

Institution: Coventry University
Unit of Assessment: UoA24: Sport and Exercise Sciences, Leisure and Tourism
1. Unit context and structure, research and impact strategy

Section 1 Structure of research

Our sport and exercise science submission draws from a focus on interdisciplinary scientific research through the application of sport, exercise and associated sciences to understand life from the molecular level through to the whole body. We conduct research which focuses on understanding the importance of sport and exercise across the lifespan, with a vision to 'make people feel and move better'. To achieve this vision, we undertake a range of basic and applied science research, using quantitative, qualitative and mixed approaches to support the physical activity and movement needs of individuals and communities. This spans children in physical education and community sport, older adults, exercisers, elite athletes, and 'hard to reach' populations, including those from deprived and ethnic minority groups. This is in addition to applying our expertise in sport and exercise science to provide solutions in order to optimise performance in occupational and organisational settings. We positively influence the lives of the people in the communities in which we work, through innovative, high quality, research with global reach and impact.

In the current REF period, we have moved from inception to reality, growing into an internationally impactful research unit, where the study of sport and exercise is at the heart of what we do and has resulted in significant reach and impact from local, through national to an international level. This is evidenced by the volume of peer reviewed papers we have published in high-quality journals in sport and exercise science and related subjects, amounting to over 450 research papers, during this period. Alongside this is the impressive and meaningful impact we have generated, particularly related to improving children's fundamental movement skills and application of techniques and methods from exercise physiology to human performance in the automotive industry. We also make our intervention programmes, and associated research material, free to the public and stakeholders as part of our commitment to open research.

Our work explicitly aligns to the University's Research Conduct and Ethics Policy, with research ethics and integrity being a key consideration in the work undertaken by our unit. Our staff have a commitment to ensuring the research we undertake meets the highest ethical standards. This is fundamental given the potential ethics issues that can arise in our areas of research, such as working with children, clinical populations, older adults or in research with the military and police.

Research underpinning our submission has been through a period of considerable growth over the past six years. A substantial injection of capital enabled the Centre for Sport, Exercise and Life Sciences (CSELS) to move into a new custom-designed £59 million Life Sciences building, with state-of-the-art research laboratories and access to £2.3 million worth of new research equipment. The new building has added capacity for existing and future collaborations with elite and grass roots sports clubs, industry, clinicians, government bodies, academics, community partners and schools. The unit has increased to 19.5FTE in the current REF period through investment in postdoctoral research fellows, senior research academics, associate researchers and early career researchers to support academic staff in undertaking focused research activity within CSELS.

Our submission is based in CSELS which is housed within the Faculty of Health and Life Sciences (HLS). CSELS is an interdisciplinary centre where work related to sports subjects aligns to UoA24 and work related to molecular biology and pharmaceutical science aligns to UoA3. We have, since inception three years ago, successfully become an internationally leading centre of excellence in sport and exercise science, where collaboration with researchers around the world is now the norm. The major thrust of our research as a focus on understanding the effect of movement on

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health, exercise and performance outcomes, taking a lifespan approach, is focussed on three thematic groups: 1) Physical Activity and Health; 2) Sport and Human Performance; 3) Clinical Exercise Science.

The University has invested in the niche strength of sport and exercise related research which has emerged during this REF period. This investment resulted in the development of CSELS, comprising expertise in sport and exercise science and biomolecular science, housed within HLS alongside the Centre for Intelligent Healthcare (CIH). The research culture is facilitated by the co-location of research staff, professional services staff and research students who work across a number of open plan spaces, with meeting rooms for large and small communal activities, a kitchen, in addition to specialist sport and exercise laboratory space.

Research activity within CSELS is divided into two broad areas:

- i) Integrative Biosciences (UoA3)
- ii) Sports and Exercise Sciences (UoA24).

Having two UoAs housed in the same centre enables effective cross fertilisation of research and inter-disciplinary work, as demonstrated by our research examining sarcopenia and age-related muscle degeneration in older adults (Duncan, UoA24, and Renshaw, UoA3). Additionally, both our research units are linked through their access to a joint Advisory Committee which is composed of recognised experts in their fields from diverse academic and research institutions and industry. They provide the mix of expertise and strategic advice to support the activities of the faculty research centres (FRCs) and to build links where appropriate.

In addition to the links between the faculty-based research centres, the organisational structure of the University is such that interdisciplinary sport and exercise related research is conducted cross-faculty via the Institution's different research centres. For example, our recent work examining machine learning approaches in assessing physical activity in older adults has drawn on expertise from sport and exercise sciences, with colleagues in computer science and engineering. Likewise, our work, showcased in Thake's impact case study, *Using Occupational Physiological Research for Commercial Innovation, Protection and Sustainability in Extreme and Changeable Environments*, related to the automotive industry, has been conducted alongside colleagues in engineering, intertwining techniques and expertise from sport and exercise physiology with principles from automotive engineering and car design. Our research and associated impact activity which we have undertaken in schools, has involved colleagues from across the University, ensuring effective translation of research to stakeholders and wider groups, as part of our commitment to open research and open science. For example, our unique collaboration of expertise in the areas of paediatric exercise science and visual presentation techniques, from the Faculty of Arts and Humanities, has augmented the impact of our work on movement interventions for children.

