Institution: University of Kent

Unit of Assessment: 26 - Sport and Exercise Sciences, Leisure and Tourism

a. Overview

The Centre for Sports Studies, now the School of Sport and Exercise Sciences, was established in 2001. During the REF 2014 period the University of Kent has invested nearly £4 million in developing the School's infrastructure and its research facilities, and research-active academics have grown from 1 to 15, with 23 PhD students. It is the University's fastest-growing research school with an international reputation, in particular for its research on endurance.

Our research activity is led by the Director of Research and it is grouped into two areas: the Endurance Research Group, and the Sports Therapy, Physical Activity and Health Research Group. Both of these research groups are multi- and interdisciplinary, and include PhD students, research staff, and technical staff as well as academic staff. There is some overlap between the two groups because some members of the Endurance Research Group also conduct clinical research and research on physical activity behaviour.

Endurance Research Group

This group advances knowledge on endurance exercise, training and performance, not just for traditional endurance sports such as road cycling and distance running, but also for any aspects of human performance in which resistance to fatigue is important. For example, improving resistance to mental fatigue in soldiers and repeated sprint ability in team sport players. During the REF 2014 period members of this research group have conducted research on the psychobiological, neuromuscular, thermoregulatory and bioenergetics aspects of exercise tolerance, pacing, cycling efficiency, and sport nutrition. They have also developed innovative training methods to reduce mental fatigue in soldiers and endurance athletes, and novel testing protocols to measure maximal oxygen consumption.

Sports Therapy, Physical Activity and Health Research Group

The aim of this group is to apply sport and exercise sciences to research on various patient groups, disabled people, and physical activity behaviour. During the REF 2014 period members of this group have been investigating diverse subjects such as exercise training and fatigue in patients with cancer and chronic kidney disease, the nutritional and exercise aspects of arthritis, exercise in cardiac patients and patients referred to surgery, diagnosis of asthma, rehabilitation after articular cartilage repair, biomechanics of the musculoskeletal system, and the health legacy of the Olympic Games. Kent was the original birthplace of the Paralympic Movement and the group has been uniquely placed to conduct research into the media coverage of disability sport.

b. Research strategy

In 2006 the University made a strategic decision to invest significantly in the Centre (now School) and to develop its research profile. During the REF 2014 period the School has benefitted from this investment in new world class research facilities, new academic posts, postgraduate research training of existing academic staff, new support staff, several PhD studentships and start-up research funding. This significant investment has been used strategically to deliver clearly defined, measurable and achievable goals during this REF 2014 period. A similar goal-oriented approach will be used for our next five year strategy.

Research Strategy for 2008-2013

The School's overarching aim for the REF 2014 period was to establish the University of Kent as one of the UK's leading centres for research in Sport and Exercise Sciences and build an international reputation for endurance research. To achieve this, we set four specific goals (in bold). For each strategic goal, objective indicators of achievement are provided. As well as internal considerations, the RAE2008 Subject Overview Report for "Sport-related Studies" informed our research strategy for 2008-2013.

1) To increase the number of research-active academics and PhD students, and to provide them with research leadership and world class research facilities

Our primary goal during the REF 2014 period was to develop a research environment that could match our ambition to become one of the UK's leading institutions for research in Sport and Exercise Sciences.

The Centre for Sports Studies was not returned in the 2008 RAE. Now the School of Sport and Exercise Sciences comprises of 15 research-active academics, including two professors that act as Head of School and Director of Research, and one permanent research staff to assist the Head of School in his research activity. The first PhD student in the School started in 2008/09. In 2012/13, there were 23 PhD students including foreign nationals from Italy, France, Portugal, Hungary, Holland and Iraq. Furthermore, 39% of our current research staff is from other European countries to create a truly international research environment in line with the University of Kent mission to be the UK's European university. Further information on how we achieved and managed this tremendous growth in research-active academics and PhD students is provided in the "People" section and the other strategic goals for the REF 2014 period. A description of our world class research facilities is provided in the "Income, infrastructure and facilities" section.

