has achieved a critical mass in terms of research output and grant capture in the REF2021 census period. While the School's REF2014 submission included numerous outputs from research conducted in previous institutions, the present submission presents research conducted exclusively at Kent. Since the previous census period, grant capture and consistent media coverage of group members' research have also increased dramatically. In addition, many of our key collaborators (such as the Vrije Universiteit Brussel and the University of Calgary) have sought to work with the School because of the pre-eminence of the ERG. The addition to the wet lab facilities within the School, and the upgrade in both quality and capacity in this area, has substantially increased our research capabilities and collaborative opportunities. In addition, we are in the early stages of planning a further Endurance Research Conference, which we aim to make a regular event in the medium term (2022 and beyond). The ERG is now able to sustain itself with external research and innovation funding with the recruitment of PDRAs on specific research projects.

Establish SSES as a leading centre for health-related research

The achievement of the requisite critical mass in the ERG is significant, but it represents just one area of expertise within the School. Thus, a major objective of the School is to consolidate the strengths of the ERG and use this expertise to support the development of the HRG. We are now beginning to develop the HRG in the same way that we developed the ERG in the last REF census period. The University will offer a number of opportunities for health-related research that the School will continue to capitalize on in the next five years. These include the establishment of an Institute of Biotechnology and Molecular Medicine within the School of Biosciences, the new Kent and Medway Medical School (on our Canterbury campus), and the various health stakeholders in Medway and the South East (CCGs).

Develop the Sport Legacies and Society Research Group

During the census period, two key appointments made in the social sciences meant that the research focus of those teaching on the Sports Management degree programme significantly enhanced the capacity for research in the social sciences. This was identified as a group with significant potential for growth. Consequently, a strategic decision was made to establish a third research group focused in this area. Each member of the SLSRG has expertise in complementary areas of sports organisation and mega-event organisation and legacy. In 2018, the SLSRG was therefore established as a group in its own right. It is being developed using the model as described above for the HRG.

Impact Strategy

Both the University and the School have robust procedures in place to support staff to achieve research impact and to capture all its activity in this area. These procedures underpin many of the strategic decisions and expenditure in the School. At University level, staff detail impact or potential impact of their work, and all research-active staff report their research impact activities annually to the Deputy Vice-Chancellor Research & Innovation. Under the previous Faculty structure, our staff utilised competitive internal funding (up to £6,000) for the development of impact case studies in a variety of ways: from seeding initial research work with demonstrable potential for impact, through to funding the gathering of evidence of impact from end-users and industry partners. In addition, the ERG's Endurance Research Conference was subsidised by funding from a successful impact-related Beacon project application (part of the celebration of the University's 50th anniversary in 2015), which brought together scientists, practitioners, and journalists. This resulted in a number of high-profile popular science publications that created significant public engagement for the School.

Since the School's three research groups are inherently structured to focus on and achieve research impact, the emphasis at School level is on achieving impact for the benefit of society and evidence-based practice in sport. To achieve this, we support impact case study development at every stage of the research process. Potential research impact is identified early in the research process through annual individual research plan meetings with all of our researchers. The development of research programmes generating impact is facilitated by input and actions from the School Director of Research, the School REF Coordinator, and the Director of Impact and Engagement. This input maximises both the reach and the significance of the impact achieved in relation to the School's research projects. For example, to maximise the impact of our respiratory diagnostic work with athletes, we conducted a significant refurbishment of our laboratory space at Medway Park. This included the establishment of a respiratory clinic and the construction of a new environmental chamber (£122,000 capital investment from the University), specifically designed to permit the study of respiratory function during extreme environmental challenges. The respiratory clinic has been pivotal in providing respiratory monitoring and support to GB athletes throughout this REF census period, and thus developing Impact Case Study 1 (Dickinson).

The School works closely with the University's Press Office in order to maximise the exposure of our work to the public and interested organisations, thereby seeding impact. For example, media appearances by Dickinson led directly to him being called to give evidence to the Select Committee for Culture Media and Sport (Impact Case Study 1). Similarly, we have taken advantage of central University funds to enable Pappous to meet with key stakeholders in the presentation of Paralympic sport (Impact Case Study 2), transforming the way in which the media across the globe portray such athletes.