Research Strategy

Our unit has distinctive strengths and an international reputation for research focusing on three themes related to sport and exercise: (1) Physical Activity and Health; (2) Human and Sport performance and (3) Clinical Exercise Science. We have particular strengths in the importance of fundamental movement skills for children's physical activity and health, thermoregulatory and environmental influences on human sport and exercise performance and the effect of ergogenic aids on performance. Research themes in our unit do not operate in silos and we enable inter-theme collaboration. Staff from all career stages, including research students, share dedicated office space and open discussion space which encourages cross-theme discussions and collaboration. The University did not return to UoA24 in REF2014 and the development of our excellence in these fields has emerged during this REF period.

Research within our Physical Activity and Health group builds on the long-standing reputation of academic researchers in exercise physiology, nutrition, exercise psychology and biomechanics, focussing on the beneficial impact of physical activity and exercise on health and well-being. Research encompasses the whole life cycle from young children to older adults, drawing upon

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cross-cutting disciplines to better understand movement and its effects (Duncan, Eyre, Broom, Hill, Clark, Clarke and Tallis).

Extensive research led by Duncan, in collaboration with Eyre, (Impact Case Study: *Improving the Health of Young People through Fundamental Movement Skills (FMS)*) has changed practices of teachers, community sports providers and world governing bodies of sport in relation to explicit embedding of practices to enhance children's fundamental motor skills within physical education and sport. This work is characterised by theoretical and methodological innovation, such as our novel work examining utility of sensors and accelerometer to quantify movement in children (Clark, Duncan), alongside applied translational benefit to schools, children and parents (Duncan, Eyre, Clark) and evidenced by the uptake of our intervention programmes in schools. The importance of childhood motor competence for exercise, sport participation and health benefit is a feature of the research undertaken by our unit, with members of the team being nationally and internationally recognised for their expertise in this area (Duncan). This work, as well as emerging research on older adults' movement and health, is characterised by theoretical and methodological innovation with applied translational benefit to schools, children and parents and wider communities (Duncan, Eyre, Clark).

Members of the Sport and Human Performance group (Thake, Price, Lee, Cullen, Clarke, Roden Morris, Mundy, Oxford), led by Thake, focus on advancing human performance, tolerance and safety in sports, recreation, educational, occupational and exploration settings. This directly addresses sport performance through applying needs analysis techniques and uses a range of nutritional, physiological, biomechanical and psychological interventions across the spectrum from recreational to elite athletes; examples being Clarke's work on examining efficacy of coffee ingestion on markers of sports performance in relation to nutritional interventions or Roden's research employing chronobiology to enhance athletic performance in relation to physiological interventions. We have extensive experience of monitoring a multitude of performance and training responses, undertaking training studies and evaluating sports equipment in collaboration with amateur and professional individuals, sports clubs, governing bodies and industry.

Key research in the areas of physiological and cognitive performance includes understanding acute and chronic responses to altitude and heat including cross-acclimation and cross-tolerance. Work in this area has strengths in industrial application and partnerships spanning sport, exercise, automotive and personal protective equipment sectors. As demonstrated in the Impact Case Study (*Using Occupational Physiological Research for Commercial Innovation, Protection and Sustainability in Extreme and Changeable Environments*) related to this area, our work has focused on understanding and managing physiological and perceptual strain experienced when wearing forms of heavy personal protective clothing through to comfort in automotive vehicles (Thake, Lee).

Our research capacity in Clinical Exercise Science has increased during the REF census period through key appointments (Broom, McGregor, Harwood, Raleigh). Our work in this area focuses on clinical, molecular, cardiovascular, lifestyle, exercise and behavioural sciences to improve health across the life course. We achieve this by improving the physiological understanding of the interaction between lifestyle and health, by bringing together molecular, cellular, human and patient-based methodologies to study acute and chronic exercise responses. (Broom, McGregor, Harwood, Tallis, Raleigh, Turner and Roden). Using a translational research approach, we develop, evaluate, and implement novel physiological, pharmacological and behavioural interventions to enhance prevention, early diagnosis and effective management of chronic conditions. For example, Tallis' basic science research has advanced understanding of how skeletal muscle physiology may constrain locomotor performance, also considering muscle fatigue and trade-offs between sprint and endurance performance.

