

Institution: University of Lincoln
Unit of Assessment: 24, Sport and Exercise Sciences, Leisure and Tourism
<p>1. Unit context and structure, research and impact strategy</p> <p>a. Summary context and structure</p> <p>This UoA covers the research of 11.8 full-time equivalent (FTE) staff, with 10.8 FTE from the School of Sport and Exercise Science and 1 FTE from the Lincoln International Business School. The staff are organized into the following two multi-disciplinary research areas/themes reflecting the sport and exercise parts of our main professional body, the British Association of Sport and Exercise Sciences:</p> <ul style="list-style-type: none"> • Performance (led by Prof Mullineaux), with a goal to explore fundamental and applied sport science research to enhance sport performance. Primarily adopting a quantitative approach, with 6 FTEs (Gee, Martin, Mullineaux, Mulloy, Taylor, Willmott), areas of expertise include: biomechanical feedback; physiology of the female athlete; professional practice issues and interventions in psychology, and; psychological states underlying excellent performance. • Wellbeing (led by Prof Allen-Collinson), with a goal to explore issues influencing health, exercise, sport and physical activity. Primarily using either qualitative or mixed-methodology approaches, with 5.8 FTEs (Allen-Collinson, Dickerson, Henderson, Jackman, Pielichaty, Timmins), areas of expertise include: the lived experience of health and illness conditions; physical-cultural embodiment; optimal experiences in exercise and physical activity; athlete mental health and help-seeking, and; race and gender representation in the media. <p>The goal of the School's research is to address topics of national and international importance aligning with government, governing bodies of sport, and other relevant regulatory bodies and industries. Research topics have arisen from:</p> <ul style="list-style-type: none"> • House of Lords' 2012 "Sport and exercise science and medicine: building on the Olympic legacy to improve the nation's health" recommendations 1 (e.g. biomechanical feedback in sport) and 3 and 6 (e.g. GP referral research); (https://publications.parliament.uk/pa/ld201213/ldselect/ldsctech/33/3302.htm). • Government's Sporting Future to address socio-cultural and socio-demographic factors affecting physical activity (e.g. Wellbeing group); (https://www.parliament.uk/written-questions-answers-statements/written-statement/Commons/2019-02-07/HcWS1311). • English Institute of Sport (EIS) along with British Canoeing focus on investigating biomechanics (Performance group). • International Sport Federations' research priorities, such as the need for Anterior Cruciate Ligament research (Performance group); (https://bmjopensem.bmj.com/content/2/1/e000168). <p>The following describes our strategy to addressing such research priorities, and examples of research in these areas are emphasised throughout (e.g. see section 4d).</p> <p>b. Achievement of strategic aims</p> <p>The implementation of the School's research strategy has ensured that all REF2014 strategic aims have been met as follows:</p> <p>i. Further increase the number of research-active staff 7 FTEs submitted to REF2014 has increased to 11.8 FTEs to REF2021.</p> <p>ii. Increase external research income Increased from £48,128 in REF2014 to £411,660 in REF2021, with a further £470,000 secured to be spent beyond August 2020 (see section 3a).</p>

iii. **Increase the number and sources of funding awards for full-time doctoral students, and increase the number of doctoral degrees awarded**

Doctoral studentships funding has been secured from 4 international, 2 national and 9 internal competitive sources, which was achieved through strategically prioritising staff and financial resources to recruit doctoral students. The 1 completion for REF2014 has increased to 13 completions in REF2021 (see section 2b).

iv. **Further develop our international collaborative links leading to tangible outputs**

International links have continued to be a strength, generating doctoral funding (e.g. £90,863 from University of Copenhagen, Denmark for 3 doctoral studentships in the Wellbeing group), staff and post-graduate research (PGR) student exchanges (e.g. Harvard University, USA), visiting researchers (e.g. Universities of Copenhagen, Jyväskylä, Tasmania, Turin), and co-authorship of peer-reviewed journal articles (see section 4b).

v. **Make optimal use of College and University support for research**

Targeted support has greatly enhanced our research capacity and capability. Examples include: School, College and University funding for 9 doctoral studentships and impact generation (e.g. Research Assistant appointments); University funding from the interdisciplinary Lincoln Institute of Advanced Studies for international visiting researchers/scholars, and; PGR student and Early Career Researchers (ECRs) resources and training programmes offered by the University's Doctoral School (see Institutional Environment Statement).