2. People

Research-active staff

A major objective of the School is to increase the number of research-active staff in order to sustain and develop the three research groups detailed above. This objective requires both investment in new staff and supporting and developing existing staff. In the previous REF period, the School invested significantly in new research-active academic staff. This included a professorial appointment (Marcora), one Senior Lecturer (Burnley) and five Lecturers (Davison, Dickinson, Mauger, Meijen, Winter). This built upon the original staff base, which consisted of a Professor and Head of School (Passfield), two Senior Lecturers (Hambly and Pappous) and two Lecturers (De Coninck and Hopker).

Since 2014, a number of staff have been promoted: Davison was promoted to Reader in 2018; Dickinson and Hopker were promoted to Professor, and Mauger to Reader, in 2020. In addition, three new members of research-active staff have been appointed at Lecturer level (Fullerton, Kohe, and Koutrou). A new Professor and Head of School (Peppiatt-Wildman) was appointed in 2018. Passfield and Marcora left the institution during the REF2021 period, but remain involved in the School's research mission as honorary members of staff, maintaining many of their research projects and postdoctoral research staff at Kent. For example, Marcora's work on mental fatigue and training, funded by the Ministry of Defence, continues to be conducted within the School by his postdoctoral research team. Fullerton, an early career researcher who had previously been a Research Associate in the School, was appointed in January 2018 to deliver sport psychology modules following Meijen's departure, and to continue his collaboration with Passfield. Winter was recruited by Loughborough University in July 2020, but continues to collaborate with staff and students at Kent. Thus, the School's research base is currently composed of 3 Professors, 3 Readers, 2 Senior Lecturers, and 4 Lecturers.

The School conducts research and promotes researcher development with due regard to issues of equality and diversity. The School will be submitting an Athena SWAN Bronze Award application in 2021. From a research perspective, the School has strongly supported and continues to support the career progression of its research-active female staff. This has included providing study leave for female staff completing their PhDs, and encouraging women to take leadership roles in PhD

supervision, grant applications, and research project management. To this end, Hambly, Koutrou, and Winter have all secured PhD studentships and grant income during this REF census period, and De Coninck has successfully defended her PhD and secured her own PhD student as part of the internal competition for studentships. The School has also recruited a Student Success Project Officer. This post is specifically intended to address the attainment gap between white and BAME students. The project officer's role is not simply student-facing, the role-holder meets regularly with staff in order to enhance their appreciation of EDI issues in relation to research student supervision and general research conduct.

The School has various mechanisms to develop research-active staff and to foster a culture that results in sustained research excellence. Annual Individual Research Plan (IRP) meetings are arranged with the School Director of Research and Innovation, and such meetings are used to identify possible funding and collaborative opportunities within the School and beyond, as well as ways in which our researchers can be supported to develop their careers. The IRP process is of particular importance to new staff and ECRs in providing momentum to their individual research programmes. All new staff are assigned a mentor whose role involves introducing them to the research culture of the School. New staff normally have a three-year period of probation, in which ambitious but realistic research targets are set and evaluated regularly.

To facilitate the development of our ECRs, new staff are given reduced teaching duties for the first two years of their appointment, normally a 50% reduction in year 1 and a 25% reduction in year 2. During their induction and initial IRP meeting, ECRs are directed to relevant University and School research support structures (e.g. the Grants Factory, the Early Career Researcher Network), with the guidance of the School Director of Research and Innovation. Furthermore, it is School policy to pump-prime ECR research, through, for example, seed-corn funding for new projects. Four ECRs have received support in this way in the REF2021 period (De Coninck, Fullerton, Koutrou, and Meijen). The School's research seminar series invites world-leading academics to speak to our researchers, in addition to providing a forum for the exchange of research findings and early-stage research proposals. These seminars are designed to provide peer support to maximise research quality during the early planning stages or before the funding applications are submitted. In addition, both the School and the University (through the Graduate and Researcher College) provide support for grant-writing activities in the form of workshops, mock review panels, and peer review of proposals in development, as well as providing advice and guidance to early career researchers.