2) To achieve world-leading critical mass in one research area (endurance)

The RAE2008 Subject Overview Report for "Sport-related Studies" points to many departments spreading their expertise too wide and too thin. To avoid this we took the strategic decision to focus our human performance research on endurance. This strategic decision has informed our staffing strategy and distribution of internal funding including PhD studentships. As a result, we have now established in our School one of the world's largest groups of researchers focusing their work on endurance: currently nine academics (including two professors), three research assistants, two technicians and 14 PhD students.

The international reach and reputation of this large group of researchers is indicated by highly-cited papers published in leading international sports science, physiology, and psychology journals (see REF2), invitations to speak at major international conferences such as the ACSM Annual Meeting (Dr Burnley, 2009) and the World Congress of Sports Medicine (Prof Marcora and Dr Mauger, 2012), and award of highly competitive grants from international bodies such as the World Anti-Doping Agency (WADA) and UEFA.

3) To conduct research on various patient groups, disabled people, and health behaviours

As pointed out by the RAE2008 Subject Overview Report for "Sport-related Studies", the number of sport and exercise scientists working with clinical populations is relatively low given current public health priorities. Therefore, we have taken the strategic decision to build on our existing expertise in sports therapy to increase the number of sport and exercise scientists conducting health-related research. This goal was achieved through recruitment of new academic staff with existing clinical collaborations, internal support, successful grant applications, and competitive support from KentHealth (a university-wide initiative to stimulate collaborations between local clinicians and Kent researchers) that awarded us two PhD studentships. As a result, over the REF 2014 period, members of the Sports Therapy, Physical Activity and Health Research Group have published 40 health-related outputs including original research papers published in leading international medical journals such as Arthritis and Rheumatism/Arthritis Care and Research, the American Journal of Kidney Diseases, and the American Journal of Sports Medicine (see REF2). Our research on physical activity behaviour has been reviewed in the British Medical Journal (BMJ).

4) To promote multidisciplinary and interdisciplinary research

We structured our research environment into two broad thematic groups (endurance and health) rather than discipline-based teams (physiology versus psychology) to facilitate multidisciplinary and interdisciplinary research. Such research was not produced in great quantity within sports-related studies in the previous assessment (RAE2008 Subject Overview Report). Academics working in our two research groups come from a variety of disciplines including exercise physiology, sport and exercise psychology, biomechanics, sports therapy, and sport sociology. By grouping these academics thematically, rather than within traditional disciplines, we facilitate multidisciplinary research collaborations and an interdisciplinary approach, as exemplified by published work combining physiology and psychology (see interdisciplinary outputs in REF2).

Furthermore, to ensure an healthy scientific debate within the School, we have recruited researchers with different theoretical perspectives as objectively indicated by letter exchanges in scientific journals between Dr Mauger/Dr Burnley and Dr Burnley/Prof Marcora, and by the invited debate pro and against the Central Governor Model between Dr Mauger and Prof Marcora at the XXXII World Congress of Sports Medicine.

Research Strategy 2014-2018

Over the next five years we will build on the tremendous growth in research activity and reputation we have achieved since 2008. Our goals are:

1) To further increase and sustain our overall research activity

We will increase our research activity in 2014-2018 by supporting further growth in academic staff, internal PhD studentships, pilot studies for subsequent grant applications, research equipment, and staff development with particular reference to participation at major international conferences and sabbaticals in other leading research institutions. We will ensure the sustainability of our research by giving priority to early-career researchers for whom external funding is more difficult to obtain. Furthermore, we will continue to support our four academics currently working part-time towards their PhDs. Objective indicators of achievement for this goal will be an increase in research outputs/citations and grant income compared to 2008-2013.

2) To continue to build the reputation of the Endurance Research Group

Many individual members of the Endurance Research Group are internationally recognized leaders in their branch of endurance research. Our aim for the next five years is to strengthen our reputation as a Group in order to establish the University of Kent as the international reference point for endurance research. We will achieve this goal by producing world-leading multidisciplinary research outputs based on large and complex group projects. We also intend to follow our successful Endurance Research Symposium in 2012 with a bi-annual conference open to all scientists interested in endurance exercise, endurance training, and endurance performance. This regular and specialised conference would be a unique event within the sport and exercise sciences. An objective indicator of achievement for this goal will be attendance to the three endurance-related conferences organised in the 2014-2018 period.