vi. **Continue to strengthen impact**

The School's impact strategy has generated an impact-focused culture among staff, further enhancing our ability to engage with a wide range of users and policy-makers to develop impact. A key strategic element was allocating greater resources and more staff time to those working with external partners, including external funding for staffing, adjusting work loading and appointing Research Assistants to work on impact (see sections 1d and 2a).

vii. **To support all staff currently without a doctorate to obtain a PhD or equivalent qualification**

The percentage of staff with a doctorate has increased from 60% to 100%. This has increased research productivity, such as, through greater doctoral supervisions, and rendering a greater proportion of staff eligible for a range of esteem activities such as internal and external examining, keynote speaking and editorial positions. It has also enhanced the professional development of staff, including assisting promotion of some staff (e.g. allowing some of those promoted during the REF cycle by meeting promotion criteria; see section 2a).

viii. **Invest in additional state-of-the-art facilities and resources**

This continued to be a key strength of the School, contributing to enhanced research capacity and output, and assisting in attracting new research-active staff and doctoral students. This has resulted in greater research productivity, supporting external income-generation (see past aim ii and aim E), and securing funds to appoint additional staff (e.g. 1 FTE project manager to work on the new industry focused Motion Capture facility, the MoCap Hub; see sections 1d and 4c).

c. Future strategic aims

Our future strategic aims, which cohere with the overarching College and University Five-Year Strategic Plan (see Institutional Environment Statement), are as follows:

A. **Produce research of value to sport and exercise science**

- In relation to national and international priorities, the aim is to advance understanding and practice in selected topics such as those outlined above (see section 1a).

B. Enhance the foci of the research groups

- **The two research groups are structured to stimulate, generate and support multidisciplinary research**, facilitated by inter-theme collaboration within the School, and across the University. Given the breadth of expertise in the School, the multidisciplinary research approach will strategically bring individuals together to form inclusive, coherent research groups and to enhance the research culture by promoting ideas/information-exchange and incorporating new members' areas of expertise.
- **External collaboration will be a key focus of the research strategy**, enhanced by research groups maintaining external membership from across universities, businesses, sport organisations, local authorities, National Health Service (NHS) and the third sector (see section 4b).

C. Dynamically align research foci with evolving initiatives

- Respond to evolving local, national and international initiatives (e.g. changes to staff, government initiatives, funding opportunities) through, for example, adjusting workloads and allocating resources.

D. Increase staffing and research productivity

- **The number of new staff with research responsibilities will be increased to 16 FTE.** The increase in staff will focus on appointments where research expertise aligns with a research group, which will continue to build capacity for greater depth of research.
- **Targeted support will be provided to staff to increase their research productivity.** This will include recognising and supporting equality and diversity (see section 2c), implementing drivers to increase the time devoted to research activities, and rewarding talent, including via promotion (see section 2a).

E. Increase external income to £1,100,000

- External income generation is a continually developing priority. As our research profile strengthens and number of staff increases, there is concomitantly greater scope to increase the amounts and widen the sources of income from national and international high-quality funders (see section 3a).

F. Increase PGR student funding to £500,000 and PhD completion numbers to 16

- The primary routes will be to continue to collaborate with external partners, and to continue to be successful in internal awards for funds. This continues to be a priority so as to strengthen the research culture, develop the next generation of researchers, enhance the research groups, and develop strong potential academic leaders (see section 2b).

G. Increase international collaboration

- Increase international links via doctoral funding, staff and PGR-student exchanges, visiting researchers, and co-authored journal articles. Staff will be encouraged and supported in collaborative work nationally and internationally to increase numbers and quality of research outputs, grant submissions and impact. For example, all staff will continue to be encouraged and financially supported to attend conferences annually to improve international collaborative links and networks (see section 4b).

H. Embed impact into our research

- The impact strategy developed over the REF2021 cycle was effective in developing impact, generating an impact-focused culture, and facilitating engagement with a wide range of users and policy-makers. We aim to continue implementing the impact strategy to fund, strengthen and broaden research impact (see section 1d).