Postgraduate research students

The School hosts a vibrant PGR student community, which has grown considerably since the last REF census period. The number of students registered for a research degree has increased from 26 in 2013 to 30 in 2018. In addition, the number of PhD completions has increased from 1 in the REF2014 period to 34 in the REF2021 period (~2.8 PhD completions per staff FTE). Our PGR students have been funded both internally through University scholarship schemes (Kent's 50th Anniversary Scholarships, and the Vice-Chancellor's annual Graduate Teaching Assistant Scholarships) and externally. The School also recruited and supervised a cotutelle student to completion in collaboration with Prof. Romain Meeusen at the Vrije Universiteit Brussel.

Our Graduate Teaching Assistants (GTAs) receive a stipend in which they are contracted to complete a full-time PhD whilst teaching up to 6 hours per week. The allocation of these studentships is according to School size, and during the REF2021 period 2-3 GTAs were awarded annually to the School. The process of allocating these studentships is strategic: we run a selection process in which the School's research priorities and staff career stage are taken into account when forming the project and supervisory teams.

Our PGR students are provided with at least two University of Kent staff members in their supervisory teams, as well as dedicated open-plan office space and a personal computer. A central programme of PGR student training is provided by the University's Graduate and Researcher College (formerly the Graduate School), and additional training requirements are

identified by the supervisory team in both individual meetings and in regular progress reviews chaired by the School Director of Graduate Studies (Research) – Burnley and Hopker during the REF2021 period. These additional requirements are often field-specific and technical, and are assessed on a case-by-case basis. As an example, training was provided by colleagues at Loughborough University that has enabled our staff and PhD students to perform muscle biopsies. Our PGR students run their own research seminar series (with funding to invite external speakers - £500 per annum) in addition to the School research seminar series, and each student receives an allowance for conference attendance (£500 per student).

3. Income, infrastructure and facilities

Research income

Since REF2014, the School has substantially increased its research income in order to achieve the strategic objectives detailed in Section 1 above. The School has developed and enhanced its procedures for the Individual Research Plan meetings, and all our staff are expected to submit one grant application per year as PI, and others as Co-I. In addition, internal peer review at School and Divisional (formerly Faculty) level serves to enhance the quality of applications, thus increasing the probability of success. Beyond costing considerations, the School does not prioritise any one funding source. The diverse nature of the research conducted within the School means that we seek funding from whichever funder best aligns with the research project or research programme being developed.

In the REF2021 period, external research income is £1,309,670, a more than fourfold increase on the £281,356 in the REF2014 period. As planned, this income has come from a variety of funding sources supporting the activities of all research groups. These sources include the Leverhulme Trust (Burnley and Winter), the Ministry of Defence (Marcora and Mauger), the World Anti-Doping Agency (Mauger, Hopker, Dickinson), UEFA (Marcora), Arthritis Action (Mauger and Davison), and the International Olympic Committee (Kohe, Pappous, Koutrou). The School has also received significant funding from UK and other industry sources, including the NHS (Hopker and Mauger), GSK (Marcora), Polar (Passfield), the A2 Milk company (Dickinson and Davison), and the Sun Chlorella Corporation (Davison), among others.

The income received from the above sources has been used to employ PhD students, research assistants, research associates, and to resource our facilities. Each grant has produced high-quality outputs and, in the case of funding from the World Anti-Doping Agency, contributed very significantly to one of our impact case studies.

Facilities

Since its foundation, the University has provided significant investment in the School of Sport and Exercise Sciences, resulting in a distinct and autonomous unit of research, which spans the disciplines of sport and exercise sciences, sports therapy, and sports management. To establish our principal research laboratories and also provide for research-related clinical space, the University invested £3 million in the development of Medway Park (a community sports centre a short distance from the Medway campus), in addition to providing £886,000 for scientific equipment to furnish those laboratories. Expenditure on key equipment has continued throughout the REF2021 period, in order to maintain a cutting-edge research environment. At present, the School benefits from four dedicated physiology laboratories, two environmental chambers, a psychobiology laboratory, a biomechanics laboratory, two injury clinics, and two wet chemistry and biochemistry analysis laboratories. Collectively, these facilities provide a state-of-the-art resource in all areas of experimental research activity, and their contents are detailed below.