3) To expand our research capacity in the social sciences

That we have a number of research-active staff in the social sciences greatly improves our ability to conduct multidisciplinary and interdisciplinary research. The relatively large number of academic staff and PhD students with a background in the biomedical sciences (exercise physiology, biomechanics, and sports therapy) clearly benefit from exposure to, and collaborations with, a completely distinct research culture. We plan to achieve this aim by prioritising candidates with a social sciences background when recruiting new staff and PhD students. The proposed expansion will be directed primarily towards the Sport Therapy, Health and Physical Activity Research Group to improve the School's capacity to conduct multi-disciplinary and interdisciplinary research in the important area of physical activity behaviour.

4) To increase Research Council funding

Although grants from Research Councils are difficult to obtain by sport and exercise scientists (RAE2008 Subject Overview Report for "Sport-related Studies") we aim to achieve this challenging goal by capitalising on our critical mass in endurance research, our track record in conducting research in clinical populations, and on our truly multidisciplinary and interdisciplinary approach. We have been successful in winning grant bids from the EPSRC in the REF2014 period, and we aim to build on this success by seeking funding for research integrating metabolic, neuromuscular, cardiorespiratory, and psychobiological approaches to understand exercise tolerance in healthy humans (BBSRC) and the application of this integrated model to understand and reduce exercise intolerance in patients (MRC).

c. People, including:

i. Staffing strategy and staff development

Staffing has been an integral part of our overall research strategy during the REF 2014 period. Our first strategic goal was to increase the number of research-active academics and to provide research leadership to the School. This aim has been achieved by increasing our research-active academics from 1 in 2007 to 15 in 2013, and employing **Professor Louis Passfield** as Head of School in 2007 and **Professor Samuele Marcora** as Director of Research in 2010. The second goal was to focus recruitment on the skills required within our two thematic groups, and in particular to build a substantial critical mass in endurance research.

This aim has been achieved by employing, in addition to Professors Passfield and Marcora, four other exercise physiologists active in the area of endurance research (**Drs Mark Burnley, Glen Davison, John Dickinson and Lex Mauger**). To help achieve our remaining goals (expand health-related research and strengthen our multidisciplinary profile), we employed an academic physiotherapist (**Dr Karen Hambly**), a biomechanist (**Dr Samantha Winter**), a sport psychologist (**Dr Carla Meijen**), and an exercise psychologist/sport sociologist (**Dr Sakis Pappous**). Importantly, to ensure a sustainable research environment, we have recruited a mix of senior academics (two Professors and three Senior Lecturers), two established Lecturers, and three early-career researchers.

As part of our staffing strategy a priority has been to develop the research skills of academics employed by the School prior to 2007. This has been achieved by encouraging and supporting academics willing to study part-time for a PhD. One of such PhDs has been awarded during the REF 2014 period (**Dr James Hopker**) and four more academics have started working part-time towards their PhDs (**Ms Lucy Hale, Ms Kyra De-Coninck Berthoud, Mr Steve Meadows, Ms Sadie Jones**). In addition to our research-active academics we have one permanent research assistant, three technicians, and three administrative staff supporting our research activity.

Staff development is supported at all levels. At **School level**, research-active academics complete formal "Individual Research Plans" with the Director of Research in which achievements over the previous year and plans for the next are determined. This review process also serves as a monitoring system for the research performance of individual members of staff as well as the School as a whole. Opportunities for developing and realising new research ideas are provided through Study Leave. During the REF 2014 period study leave was awarded to five of our academic staff. We have a weekly research seminar series with both internal and external speakers, group-specific strategic meetings and journal clubs, and funding is allocated for conferences and external courses including tuition fees for part-time PhD studies.

At **Faculty level**, competitive funding is available every year for research projects (individual grants typically in the region of £1,000) and priority is given to early-career researchers. Over the REF 2014 period, seven members of staff were successful in obtaining this Faculty funding.