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Our research aims within the current assessment period were:

- a) **Strengthen the CSELS by building on existing research expertise related to physical activity and health, particularly in children and older adults and in human and sport performance, particularly related to environmental exercise physiology.**

We have developed a cohesive structure specific to research within the field of sport and exercise sciences with a focus on physical activity and sport performance comprising 20 staff with a specific remit for research. The rapid growth in the work we undertake related to sports related subjects is acutely demonstrated by the increase in research active sport and exercise science staff from 2 FTE, who were submitted to UoAs other than 24 in 2014, to 19.5FTE entered in UoA24 for REF2021. Likewise, our unit demonstrates a high volume of peer-reviewed, high-quality publications (an average of 25 per FTE in the period 2014-2020) and publication of research findings in leading journals in their fields (e.g., *Medicine and Science in Sports and Exercise*, *Journal of Applied Physiology*, *Journal of Sports Sciences*, *Journal of Strength and Conditioning Research*). Based on SciVal data (accessed 04/11/2020) in this REF period, 27% of papers in this REF period were in the top 10% of journals (CiteScore) and 11% of papers were in the top 10% most cited worldwide (field-weighted).

- b) **Produce excellent research with stakeholder involvement at all stages of the research journey.**

Our high-quality research includes co-production and patient and public involvement from inception to end point. Our development over the current REF period is well illustrated by our impact case studies and is reflective of our overall approach and vision to make people feel and move better. For example, our work examining motor competence interventions in primary schools has included stakeholder involvement from schools, head teachers and world governing bodies of sport, leading to substantial change in practice in individual school settings and guidelines for the administration of sport specific interventions in over 130 countries. Additionally, our work focused on preparation for performance in extreme environments has included military personnel as key stakeholders involved in co-creation of the development of research, execution of research activity and subsequent dissemination. This industry-based research has also impacted on and informed real-life bespoke solutions for clients including **NP aerospace, Atomic Weapons Establishment, the Prison Service and Jaguar Land Rover**. Foci of this work include characterisation, evaluation and optimisation of human tolerance and performance whilst operating in personal protective clothing and developing vehicular based postural and thermal comfort systems with world leading automotive manufacturers.

- c) **Build on our existing relationships with funding councils, government agencies, sports organisations and business to increase funded studentships.**

During this REF period, we have built on our existing relationships to enable an increase in funded studentships broadly related to the study of sport and exercise. This includes studentships funded by businesses (**Cyber International; Jaguar Land Rover (JLR)**), sports organisations (**Coventry City Football Club, Badminton World Federation, British Cycling**) and hospitals (**University Hospital Coventry and Warwickshire (UHCW)**).

- d) **Increase our grant success.**

We have shown a significant upward increase in research income during this REF period from £9k in the first year of this REF cycle to £80K in 2019-20, amounting to a total research income of £451k. We have obtained research funding from high-quality funders such as the **British Heart Foundation, British Academy and National Institute of Health Research (NIHR)**, in addition to industry related funding from global business such as **JLR**. This shows an increasing trajectory of income, deriving from a variety of sources which includes charities, governing bodies of sport, government and industry.

e) Increase international engagement

We collaborate with many prominent international groups, academics and organisations (see section 4). More broadly, we have engaged with international societies (e.g. **International Motor Development Research Consortium**, Duncan) world governing bodies of sport (e.g. Duncan is on the health and wellbeing board for the **Badminton World Federation**), business (e.g., Duncan has worked alongside Tanita Inc., a worldwide leader in the development of body composition analysis), in knowledge exchange activities (e.g. Thake has worked alongside **JLR** on industrial projects relating to thermal physiology as well as advising the **Singapore Civil Defence Force** in relation to current practice. Clarke has worked with the **Institute for Scientific Information on Coffee** and Raleigh is an international scientific advisory panel member for the **South African Open Genome Project**. Roden holds an Honorary Associate Professorship in the **Division of Exercise Science and Sports Medicine, University of Cape Town, South Africa**. Staff in the centre have examined PhDs internationally (Australia, Spain, Ireland, Portugal, Italy). Latterly, we have also developed cotutelle PhD programmes, specific to sport and exercise science with Deakin University, Australia and Stellenbosch University, South Africa.

Impact

Given the Institution's vision to create 'research excellence with impact', our research and impact strategies are inextricably linked.

Our unit and research centre position impact as a central aim of our research. Staff within the centre are supported by a Research Impact Officer with a senior academic being the 'Impact Champion'. Given the embryonic nature of the unit, these roles have been key in enabling staff to better understand, appraise and make decisions about how to connect their research to the outside world. Over the last three years (i.e. since formation of CSELS) there has been a step-change in the unit in relation to knowledge mobilisation and knowledge exchange.

The selected case studies in this submission reflect the approach of the unit in relation to involvement of stakeholders throughout the research process, in working on research which directly generates impact for the communities in which we work and ensuring the impact we generate has reach beyond the University.

For example, our work examining fundamental motor skills interventions in schools involves aspects of co-design with world governing bodies of sport, teachers and children. This approach has become an inherent feature of our research during this REF period. This is exemplified by our commitment to open science where we give users, practitioners and researchers free access to all our intervention materials for their use. We have deliberately created printed materials/booklets translating our interventions into lay language for schoolteachers to use in their day-to-day work. In the current REF period, we have sent these materials across the world including to Australia, the USA, Ireland, Spain, Portugal, Belgium and Finland. Other modes of dissemination make use of open channels for sharing non-standard research. These include practice, digital modes of access to, and interaction with, research, through, for example, webinars (Duncan, Broom) and digital resources (Duncan). The breadth of the theoretical fields represented within UoA24 specifically promotes generative dialogue between researchers and practitioners outside of academia (e.g. teachers, automotive industry) and ensures that our approach enables open access whilst also developing new research enquiries within our research themes. Importantly, and in addition to our original research, we also seek to conduct replication studies to ensure our work is reproducible more widely.