Exercise Physiology Laboratories

These dedicated spaces are a key part of the School's research infrastructure. The centrepiece is a large multi-purpose physiology research laboratory (182m²), containing an array of treadmills, dynamometers, and cycle ergometers (Lode, SRM, Velotron, Wattbike, and Cyclus). Respiratory gas exchange can be measured using both online and off-line systems. We have both off-the-

shelf and modular data collection systems for EMG (Biopac, Delsys), transcranial magnetic stimulation (Magstim), transcutaneous muscle stimulation (Digitimer), and near-infrared spectroscopy (Oxymon Mk III, Artinis Medical Systems). Key among these is the Cybex dynamometer, around which much of our neuromuscular research is based. Data acquisition is provided by both Biopac and CED systems software and hardware. The bulk of the physiology research produced in this submission was performed in this space.

The primary Exercise Physiology Laboratory also contains facilities for molecular biology (see Biochemistry and Molecular Biology Laboratory below), as well as an environmental chamber allowing control of temperature, humidity, and O₂ content. Workstations are provided within a shared office to enable staff, postgraduate students, and technicians to perform research administration tasks between periods of data collection.

Respiratory Physiology Laboratory

The Respiratory Physiology Laboratory, managed by Dickinson, provides facilities for both research and clinical support. This laboratory includes equipment necessary for eucapnic voluntary hyperpnoea challenges and Mannitol administration, as well as spirometry for the full evaluation of lung function at rest and during exercise. In addition, there is capacity for the analysis of airway inflammation with exhaled nitric oxide (NIOX mino NO analyser). The laboratory is also equipped with a Thora 3DI structured light plethysmography (SLP) system for the analysis of chest wall movements, which can also be accomplished using motion capture in the Biomechanics Laboratory (see below). The Respiratory Physiology Laboratory houses a large (16m²) environmental chamber specifically designed to impose environmental conditions that provoke airway challenges (such as stable cold and dry environments whilst athletes exercise at high intensities). The investigations conducted in this laboratory have been a major contributor to Impact Case Study 1, and the associated engagement with the media and Parliamentary inquiries.

Psychobiology Laboratory

Since 2014, the School has significantly grown its research capacity in line with its strengths and strategic priorities. One of those strengths is the psychobiology of endurance performance, headed by Marcora and Fullerton. A newly built laboratory houses treadmills, cycle ergometers, and an electroencephalography (EEG) system (B-Alert X10). This space provides the highly controlled environment in which to perform sensitive measures of brain function during exercise and other cognitive tasks. This laboratory also houses a bespoke neuromuscular testing area dedicated to the study of exercise-induced pain, a research line developed by Mauger's research team.

Biomechanics Laboratory

We have invested ~£120,000 in our biomechanics facilities since REF2014, in which biomechanics was identified as a research strength in our submission. Refurbished teaching space on campus now provides a large dedicated Biomechanics Laboratory, containing two force plates (AMTI, Kistler), a 13-camera motion capture system (Qualisys), and a portable EMG system capable of both intramuscular and surface electrode-based signal decomposition for the non-invasive analysis of individual motor unit behaviour *in vivo* (USB-2 OT Bioelettronica). We are one of the first Sport Science schools in the UK to acquire and use this equipment. These facilities are utilised in the work of Burnley and Winter's team investigating the mechanistic basis of physiological complexity and optical methods of tracking lung function, in collaboration with Dickinson. The Biomechanics Laboratory facilities are of such high quality that the University's School of Anthropology and Conservation, situated on our Canterbury campus, has sought to perform research projects investigating the evolution of stone tool use in humans and the kinematics of grasping tree branches in the great apes.