I. Enhance professional development

- **To maintain 100% of staff with a PhD or equivalent qualification** through future staff appointments.
- **Provide enhanced professional development opportunities** (see section 2a). The primary aim will be the provision of funding and opportunities for staff to enhance research skills through focused opportunities to develop cutting-edge theoretical, methodological and analytical approaches, and develop income-generating skills.
- **Enhance mentoring support** to maintain a framework for developing staff members' research capability, range and expertise. Membership of a research group germane to their research will provide a supportive, motivating and effective forum for enhancing research capabilities and working synergistically (see section 2a). Mentoring will be provided by experienced research staff, particularly to ECRs, and engaging in the University's Mentoring Pipeline scheme (see Institutional Environment Statement).

J. Invest in facilities to retain state-of-the-art status

- We will continue an investment programme to upgrade state-of-the-art equipment to ensure the School retains leading-edge technology suited to maintaining and enhancing the activities of the research groups (see section 3b).

d. Impact strategy

The key elements for impact are to continue to: develop strong networks of partnerships with both academic and non-academic organisations; identify important local, national and global challenges requiring research to provide in-depth understanding of the topic, and; empowering organisations to act upon the research. These partnerships will be strengthened and extended through the two research groups, and overseen by the School Research Committee, and College and University support systems.

We will continue to focus on identifying new partners, and appropriately supporting this work through directed funding. The primary route for most impact-related work will continue to be strategically managed, including via activities represented in the case studies, through the following steps:

- **Identification of the partner** usually through School-level contacts, individuals' contacts or by the College's Research Impact Knowledge Exchange Manager contacting or being contacted by existing or new external partners (including businesses, local government and charities) to identify their needs and potential services that could be provided by the School. In addition, individuals and organisations will identify staff and group research specialisms via, for example, websites, social media and the open access University repository showcasing our research.
- **Refining needs and funding proof of concept work.** The School and partner will meet to understand each other's requirements, and identify specific benefits from the School's research. Subsequently, pump-priming funding will be obtained, for example, as in past from Innovate-UK Innovation Vouchers (£10,000 covering two projects); College Research Fund (e.g. four projects totalling £6,000); European Regional Development Funding combined with Lincolnshire County Council to purchase equipment and matched by staff-time to provide 12 hours' free support to businesses (e.g. in past, three projects totalling £82,569). Some of these previously have led to impact, such as, those described in the impact case studies.
- **Securing funding** to cover resources and provide expert staffing; achieved in a combination of ways, including: the Innovate-UK Innovation Vouchers; Research Assistants from internal funds; partner-match-funding from external businesses (e.g. £33,829 in 2020-23 from Delsys Europe Ltd), and; Innovate-UK Knowledge Transfer Partnerships (KTP; £224,835 for 2018-21; £261,009 for 2020-22).
- **Recording impact** is a key element of impact through collating evidence. Staff working on impact-related projects will be supported in encouraging partners to record evidence related to the underpinning research, from collaboration with the University. Assistance will be provided via: the University Press Office and the Director of Research Impact Development; College away-days on developing impact; and through

themed discussions in Research Committee meetings on how to promote and obtain suitable evidence on impact.

A range of mechanisms will enhance our ability to engage with impactful work, including through: capital expenditure prioritising purchasing bespoke portable equipment (aim J); the multidisciplinary research groups with membership or attendance from business, community and third sector groups (e.g. County Council Public Health, Community Lincs, The Golf Foundation), and; interaction with Public and Patient Involvement (PPI) groups linked to other departments, the NHS, and third sector (e.g. older citizen groups, such as U3A, Age UK, Evergreen, and the Healthy Ageing PPI group). Examples of mechanisms to achieve impact including the new MoCap Hub devoted to working with industry (see section 4c) and resulting impact such as improving the health and wellbeing of the police (see section 4d).

e. Open research

The University's Lincoln Research Repository (see Institutional Environment Statement) provides a publically available resource to store research and other outputs. Staff are encouraged to upload all outputs, including abstracts and external presentations, which provides a full record of the variety of research activity conducted within the School. The Repository provides efficiency in the ability to, for example: generate reports on research activity; pre-populate forms for individualised staff monitoring through the annual Individual Research Plan process (see section 2a), and; provides supporting evidence of research activity to meet eligibility criteria for internal funding opportunities. The repository is also used to store accompanying material so that raw data, detailed analysis and computer code are made publicly available. To enable others to use or replicate their work, staff actively make their data and code available elsewhere such as in supplementary journal material (e.g. Mullineaux 2017, <https://doi.org/10.1016/j.gaitpost.2016.12.028>).