At **University level,** the Human Resources strategy and policies support the research environment though the effective recruitment, selection and induction of staff; good employment practices including a mediation scheme and work/life balance initiatives; a promotions process which recognises and rewards research excellence; and proactive equality and diversity initiatives, such as Athena SWAN and networks to support individual equality strands such as Gender, LGBT, Disability, BME. Staff development is also supported by the University's Research Services by organising an Early Career Researcher Network that provides ECRs with a forum to meet and discuss issues and concerns about developing their academic career, and to hear from more senior staff who have been through similar experiences. Workshops ran by the ECR Network included topics like "Planning a Personal Research Strategy", "Developing Collaborations", "Constructing a Realistic Project". As a result of this staff development system, a previously teaching-only academic in our School (Dr Hopker) has obtained his PhD, published several high-quality papers, and attracted external funding. Consequently, his contract has recently been changed into research and teaching, and he has been included in REF 2014.

ii. Research students

During the REF 2014 period, we achieved a tremendous growth in PhD students: from 1 in 2008/09 (now completed) to 23 in 2012/13. This growth has been achieved with 22 PhD studentships from a variety of sources including the School (5), Faculty (12), Kent Health (2), and external UK funding (3). Two Kurdish students also received funding from the Iraqi government to study for a PhD at the School. Full-time equivalents of postgraduate research students from 1st of August 2008 to 31st of July 13 are provided in the table below broken down in academic year.

Postgraduate Research Students FTE per Academic Year				
2009/09	**2009/2010**	**2010/11**	**2011/12**	**2012/13**
1	3.5	6.5	10.5	19.5

At **School level**, the Director of Postgraduate Research monitors the quality of PhD supervision and progression which is guaranteed by a system of team supervision. This system ensures that PhD students are supervised by at least two academics of which one must have experience in supervising PhD students to completion. PhD students take part in our weekly research seminar series, group-specific journal clubs, and funding is available for conferences and external courses.

At **University level**, the Graduate School works in partnership with academic schools, faculties, central service departments and Kent Union to enhance the quality of the postgraduate student experience across all campuses and create a vibrant postgraduate community at Kent. It aims to ensure that the academic and social interests of postgraduate students, both taught and research, are appropriately provided for within the University. Specifically for postgraduate research students, the Graduate School runs the Researcher Development Programme which offers training and career development in line with the Researcher Development Framework and utilises the Vitae "Every Researcher Counts" resources.

d. Income, infrastructure and facilities

External research income

During the REF 2014 period the School has increased its grant capture substantially, from £25,000 awarded in 2008/2009 to £428,706 in 2012-13. Of particular note is the continuing research support provided to the School by the **Ministry of Defence** (MOD). In 2011, Prof Marcora was awarded £42,736 in response to the highly competitive call "Improvised Explosive Devices (IED) Threat Awareness" issued by the Centre for Defence Enterprise (CDE). Following the successful completion of this initial research, the MOD approved a second research grant for £203,933 to further develop a novel training method to increase resistance to cognitive fatigue in soldiers. These prestigious MOD grants indicate the quality and innovative character of the interdisciplinary endurance research being conducted within the School. Our academics are also able to capture highly competitive international grants in the field of sport. Prof Marcora and Dr Hopker were awarded a €17,000 grant from **UEFA** to investigate the effects of mental fatigue in professional soccer players (only five projects were funded out of 59 grant applications from a global spread of authors). Dr Dickinson has been recently awarded a grant from **WADA** to investigate the long-term ergogenic effects of long-acting Beta-2 agonists (160,000 US dollars over 2 years). The School also achieved the difficult goal to attract research councils funding when Professor Passfield obtained an **EPSRC/UK Sport** Achieving Gold grant to analyse sprint cycling (£72,000). These significant achievements in terms of grant capture has been possible thanks to staff expansion, a clear research strategy, strong research leadership and support systems at University level such as the Grants Factory, a series of workshops and writing groups to help Kent academics develop and submit grant applications of high quality.

Research infrastructure and facilities

During the REF 2014 period the University invested £3,000,000 in the development of Medway Park (a community sport centre hosting our main research labs) and £886,000 in scientific equipment for teaching and research. This substantial university investment means we now have excellent laboratories across the whole spectrum of methods used in sport and exercise sciences.