Biochemistry and Molecular Biology Laboratories

The School currently has one dedicated wet chemistry laboratory at Medway Park and a newly established Biochemistry and Molecular Biology Laboratory on the Medway campus, as well as Level 2 laboratory facilities in various locations for the analysis of human tissue and body fluid samples. The investment in wet lab facilities (£130,000) provided centrifuges and cold storage facilities (e.g. -80°C freezer), as well as a range of equipment to measure biochemical, nutritional,

and immunological parameters, including an automated haematology analyser, microplate readers equipped with various read functions (e.g. bioluminescence), a flow cytometer, a clinical chemistry analyser, automated glucose and lactate analysers, a spectrophotometer, CO₂ incubator, 2 UV PCR cabinets, a thermal cycler and electrophoresis equipment, gel imaging/documentation system, and a real-time quantitative polymerase chain reaction (qPCR) instrument.

This laboratory has been used to conduct biopsy studies, in which a number of staff are now trained. The latest phase of laboratory expansion (the Biochemistry and Molecular Biology Laboratory on the University's Medway campus: opened early 2020) has significantly developed and extended the School's wet chemistry capabilities. This development included the refurbishment of ground-floor offices into a dedicated wet lab facility (56m²) in the Medway Building, to significantly increase the capacity to process tissue and body fluid samples in-house. In addition to the aforementioned equipment, this laboratory houses high-calibre microscopy and fluorescence microscopy, tissue analysis, and electrophysiology equipment. This includes: two Differential Interference Contrast (DIC) imaging rigs that include upright microscopes and digital cameras for time series imaging of live tissue and cells, peristaltic bath perfusion systems; two electrophysiology rigs that include microscopes and software for image capture as well as recording of cell membrane potentials/current; two organ bath set-ups for isolated gut/muscle tissue work; and three vibrotome tissue slicers for the slicing of live tissue, and one for slicing fixed tissues; Histochemistry equipment for immunohistochemistry work; and a Western blot kit.

Sports Therapy Clinic

Within Medway Park, our Sports Therapy Clinic contains facilities and equipment used for both research and clinical practice. These include the Alter-G treadmill, which uses lower-body positive pressure to effectively unweight the body during walking and running, as well as an ultrasound scanner primarily used in the assessment of fascial tissue properties.

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

From its founding as a research-intensive unit in 2011, the School of Sport and Exercise Sciences has endeavoured to make significant contributions to the research base and society. These contributions have been achieved primarily through the synthesis of research investigations performed within the School, the application of that research to real-world problems, and engagement with the research base and the public to publicise that work. This includes supporting staff in conducting editorial duties and hosting and chairing conferences, the latter with both internal School and University funding. Throughout the lifetime of the School, therefore, we have adopted an outward-facing attitude to our research. Below we highlight the outcomes of this approach.

The School collectively makes a substantial contribution to the sport and exercise science research base through its national and international collaborations, its work with community groups (Parkinson's disease and Stroke Rehabilitation groups operated in conjunction with community groups in the Medway area, such as the Parkinson's UK Medway and District Working Age Group; the Cardiac Rehabilitation Team of Medway Community Healthcare (MCH); and Stroke Services within MCH), learned societies, and respected discipline-specific journals.

The ERG organised the World Cycling Congress in Leeds in 2014, and hosted the Endurance Research Conference in 2015, the first conference of its kind, and attracted 200 delegates. This meeting led to a special issue of the *European Journal of Sport Science* on 'Integrative Models of Exercise-Related Fatigue' (January 2018), featuring the School's research. Both of these events also hosted free public lectures on one of the evenings to disseminate beyond academia and engage the public with these areas of research.

Staff in the School are also regularly invited to deliver invited public lectures hosted by international universities (e.g. University of Lausanne, Saarland University, São Paulo University). The HRG

organised the Translating Research into Practice Symposium in July 2017, which attracted 84 delegates from across the world. School staff contribute positively to the research landscape; our staff are regularly invited to speak at leading international conferences (such as ACSM, ECSS, FEPSAC, and BASES).

Collaborations and contributions in the Endurance Research Group

Collaborations

The ERG's researchers are involved in a large number of collaborations worldwide. Both staff and PhD students have worked with the University of Calgary, as a result of Passfield's move to that institution. In addition, there are ongoing collaborations with the University of Exeter and Kansas State University (Burnley); Queen Mary University of London, the University of Plymouth, and National Taipei University of Nursing and Health Sciences (Davison); Sao Paulo University, Saarland University, the University of Essex, and Loughborough University (Mauger); Granada University, University of Lyon, Lillehammer University, and Universidade Federal de Juiz de Fora (Hopker).