Our unit uses Twitter and other social media to publicise our research outputs and facilitate discourse between researchers, the public and practitioners. Our research output has led to important changes in behaviour (e.g. changes to teaching practices in physical education, design and guidance in the use of training regimes and explosive ordnance disposal suits used by the UK military and others, as demonstrated in our submitted impact case studies), policy (e.g. changes to the Active Lives Survey through the Department for Culture Media and Sport, as demonstrated in

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our submitted impact case studies) and approaches to outreach (e.g. changes to world governing bodies of sport activities and changes to a large, multi-national automotive company in relation to their approach to human factors).

It is important to note that we have moved to capture impact at all sizes of effect, in line with the Bayley and Phipps (2017) conceptualisation of impact literacy. We recognise that impact is incremental in nature and by considering this, rather than positioning impact as a prohibitively distant goal, we embrace the nature of incremental impact where smaller initial effects will produce more substantive change as it accumulates through the research journey. As a consequence, our research informs recommendations for those we work with, gradually feeding through organisations and gaining momentum for them to be adopted and implemented and potentially informing policy (e.g. our researchers have contributed to the Chief Medical Officer's Physical Activity Guidelines Expert working groups). Given no return was made to UoA24 in 2014, our approach has been to develop incremental impacts which build upon each other and increase over time, as demonstrated by our impact case study (*Improving the Health of Young People through Fundamental Movement Skills (FMS)*) related to fundamental movement skills, where over this REF period, localised impacts, have led to larger, national level impacts, which have then built to impact on an international level with a world governing body of sport in over 130 countries.

Research Objectives over the next five years

Aligned with the Institution's corporate strategy and our research aims for the next five years, we will focus on the following strategic aims:

1. Continuing to further enhance the significance, quality and impact of our outputs researching real world issues that influence human sport, exercise, occupational and environmental performance, and health.
2. Increasing the impact of our work by further building stakeholder involvement and extending understanding of how to connect our research to the outside world.
3. Further development of the research environment specific to the study of sport and exercise.

To achieve these aims, we will undertake the following activities:

Outputs

We will extend our current work in relation to outputs in the following areas:

- understanding the importance of motor competence for children's physical activity, health and sport;
- the importance of physical activity and exercise in enhancing health and function in ageing; understanding and mitigating occupational and environmental challenges in industry and the armed services;
- developing strategies related to athlete preparation for performance in team games.

We will build on our existing international reputations in these fields by continuing relationships developed during this REF cycle with world-leading institutions in the field, including VU Amsterdam, University of Porto, University of South Carolina, Deakin University and Stellenbosch University.

Impact

Our research programmes over the next five years will be underpinned by greater impact of patients and the public in all aspects of the aforementioned programmes of work by continuing to place impact literacy at the core of our research. This will be achieved through enhanced work with stakeholders at all points in the research cycle and focusing on all levels of beneficiaries from individual participants to community groups and Small and Medium Enterprises (SMEs), to governmental levels. Greater use of Patient and Public Involvement (PPI) strategies. Embedding the potential impact of our research with beneficiaries of the research will be central to our planning and the unit's philosophy on research output.

To implement these aims, we will work with a wide range of stakeholders, including participants, schools and preschools, coaches, athletes, governing bodies of sport and industry partners as well as UHCW, Sport England and Public Health England (PHE) to enhance the reach of the work we undertake. We will extend our existing collaborations, extending our interdisciplinary focus with other centres across the University such as CIH, Centre for Care Excellence (CCE), and Centre for Dance Research (C-DaRE). We will extend our reach and partnerships externally with aforementioned collaborators at national and world level and by building our existing, high-quality work with other Higher Education Institutions (HEIs) internationally. Integration of living lab approaches in the communities in which we work will be a key feature of this work going forwards to amplify and extend the already positive effect our work has on society.

Environment

We will continue to develop and extend our excellent research environment through increasing specialist spaces and facilities related to sport and exercise science by working with various support services and aligning with the University's Corporate Plan. We will engage with the opportunities provided by the Doctoral College to develop activities with partners whilst strategically allocating University studentships to support established and emerging areas of research excellence. We will extend our efforts to ensure diversity by attracting research students who are under-represented in the unit, such as those from minority ethnic groups. Collectively, this will promote local, regional and international partnerships including activities related to sports performance and health in the communities we work within. This activity will consequently enable the University to foster an environment that facilitates increases in UK and international grant funding and recruitment of high-quality research students, related to the four thematic areas identified in the outputs section.