Exercise Physiology Lab

This large laboratory (182 m^2) is equipped with a range of treadmills, Lode/SRM ergometers, and rowers including a Velotron system for simulated cycling competitions and a non-motorized treadmill for power assessment. Physiological measures include respiratory gas exchange (three metabolic carts, a portable gas analyser, and two Douglas bag systems) and various cardiorespiratory variables such as cardiac output (PhysioFlow) and blood pressure (Tango).

Electromyography (EMG) and near-infrared spectroscopy (NIRS) are used to measure muscle activity during exercise. An Equivital remote physiological monitoring system is used for various physiological recordings in the field (e.g., during a motorbike trip from London to Beijing including high altitude research in Tibet).

Environmental Physiology Lab
This is a spacious climatic chamber for hypoxia (up to a simulated altitude of 5,000 m) and temperature regulation (range 15-35°C) with a dedicated cycle ergometer and a treadmill. Skin and core body temperature are assessed with wireless monitors. Additionally, there is an AltiTrainer for hypoxic exercise training and testing outside the climatic chamber.

Respiratory Lab
This lab is equipped for diagnosis of respiratory disease/dysfunction. Measurements of lung function and respiratory muscle strength can be made with a Micro Medical MicroLab and Mouth Pressure Meter. Indirect airway challenges can be imposed for research and diagnostic purposes, including Eucapnic Voluntary Hyperpnoea and Mannitol. In addition, there is capacity for the analysis of air inflammation with exhaled Nitric Oxide (NIOX mino Nitric Oxide Analyser) and various metabolites of airway inflammation in blood and urine (see Wet Lab). Importantly, the respiratory laboratory is able to analyse movements of the chest and abdomen using structured light plethesmography (SLP). The Thora 3DI SLP scanner provides a new way of non-invasively tracking chest and abdomen wall movements in participants. At present, our School is the only sports and exercise science department in the UK that has this technology.

Wet Lab
This lab is equipped to obtain and analyse (or store for later analysis) bodily fluids such as blood, urine, saliva and sweat. It contains centrifuges and cold storage facilities (e.g. -80°C freezer) and a range of equipment to measure biochemical, nutritional and immunological parameters including an automated haematology analyser, microplate reader, clinical biochemistry analyser, automated glucose and lactate analyers, spectrophotometer, thermal cycler and electrophoresis equipment (including gel imaging, documentation and analysis equipment and applications). This lab has been used to conduct biopsy studies with the support of a surgical team on site.

Neuromuscular Lab
This lab is equipped for full assessment of the whole neuromuscular axis: cerebral cortex, spine, and skeletal muscle. The equipment in this lab includes a Cybex dynamometer, a Magstim BiStim2 for peripheral and transcranial magnetic stimulation (TMS), a Digitimer for electrical stimulation of peripheral nerves and muscles, a Digitimer for cervical stimulation, EMG, and two transcranial direct current stimulators (TDCS). Signals and stimulator control is provided through a dedicated Biopac unit allowing full experimental integration and measurements of muscle function, central and peripheral fatigue, motor-evoked potentials (MEPs) and cervicomedullary evoked potentials (CMEPs).

Biomechanics Lab
This lab is equipped for kinematic and kinetic analysis of movement. Equipment in the biomechanics lab includes a Qualisys infrared camera system (3 three cameras), a force plate (Kistler), a gait analysis system (RSscan Lab), and a bike set-up system (Radlabor BikeScanner).

Psychophysiology Lab
This lab is equipped with a nine-channel wireless electroencephalography (EEG) system (B-Alert X10) and a four-channel Functional Near Infrared Brain Imaging system (Artinis) to measure brain activity during exercise. In addition, we have a state-of-the art Biopac psycophysiology system that includes an high spec PC, a response pad, software (E-Prime) for cognitive testing, and wireless measurement of electrocardiogram, EMG, galvanic skin responses and breathing frequency. Brain function is manipulated with computerized mentally fatiguing tasks, TMS and TDCS (shared with Neuromuscular Lab). The Psychophysiology Lab also provides a quiet area for psychological assessment and interventions. To the best of our knowledge, this is one of the best psychophysiology labs within sport and exercise sciences departments in the world.