2. People

a. Staffing strategy and staff development

Our research and staffing strategy aims to increase staffing (aim D) and enhance staff development (aim I), as described below.

The staffing policy supports researchers within the two research groups, with the following considerations:

- **Staff numbers** continued to expand over the REF cycle (up to 11.8 FTE). This growth has greatly enhanced existing research strengths, and refined strands germane to our core strengths of research in Performance and Wellbeing (see section 1a).
- **Research leadership** is provided via both the School's Research Committee, and through the research groups. These groups are led by Professors Mullineaux and Allen-Collinson whose research expertise and experience are broadly quantitative and qualitative, respectively. Both chairs use their time and expertise to support and develop staff within the School. All staff are provided with and supported in leadership opportunities.
- **Succession planning**, once a role has been established by a senior staff member, junior staff are appointed to lead the role, with support maintained via mentorship and the Research Committee's oversight. For example, the Athena SWAN group was initially chaired by a Professor, and following good-practice, a more junior staff member was appointed as chair after 4 years' operation (see section 2c).
- **New staff and Early Career Researchers (ECRs)**. Research capacity was enhanced by increasing the number of researchers in both research groups, where 6 additional new staff were appointed during the census period (4 of whom were, and 2 remain as, ECRs on the REF census date). All new staff are supported via a structured system of mentoring and peer support, with regular meetings to identify and action needs, and to ensure maximum use is made of individual and group training opportunities.

Staff development is used to develop staff knowledge, skills and employability. This is in accordance with the University's People Strategy (see Institutional Environment Statement) and external guidelines, including the UK Concordat to Support the Career Development of Researchers. Hence, all staff are strongly encouraged and supported in their research as follows:

- **Time efficiency mechanisms** have been introduced for all staff, to help develop their research training and activity. Mechanisms include allocating a minimum of one designated day-per-week for research time, alternating light and heavy semester teaching loads, and initiating research-leave awards. Further, all staff are encouraged to adopt flexible working, and in particular, to work at different locations including at home to suit their requirements for research or personal circumstances (see section 2c).
- **ECRs** are specifically assisted in developing research that leads to collaboration, journal publications and larger grant submissions. This is achieved during their first 3 years via lighter teaching loads, fewer administration roles, and greater time of an additional day per week for research. Hence a minimum of 40% of time is devoted to research, which has provided greater capacity to develop as researchers.
- **Funding** is provided to pay for research expenses, professional development, and conferences. For example, the University has provided funding for staff to attend national training events. Within the College, examples include securing funding for 12 projects totalling £18,000 from the annual pump-priming grant competitions that particularly support collaborative research, including multi-disciplinary, and which actively encourages ECRs to apply.
- **Supervisory experience.** All staff are supported in undertaking PGR supervision as a means to enhance research activity and to promote professional development. To date, all staff members have become involved in doctoral supervision. By achieving the past aim vii for all staff to have a PhD or equivalent qualification, this has increased the pool of supervisors contributing to our doctoral programme, and will aid in meeting aim F to increase the number of doctorates awarded. Supervisory teams must include experienced supervisors who must undergo University Doctoral School training, which provides new supervisors and ECRs with additional mentoring.
- **Achievement is recognized** through staff promotion. There have been 3 promotions: Drs Pielichaty and Willmott to Associate Professor, and Allen-Collinson from Associate Professor to Professor in recognition of their research track record and research leadership within the School and across the University.
- **Quality assurance mechanisms** are in place to support staff in maintaining high standards of research quality, integrity and ethics. All research protocols are examined in-depth, and must be approved by a University Ethics Committee. Internal peer-review processes are used to assess the quality of research grant applications prior to submission. For grants, there is a mandatory internal peer-review process within the College that is constructive and supportive, and has been effective in increasing the success rate in grant applications. Alongside more formal mechanisms, the research groups also operate collegial support systems, such as 'Papers in Progress' reviewing, whereby all researchers (newer and more established) can seek colleagues' constructive critiques of their work at various stages.
- **Seminar series.** The School seminar series includes contributions from staff and PGR students, an annual update from the research groups, and presentations from selected visiting international scholars. These seminars provide a rigorous yet friendly environment for presenters to disseminate and defend their work, and the multidisciplinary audience provides detailed input from wider perspectives. The College also operates a monthly Research Seminar Series, also multidisciplinary in nature, to which many of our staff and PGR students frequently contribute.
- **Wider mechanisms supporting the strategy.** The University has many central policies and processes supporting staffing in their development, such as, the Continuing Professional and Personal Development Framework and academic appraisal process (see Institutional Environment Statement). In addition, there is wider assistance through appointment of specialists across the College (e.g. Professor

in Medical Statistics) where the breadth of this leadership also contributes to the multidisciplinary strengths of the School's research.