2. People

Staff Development

Staff development is a central tenet of the research centres. Academic development and progression are assisted by mentoring, internal funding schemes, identification of research funding support, training in the preparation and submission of grants and papers, research seminars and newsletters and funds for conference attendance.

Research is divided into research themes each guided by a Theme lead. Theme leads are usually professors and experts in their field and themes consist of independent researchers at all stages of their careers. Research staff have access to mentors to assist their training and career development. Senior researchers within the unit (Broom, Clarke, Duncan, Price, Thake) provide such mentorship and guidance to colleagues who are at the beginning of their careers to ensure effective talent management and succession planning. Staff may also request to have a coach or mentor of shared identity as outlined by the Coaching and Mentoring Academy and provided by Coventry's Organisational Development department.

When new staff are appointed there is an extended period of induction and probation usually for 12 months, accompanied by three monthly assessments of their progress against agreed targets. During and after probation, the University uses an online appraisal system to determine progress against agreed targets and whether training is required. There is a variety of training for new research staff including a research centre induction, training within Coventry's postgraduate supervision framework and training focused on Enterprise and Innovation of research.

Unit's staffing and recruitment policy and evidence of its effectiveness

Coventry University's research strategy is selective in its approach, identifying that optimal results would be achieved by focussing research into a number of University and faculty research centres that represent niche research areas where Coventry could be dominant. The commitment to provide Research Excellence with Impact and for research at Coventry University to enhance the

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student experience (Coventry University 2021 Corporate Strategy) is evidenced through a recruitment strategy that is strategic to the *foci* of the unit and has: a) emphasised investment in early career and other researchers who show the potential for work of 3* and 4* quality. This has been realised through: a) secondments to pursue research, PhD studentships, pump prime funding for research ideas and mentoring (Clark, Cullen, Morris, Raleigh, Roden, Tallis, Eyre, Hill, Domene); b) supported internal promotion from senior lecturer to reader (Price) for deserving applicants and c) internal promotion to professor for more senior researchers who have developed their research leadership alongside an international record of grant capture, outputs and impact (Duncan). Researchers and students in each centre are co-located to generate a research environment conducive to high-quality research and the centres are regularly reviewed to ensure the quality of their research outputs, outcomes and partnerships. To ensue and maintain high standards, staff recruitment and retention has become a central part of the University strategy, including investment to support development and growth of the research centre.

Growth in staff numbers has been achieved through external appointment and internal promotion and development. Our recruitment strategy has been to bolster existing areas of niche research strength and to add expertise in order to broaden and deepen the scope and reach of the research we undertake. We have recruited six academics (Broom, Clark, Cullen, Harwood, Lee, Turner), distributed evenly across our three themes, in the latter third of this REF period. They have shown tremendous potential to deliver high-quality research outputs in the niche areas of the research centre.

Staff who are Associates of the research centre and who have produced high-quality outputs have been provided with more resources and more research time (Tallis, Hill, Clark, Raleigh, Price) to make progress in their career.

Support for ECRs

Investment schemes are available to support networking and skills' development, doctoral supervision, international and interdisciplinary working, research enterprise and engagement, and the purchasing of research equipment. Schemes have clear eligibility criteria to ensure a sustainable and targeted approach to support and to ensure applicants have sufficient experience. Those who are not currently Members or Associate Members of research centres can develop their research career and expertise through the University's Academic Support Programme in Research Excellence (ASPiRE) which provides a structured pathway for staff to progress in order to become independent researchers. In addition to access to central University scheme funds, the research centres run a series of seminars with a mixture of internal and external speakers and journal clubs. Each theme receives annual funding which enables researchers to travel to national or international conferences. This funding is specifically targeted to conferences which are likely to have the greatest impact, in relation to the unit's areas of niche strength.

At unit level, staff within UoA24 support early career researchers (ECRs), including research students, through a variety of means: informal mentoring, sharing networks and running skills workshops to aid in the development of expertise to complement and extend the existing skills base with our ECRs.

For staff within the University who are not currently members of the research centre, the ASPiRE programme provides a combined mentorship, training and governance offering to enable staff to grow their research expertise over a two-year period which prepares staff for research independence and entry into the research centre. In the first iteration of the University's ASPiRE programme, there are two individuals aligned to future inclusion within UoA24, ensuring that staff who are not yet members of University research centres have a defined pathway to membership.

Procedures to stimulate and facilitate exchanges with non-academic bodies

Our unit has developed partnerships with SMEs through the activity of its members in conjunction with the Enterprise and Innovation Office (EIO). This Office is responsible for running the UK and European government funded knowledge transfer programmes (such as Knowledge and Transfer Partnerships (KTPs)) and for a substantial percentage of the SME engagement activities under the

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Higher Education Innovation Fund (HEIF) activity undertaken by the University. The EIO is frequently the first point of contact and engagement for SMEs and larger companies and also supports University spin-outs in the exploitation of our Intellectual Property (IP). Partnerships during this period include work with industrial partners such as **JLR** (Thake), the **Army** (Thake), the **Institute for Scientific Information on Coffee** (Clarke), **Sport England** (Duncan, Broom) and the **Badminton World Federation** (Duncan).