Contributions

The ERG has made a variety of highly influential contributions to the research base and to society in the census period. In the case of the research base, various staff have prominent roles in the leading discipline-specific journals.

Burnley is a Physiology Section editor for the *European Journal of Sport Science*, and sits on the editorial boards of *Medicine and Science in Sports and Exercise*, the *Journal of Applied Physiology*, and the *International Journal of Sports Physiology and Performance*. Burnley has delivered a number of invited talks in the REF2021 period, most notably to the World Congress on the Basic Science of Exercise Fatigue in 2015 in San Diego, USA. A review paper, based in part on this presentation, has become a highly cited paper according to Web of Science. Based on his research expertise, Burnley has appeared on Sky News and on the BBC World Service, as well as in *Runners World* and *Cycling Weekly*.

Davison is a board member of the UK Society of Exercise Immunology (UKSEI), established in 2018. He has been invited to present his research (invited talks/keynotes) at numerous national and international events (UK, Poland, Sweden, Switzerland, Taiwan), and his research has also been disseminated amongst national or international organisations (e.g. British Dietetic Association, Swedish Sports Confederation). Davison is an Associate Editor of *Medicine and Science in Sports and Exercise* and *Frontiers in Nutrition*. He has hosted, as guest editor, a special topic for *Frontiers in Physiology* (for the research topic 'Towards Tokyo 2020: What Will Contribute to Optimal Olympic Athlete Performance?'). He also sits on the editorial board of *Physiological Reports*.

Hopker sits on a working group for the World Anti-Doping Agency, discussing the implementation of performance data within the current athlete biological passport system. He is also currently advising the International Testing Agency, Athletics Integrity Unit, International Paralympic Committee, US Anti-Doping, and UK Anti-Doping on the use of performance data for anti-doping purposes. Hopker has also recently completed a term as Deputy Chair of the British Association of Sport and Exercise Sciences Sport Performance Division, and was Chair of their recent Policy Review Committee (2016). He has also been the organiser of an international sports science research conference centred around the Tour de France (Science & Cycling) in Leeds in 2014, and has continued to sit on the conference scientific committee each year since then. He is an Associate Editor for *Frontiers in Sports and Active Living*.

Mauger is a Fellow of the European College of Sports Science and has hosted, as an Associate Editor, a Special Issue Research Topic for *Frontiers in Physiology*. He has been invited to present his research (invited talks/keynotes) at numerous national and international events around the world (Brazil, Czech Republic, Germany, Italy, New Zealand, Portugal, Qatar, Switzerland, USA), where his research has been disseminated amongst national or international organisations (UK

Anti-Doping, Canadian Society for Exercise Physiology). Most notably, he organised and spoke at an Invited Session for the European College of Sports Science annual congress, a public lecture for the seminar series accompanying the Youth Olympics Games in Lausanne, and was a member of a four-person discussion panel at the North American Neuromodulation Society annual congress. He was also invited on to the Scientific Committee for the 2020 International Scientific Conference on Kinesiology. Mauger has discussed his research on television, radio, and other media, including BBC Horizon, BBC Radio 4 File on 4, Stade 2, NBC Today, *Runner's World*, and *Men's Health*.

Mauger's and Marcora's research was featured in the best-selling popular book *Endure* by Alex Hutchinson, along with studies and interviews by several other ERG group members. This title has sold more than 150,000 copies worldwide. Marcora has been invited to present his research at dozens of universities and conferences in Europe, USA, Brazil, and Australia. Highlights include plenaries at the annual conference of the European College of Sports Science (2018) and the Royal Society 'Theo Murphy' scientific meeting 'Understanding the Neurobiology of Fatigue' (2017). He is also a nominated member of the NATO Research Task Group on mental fatigue.

Collaborations and contributions of the Health Research Group

Collaborations

Researchers in the HRG maintain strong collaborations nationally and internationally with other research leaders in their respective fields. De Coninck has developed and sustained a collaboration with researchers at Harvard Medical School, Brigham and Women's Hospital, and the University of Vermont. Dickinson maintains a world-leading collaboration with respiratory physiologists and clinicians across the UK, including Dr James Hull at the Brompton and Harefield Hospital and Professor Greg Whyte (Liverpool John Moores University). Hambly belongs to an internationally respected network of research clinicians investigating the management of knee injuries, including the University of Western Australia and the University of Kentucky.