Other facilities

In collaboration with the Medway School of Pharmacy, we have equipped a lab with a one-lane modular treadmill for mice with humane stimulation (Columbus Instruments) and an Ugo Basile device to humanly damage specific brain areas. These facilities enable us to investigate the role of various brain areas in endurance performance and spontaneous physical activity, and provide mechanistic data to complement our Psychophysiology Lab studies in humans. The Sports Therapy Clinic, located at Medway Park, provides facilities for sports therapy research, and facilitates recruitment of injured athletes into our research studies. The clinic also contains one of the first AlterG treadmills located in a UK university.

e. Collaboration or contribution to the discipline or research base

Collaborations

The School have strong collaborative links with many institutions across the UK, Europe, the US, and beyond. These collaborations are testified by co-authored papers (see REF2), joint PhD students (University of Burgundy and University of Verona), visiting students and visiting scholars (e.g., University of Granada, Institut Nacional D'Educacio Fisica de Catalunya, Federal University of Parana' and University of Cagliari), and hosting of our staff as visiting scholars (e.g., University College London, Massey University and the University of Western Australia). Examples of non-academic research collaborations in the human performance sector include British Cycling, the Defence Science and Technology Laboratory (DSTL), sports nutrition companies including Science in Sport and Colustrum UK, and local academy schools (Canterbury and Brompton). In the health sector, our academics work with clinicians specialising in cardiorespiratory diseases, sports medicine, anaesthesiology, orthopaedics, nephrology, rheumatology, and oncology. Furthermore, the School is collaborating with MacMillan Cancer Support and Medway Council to evaluate an innovative cancer rehabilitation service being tested in the Medway towns. We have also worked on research projects with Medway Council (Physical Activity in Medway Towns) and Sport England (Calorie Mapping of Sport and Active Recreation).

Contributions to the discipline

Our academics contribute to the sport and exercise sciences in many ways. **Professor Marcora** is Representative of *The Physiological Society* at the University of Kent, and sits on the Editorial Boards of the *Journal of Sports Sciences* and the *Journal of Sports Medicine and Physical Fitness*. He has taken part in the Italian equivalent of REF as assessor, and he is external research assessor of the Department of Health Sciences (including the Faculty of Medicine) of the State University of Milan, one of the most important universities in Italy. **Dr Burnley** is an Associate Editor of the *European Journal of Sport Science* and sits on the Editorial Boards of the *Journal of Applied Physiology* and *Medicine and Science in Sports and Exercise*. **Dr Hopker** was in the *BASES* working group on the Science Council M-Level Equivalence. **Dr Meijen** sits in the managing council of the *European Network of Young Specialists in Sport Psychology* (*ENYSSP*). In 2010 **Dr Hambly** was the first physiotherapist to be awarded a fellowship of the *International Cartilage Repair Society*, and acted as Guest Editor for the special issue of *Journal of Sports Rehabilitation* on cartilage repair rehabilitation.

In 2012, the School hosted its first **Endurance Research Symposium** (attended by 123 scientists, athletes and coaches) and organised and sponsored a symposium on "Different Perspectives on the Brain Regulation of Endurance Performance" at the International Convention on Science, Education and Medicine in Sport (**ICSEMIS**) 2012 in Glasgow. We are now organising the **2nd World Congress of Cycling Science** in Leeds in July 2014. The School also engages the general public and young people with sports science and physiology. For example, Prof Passfield was part of **Cutting Edge 2012**, a *Research Councils UK* and *Royal Institution* initiative aimed at engaging the public with world-class researchers and top Team GB stars to discuss the research behind the UK's sporting achievements (video summary of the "Behind Cycling" event featuring Professor Passfield). Prof Marcora mentored a group of four A-level students who won the biggest school competition run by *The Physiological Society* to date, **The Science of Sport: How to Win Gold**, which encouraged young people to conduct their own research into sports physiology and communicate their work at "The Biomedical Basis of Elite Performance" meeting on the 20th of March 2012 in London (video interview with three of the students).