The unit has also linked with local schools, community sports clubs and governing bodies of sport (Duncan) and world leading non-profit, science communication organisations (Clarke). Our links with local schools and community sport are deliberate. As an anchor institute within our city, we focus our interventions to link the University to our communities and embody the University's mission for 'Creating better Futures' and delivering 'Research Excellence with Impact'.

Research students

PhD students are at the centre of research in UoA24; our students are embedded in all of our research, co-author on most of our papers, run seminars with us, are physically co-located with staff and are considered as research staff. For example, our PhD students take leadership roles in running bi weekly journal clubs which are attended by staff including professors, mid-career and early career researchers as well as the research students. Likewise, in our outreach and stakeholder work, such as the Coventry University Young Footballers events, our PhD students work with staff to create and deliver innovative and impactful events to showcase our research to the communities we serve.

In addition, staff within UoA24 support PhD students, through sharing professional networks, mentoring and providing related activities to assist in the development of expertise to complement and extend skill development. For example, one of our current PhD students has recently taken on a student member role on the executive board of the International Motor Development Research Consortium by virtue of our commitment to developing our research community via sharing networks of senior staff with early career staff and research students. This approach is reflected across the unit.

As a new unit in this REF period we have seen an increasing number of doctoral students awarded per year, as demonstrated in Table 1 below.

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
PhDs	1	3	1	1	1	2	3

Table 1. Doctoral students awarded per year from 2013-14 to 2019-20.

Equality, Diversity and Inclusion

Issues relating to equality, diversity and inclusion (EDI) are central to the research we undertake in UoA24 and issues related to EDI drive decisions about role allocation and leadership development within the centre.

Staff in the UoA24 submission are committed to promoting EDI and are proud of providing and promoting an inclusive environment in our research community. Our work and practices follow the University's policy on Equality, Diversity and Inclusion. Staff in UoA24 are comparable in terms of ethnic make-up (95% white) to the sector average for sports science and leisure studies (96% white). With regard to recruitment, irrespective of job role, any candidate who declares a disability and meets the essential criteria for the role is included as part of any shortlist. There have been increases in the proportion of females and individuals from BME backgrounds working in grade nine and ten posts at the institution since 2016, and in CSELS specifically, where the most senior member of staff, our executive director (ED), is female. This is supported by the University's Gender Leadership and Development Working Group and via ongoing sponsorship of the Advance HE Aurora programme.

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Our senior research leadership team in CSELS has a membership with a diverse scientific and employment background. This is also reflected in some of the research conducted in the research centre where research themes in the unit directly address issues of (EDI). For example, our research which focuses on ethnic and socioeconomic differences in physical activity and movement in children (Duncan, Eyre) and in piloting interventions to close early attainment gaps in academic performance in disadvantaged children (Duncan, Eyre). EDI is also a regular item on monthly CSELS team meetings to ensure that all researchers are committed to EDI in all aspects of their work and are empowered to request support. Each researcher and research student is shown respect for protected characteristics and researchers are supported on an individual basis and without prejudice. Consequently, individual researchers have been supported to work productively through flexible working, managing long-term illness and have been supported in leadership roles, in funding applications and in accessing internal funds for research.

3. Income, infrastructure and facilities

As a new unit which was only conceptualised halfway through the current REF period, we have a significant upward trend in research income (totalling £451K as principal investigators). Based on Higher Education Statistic Agency (HESA) data, this places us at the midpoint of institutions in the UK for sports related research income. Given that we are relatively new and have only developed during this REF period, this represents a significant increase in research funding during this REF period. Researchers have acted as Principal Investigators (PIs) and Co-Investigators (Co-Is) on numerous projects ranging from research networks, responsive mode, follow-on for impact and engagement and strategic programmes from a number of prestigious grant awarding bodies including the **British Heart Foundation** (Duncan, McGregor). Funding has also been secured from a number of charities and third sector bodies (e.g. **Badminton World Federation, The British Academy, Institute for the Scientific Information on Coffee, Coventry City Football Club**) (Duncan, Clarke, Thake) Additional funding has been secured from the **European Commission (EU)** for collaborative, cross-European projects funded through the **Erasmus Sport+** programme (Duncan).

Organisational, operational and scholarly infrastructure supporting research and impact

The University Research Committee (URC) oversees the University's Research Strategy. The Faculty Research Committee (FRC) oversees the research activities within the faculty's research centres, including CSELS. Decisions about the strategic direction and activities within CSELS are discussed at centre-level, through monthly research centre meetings, chaired by the centre's ED. Monthly meetings review the centre's portfolio of funded research and a range of additional meetings with central and local professional services staff provide a continuous review of impact activities, future funding proposals and research student recruitment. The centre's Operations Manager works closely with the ED on strategy, budgeting and future planning. The centre is subject to an annual review prepared by the ED and Operations Manager, reviewed by a panel comprising senior management of the University, chaired by the Vice-Chancellor. Researchers are members of various University committees and have served on the University's Academic Board.