Contributions

De Coninck was an invited speaker at the 13th International Isokinetic Conference on Sports Rehabilitation and Traumatology in Milan in 2014, and was invited to speak at a sport medicine and traumatology specialist meeting 2015 in Rimini. Dickinson is head of our Exercise and Respiratory Clinic, which provides consultancy services to athletes with exercise respiratory issues. Through this clinic he has supported Olympic and Professional athletes as well as recreational athletes. In the build-up to the 2016 Olympic Games, the Respiratory Clinic provided respiratory support to Team GB athletes who achieved 26% of the gold medals, 35% of the silver medals, and 18% of the British bronze medals won at the Olympic Games. In 2016, he also worked with squads of elite football teams from Arsenal FC, Hull City FC, Brentford FC, and Gillingham FC. Additionally, Dickinson served as an expert witness in the DCMS Select Committee's report on 'Combatting Doping in Sport', a report that will likely have ramifications for British sport for many years to come. Hambly has served as the invited health professional on the EULAR European taskforce for management of Antiphospholipid Syndrome, and has been an invited speaker at 14 national and international conferences. Hambly was a member of the scientific committee for the 19th European Society for Sports Traumatology, Knee Surgery and Arthroscopy congress in Milan in 2020.

Contributions and collaborations of the Sports Legacies and Society Research Group

Collaborations

Kohe has ongoing collaborations with Loughborough University and the University of Worcester, investigating sports corporate governance. Koutrou maintains links with Loughborough University in the investigation of sports mega-events volunteering and legacy agendas. Pappous has experience as a supervisor to the 2004 Athens Olympic Games organising committee, and from this has developed a very strong network of international collaborators within and around the Olympic movement. This background enables Pappous to assume a leadership role in his collaborations. For example, he recently led an international research project in collaboration with

the Brazilian Paralympic Committee aiming to use the Rio 2016 Olympic and Paralympic Games to promote inclusion of disabled athletes.

Contributions

Kohe has delivered keynote lectures in Taiwan and the Czech Republic, and also featured regularly in local, regional, and national BBC broadcasts on the London 2012 Olympic Games and related Olympic education and participation legacies. Kohe contributed to the recent 'From London 2012 to Paris 2024: Lessons learned from research into the social legacies of the Olympic and Paralympic Games' symposium, convened by SSES colleague Pappous and hosted by the University of Kent at its Paris institute. The event brought together key European and international academics, sport policy makers, high performance and grassroots sport organisations and workers, and national sport governing bodies to share knowledge, experience, and challenges, and propose new directions for collaborative legacy projects. Kohe has also served as an advisor for sport museums in Italy, Taiwan, and the United Kingdom, and is currently the Director of the UK's inaugural National Basketball Heritage Centre. As an officially recognised repository and affiliate of the UK's Sport Heritage Network, the centre serves as a research hub and has recently attracted further support from the Arts & Humanities Research Council.

Koutrou was a guest speaker at the University of Kent's HR Conference in 2017, and at a Miami University summer school in 2018, and was an Academic Facilitator at the European Youth Sport Forum in 2017. She has also recently collaborated with the Olympic Museum of Qatar in researching content in order to develop their galleries.

The international reach of Pappous' research is evidenced by the eight keynote talks he has been invited to deliver during the REF2021 period and the four international PhD vivas in which he has been invited to act as an external examiner. During Rio 2016, the media guide that he authored was strongly supported and promoted by the Presidents of the International Paralympic Committee and the Brazilian Paralympic Committee, and was distributed to all registered journalists who covered the Games following a launch event at the British Embassy in Rio. Pappous has been approached by the organisers of the Tokyo Paralympic Games to translate his media guide. The President of the French Olympic Academy has offered to sponsor the French adaptation and translation of Pappous' Paralympic media coverage research, and to use it as the base for a series of educational interventions for Paris 2024.