Infrastructure and facilities

Recognising the unit is new for the current REF period and the relatively new growth in research in sports related subjects during the current REF period, we have been supported by relatively high levels of investment in a short space of time in order to extend our work and its subsequent impact.

The University has supported and encouraged the development of research activity through the provision of new research laboratory space in the newly built Alison Gingell building which was opened in 2018. This is a £59 million building which, in addition to teaching laboratories and simulation facilities, contains approximately 2000m² of research laboratory space along with specialist research equipment totalling £2.3 million. Office and meeting spaces are provided for researchers at all stages of their career. The unit has benefitted from the approach taken by the University in assisting in the development of impact through the provision of expertise and facilities. One example of this, relating to environmental and occupational physiology, is the environmental

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chamber installed in the Alison Gingell building, which aids the continued development of research and applied occupational industrial work in extreme heat (10 to 40 deg C) and altitude (to 8,750 m). This has enabled an increase in the reach of the work we undertake related to environmental influences on performance, as identified in one of the impact case studies included in this submission. Continued growth in this area has led to further investment (£264K) to double the chamber size and enable cold simulations below freezing (-25 deg C). This capability will further expand the applied and basic science work that can be conducted in the centre. Similarly, in recognition of our growing work examining health benefits of exercise in different populations, the university has invested in a specialist body composition laboratory space housing an iDEXA (£116K) to increase capacity for research and engagement activity related to bone and muscle health.

Within the unit we have a commitment to meaningful engagement with researchers, practitioners and stakeholders nationally and internationally, alongside a wish to put back into the communities in which we work. This is reflected in how we work with stakeholders, through engagement and impact related events, where children and families are given access to the University laboratories as part of Coventry University Young Footballers. This approach is also reflective in how we work with practitioners, where we give free access to our interventions, resources and the research we produce for their use and how we work with collaborators where international collaboration is a feature of the majority of our published outputs in UoA24. For example, we have published with researchers in every continent (excluding Antarctica) and most recently, in December 2020, researchers within the unit published a horizon scanning review on children's motor competence with 56 leading scientists from 22 different countries extending the global reach of our research. Our international research reputation has led to invitations to participate in pan-European projects, to visiting scholars taking up sabbaticals with us from Brazil, Australia and Spain in this REF period and to a research student community that includes many international candidates who join us to benefit from the expertise of the team.

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

A significant feature of our research is the emphasis on collaboration both within the academic community and with external partners. The staff within CSELS have a robust profile of national and international collaboration and make a major contribution to the discipline of sport and exercise science.

The scope, reach and impact of these collaborations is a particular strength of staff within the centre. We collaborate with colleagues in a wide range of academic disciplines including epidemiology, engineering, psychology, allied health, and ergonomics. This facilitates a multi-disciplinary approach which helps us create research excellence with impact. For example, Duncan has collaborated with colleagues in five European countries as part of an **Erasmus Sport+** project focused on health benefits of recreational football for older adults and his research with **World Badminton** has had impact in over 130 countries. We have existing cotutelle PhD studentships with Deakin University (Duncan) and Stellenbosch University (Duncan). Duncan has current ongoing collaborations with researchers in 16 countries and over five continents.

These partnerships have led to major international publications and have enhanced CSELS' profile and ability to attract additional funding. We have been instrumental in developing movement skills for physical activity participation in children (Duncan, Eyre, Clark), in the use of recreational football for health to improve physical and mental well-being in older adults (Duncan, Eyre, Tallis, Clarke), in the utility of exercise training for clinical populations, including those with renal failure (McGregor), peripheral arterial disease (Harwood) and polycystic ovary syndrome (Broom). Our contribution has played a pivotal role in Antarctic exploration by the British Army (Thake) and use of personal protective equipment in the Police (Lee, Thake). In the case of the latter, to align with Home Office guidelines in such activity, our work is enabled by the Defence Services Technology Laboratory and informed by the Human Social Sciences Research Capability Framework and has involved all 43 police forces in the UK. Staff members have created novel exercise interventions

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that are used in over 130 countries (Duncan) and Clarke is internationally recognised on the topic of coffee in exercise at the Institute for Scientific Information on Coffee, being called upon as an independent expert in scientific roundtables and the development of scientific reports for the coffee industry. Our strong research work is complemented by meaningful partnerships with public and third sector agencies who are actively involved in our research grants, dissemination and public engagement activities. This has included Sport England, Badminton World Federation, JLR and Tanita Worldwide amongst others.

Engagement

An important element of the research we undertake is in its commitment to engage with the wider public. The staff within CSELS have experience in running translational activity which engage and inform individuals and groups outside academia in relation to the research we undertake. For example, the unit has run the Coventry Young Footballers event several times during this REF period. This public engagement family event, for children aged 6-12 who play in community grassroots clubs in the region is designed to develop knowledge transfer of the research we undertake within the communities involved. At this event, families were able to learn about science of sport and research through experiments and demonstrations. This embeds our work with one of our key stakeholder groups (children) in a fun, meaningful way that demonstrates the positive effect a university can have on the region in which it is based. Due to the success of this approach, other UoAs (e.g. UoA3) have taken this approach and adapted it for their research. Researchers from the research centres in the unit welcomed more than 100 children to these lively sessions, along with parents, grandparents, aunts and uncles and feedback from these events was overwhelmingly positive.

Our research work in schools with children and teachers is based on partnership where our research feeds into changes at school or local authority level and does not simply finish when work is published. Research centre staff provide outreach and aspirational activities for schools that work with us in our research activity and teacher training Inset activity for teachers so they can use the intervention programmes we design on a wider basis. In the present REF period, over 5,000 primary school children and over 1000 pre-schoolers have engaged with the research centre in this way. Similarly, our Erasmus+ funded recreational football for health programme was conducted in collaboration with local community sports clubs and participants in the community. This is central to our work, where the research we conduct in community settings is embedded in real world community activity, where the participants feed their views on the process as part of a co-creation approach which adds value to the local community or research participants and enriches the research and subsequent impact we produce such as our recreational football for health research (www.coventry.ac.uk/research/research-directories/current-projects/2019/6-0-promoting-health-through-recreational-football/). Staff in the centre also engage more widely with the public and public organisations. For example, Duncan has given invited talks and workshops for the Association for Public Service Excellence, who represent more than 250 local authorities across the UK in relation to frontline public services, engaging them in the use of play spaces to develop movement competence in children. Thake, has advised the Army in relation to physiological effects of prolonged exposure to extreme conditions for the Ice Maidens record breaking attempt (Antarctic record-breaking Ice Maidens put through their paces in Coventry University testing | Coventry University). Our work (Duncan, Domene) has also featured in the mainstream media, promoting the beneficial effects of exercise on cognition (<https://www.coventry.ac.uk/primary-news/salsa-dancing-boosts-brain-function-says-coventry-university-study-for-tv-show/>).

Wider influence

The unit's leading contribution to the discipline of sport and exercise science within the UK and globally is evident through staff members taking up posts indicating their wider esteem.

Staff hold senior roles in wider academic organisations. Duncan was elected for two terms (the maximum possible) as Chair of Division of Physical Activity for Health with the British Association for Sport and Exercise Sciences (BASES). During this time, Broom acted as Deputy Chair and was subsequently elected to the Chair position and Price was elected to the Chair and Clarke Deputy Chair of the Division of Physiology and Nutrition in the same subject association. McGregor was

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also an elected officer of the British Association for Cardiovascular Rehabilitation in the period 2013-2017.

On behalf of BASES, Exercise and Sports Science Australia, American College of Sports Medicine, and Sport and Exercise Science New Zealand, Duncan led a joint international consensus statement on the role of sport, exercise and physical activity in closing the life expectancy gap of people with mental illness. Broom also led the development of accreditation for clinical exercise physiologists with BASES. Duncan was recently elected to the executive board for the International Motor Development Research Consortium and Mundy is on the board of the United Kingdom Strength and Conditioning Association. Broom, Clarke, Duncan and Price have all been awarded fellowships of the British Association of Sport and Exercise Sciences during this REF period. Raleigh was also appointed scientific advisor to the South African open genome project from 2019-2020.

Staff have a track record in providing leadership in the field. This is achieved through undertaking editorial roles for journals, acting as referees for internal promotions in other intuitions, undertaking grant application and journal manuscript referee duties as well as having significant profile in chairing sessions at international conferences and in involvement in organising committees for high profile conferences in sport and exercise sciences. Staff in the unit undertake editorial roles for key international journals including the European Journal of Applied Physiology, European Journal of Sport Science, Appetite and Vascular Medicine Researchers in the unit have also acted as referees for evaluating candidates' research for tenure or promotion to Chairs at universities, both in the UK and internationally, including institutions with well-established and high profile research groups in sport and exercise sciences (University of Bath, University of Exeter, Manchester Metropolitan University, University of Limerick amongst others). This is mirrored by our activity in examining PhDs both in the UK and overseas, including, in the UK: universities of Bangor, Brighton, Exeter, Liverpool John Moores, Manchester Metropolitan, Limerick (Ireland), Malaga (Spain), Newcastle (Australia), Victoria (Australia), amongst others.

Our expertise is reflected in requests from high profile funders for our staff to act as external grant reviewers including research councils, and charities such as the **Medical Research Council**, the **British Academy**, **British Heart Foundation**, **NIHR** and **Heart Research UK**. Staff in the centre have also been invited to chair sessions at national and international conferences such as the Annual Conference of the British Association of Sport and Exercise Sciences, Annual Congress of the European College of Sports Sciences and Annual Conference of the United Kingdom Strength and Conditioning Association. All staff within the research centre regularly act as reviewers for journals across the spectrum of sport and exercise sciences.