b. PGR Students

One of the major elements and successes of our research strategy was increasing PGR completions from 1 in REF2014 to 13 PhDs and 15 MSc by Research in REF2021.

Research students are an integral part of our research strategy, as detailed in aim F. Enhancing the doctoral experience through developing a group of research students enhances the School's research culture. Each student is aligned with one of the two research groups to ensure each receive discipline- and subject-specific support. Full-time doctoral studentships have included full-studentships and Graduate Teaching Assistantships with no and some teaching responsibilities, respectively, which during the REF cycle comprised of 9 funded by the College and 2 from national and 4 from international sources (see section 3a).

The environment for PGR students is effective and supportive, with University-wide support mechanisms coordinated by the Doctoral School, a growing team of experienced supervisors in the School, and a strong research culture developing amongst students and staff. A School PGR Lead (at Professorial level) oversees the recruitment, induction, and progression of students, along with their skill-development and training opportunities. A School PGR Administrator oversees the regulatory and procedural progress of the students. PhD students have dedicated shared office space with high-specification, networked computers and printers with the required specialist software. The shared space fosters a collegial research culture facilitating the sharing of skills and advice and allowing students to assist one another with research tasks including data capture. The office space is adjacent to the School ensuring students feel an integral part of the School community and its activities. PGR students present their work annually within the School seminar series, and student representatives sit on all relevant committees.

The majority of students are funded, with approximately 55% from external funding, each with a budget of £1,500/year to pay for professional development, research expenses and conference attendance, and students can also make further requests from the School budget for such expenses (e.g. purchase of bespoke equipment for their studies). PhD students also contribute directly to the work of the two research groups, via joint publications with supervisory and other staff, and collaborative research bids. The national Postgraduate Research Experience Survey has resulted in the School achieving above the sector average scores in all areas. In addition to standard supervisory arrangements, students receive frequent mentoring, seminar and focused training. This has contributed to 'supervisory support' being particularly highly commended by the students in the national survey.

A comprehensive support structure is provided for PGR students, addressing aim F. The central support through the Doctoral School is described in the Institutional Environment Statement, and relates to aspects including regulations, training, support, central resources, careers' advice, social and academic space, and academic and social events. Within the College, the annual showcase event provides students with the opportunity to highlight their research. Within the School, there are development opportunities through seminars, teaching opportunities and focused training (e.g. in ethics; in specialist analysis including NVivo and MATLAB). There is also further School support from an administrator to track, monitor and guide PGR students and supervisors in adhering to University protocols. Staff in the School also contribute to the Doctoral School's programmes, helping to ensure a two-way flow of experience and expertise. Students are supported in enhancing their research profile including through authoring journal papers. Of the 13 doctoral graduates during this REF cycle, all are now employed with 12 in academia and 1 in industry.

c. Equality and diversity

The School fully embraces equality and diversity, reflected in our Athena SWAN charter's Bronze Award first awarded in 2015. The School's Equality and Diversity Committee sits within the University's structure to support equality and diversity for all protected characteristics of the Equality Act 2010 (see Institutional Environment Statement). The committee meets quarterly with representation from across the staff and student bodies, including representation on gender (equal numbers), age (full range from ECRs to Professors) and minority groups (e.g. BAME staff). The committee's overall goal is to monitor and implement initiatives to maximise equality. Examples of roles and actions of the committee that relate to research cohere around the following:

- **Recognise all protected characteristics.** In REF2014 there were 7 FTE submitted, all white British, comprising 6 males and 1 female. For REF2021, 11.8 FTE have been submitted made up of: race (9.8 white British; 1 white-Irish and 1 African-American); sex (4.8 female; 7 male), and; pregnancy/maternity and paternity (6 and 4 instances, respectively). The School actively implements actions to enhance all staffs' ability to research regardless of their characteristics (see examples below).
- **Support staff in producing strong research.** This includes: supporting staff in further enhancing the quality of their research through individual annual research-plan appraisals (Individual Research Plans (IRP); see Institutional Environment Statement); responding to the IRPs in work-load allocations; funding training events and conference attendance, and; identifying resources and equipment purchase needs. The IRP process has been and will continue to be conducted by the two Professors in a supportive manner; ensuring actions are tailored to support all individuals in maximising research productivity while reducing any negative influence of individual equality and diversity circumstances. For example, some staff 'over-working' were advised in their IRP on how to be more selective in engaging with opportunities, and workloads were reduced through liaison with the Head of School. Further, the committee facilitates engagement with University initiatives such as the Women in Science and Engineering Scheme and the Eleanor Glanville Centre, such as, to acquire funding to support research (see example below).
- **Improve the gender balance of staff and PGR students.** To facilitate this, female staff and PGR students are encouraged to apply for staff positions, and active initiatives are used to support and retain female staff. For instance, 1) opportunities for internal funding are not announced prior to national holidays as it is generally acknowledged that such timing would hinder women disproportionately owing to their greater caring responsibilities outside of work; 2) support is provided to apply for funding to assist with, for example, keeping research projects active via staff during maternity leave (see below and section 2c), and; 3) promoting role models of successful women whom accounted for 67% of the promotions. The success of this strategy has resulted in female percentages for staff submitted rising from 14.1% in REF2014 to 40.7% in REF2021, professors rising from 0% to 50%, and PGR completions rising from 0% to 38.4%.
- **Education.** Raise staff and student awareness of equality initiatives, and operate our facilities to maximise accessibility for all staff and participants. General awareness is raised in the School's staff meetings, and more in-depth awareness and training is achieved through seminars and workshops directed to the needs of PGR students and staff.

As an example of supporting equality, during the REF2021 cycle we have used enhanced support for maternity and paternity leave. For the 6 instances of maternity leave, staff have used the 'keeping in touch days' allowing them to work for 10 days during their leave, which has been a priority to support them in maintaining research impetus. All staff returned to full-time and one to a 0.8 FTE, and two on their return to work were further supported with a time-allocation and funding support to allow them subsequently to complete their PhDs. There have also been 4 paternity leaves, one of which included further support of a 4-month reduction to half-time employment before returning on a full-time basis. Staff are also actively encouraged to adopt flexible working, which may suit their research or personal circumstances (see section 2a). Additional benefits were achieved through actively working with the University's

Eleanor Glanville Centre, an interdisciplinary centre with an institution-wide remit to maximise inclusion, diversity and equality (see Institutional Environment Statement). As examples, this Centre provided the School with: 1) support including data and reviews of the application for the School to achieve the Athena SWAN award (see top of this section); 2) access to the Academic Returners' Research Fund (AR2F), allowing one member of staff to reduce her teaching on return from maternity leave, to enable her to spend more time on resuming her research, and; 3) accommodating international visiting researchers, including from Australia and Finland, to collaborate with our research groups.

3. Income, infrastructure and facilities

a. Income

The previous REF income of £48,128 has substantially increased to an income of £411,660 spent during REF2021, and approximately a further £470,000 secured to be spent in the future, which related to meeting the previous aim ii. Income remains as a strategic aim E, and was intended to assist in meeting aspects of the research strategy to increase PGR numbers (aim F) and to build the impact agenda (aim H).

Regarding aim F, funding was secured to increase PGR students in relation to the research priorities of the two research groups. Funding included: 4 sources from international institutes (University of Copenhagen, Denmark for £29,910, £29,239 and £31,713; Southern Cross University, Australia with costs provided by the each institute while the student spends 2 years at each location); 1 national governing body of sport (British Canoeing and English Institute of Sport for £56,000), and; 1 company (Delsys Europe Ltd for £33,829). In all 6 cases, there was also matched funding provided by the University.

In relation to aim H, funding was secured to build the impact agenda. This funding supported varying sizes of projects from small to large, and at different stages from early to later on in projects. For small projects, 2 projects each received up to £5,000 of funding from a variety of sources including Innovate-UK Innovation Vouchers. For medium sized projects, funding was for example obtained from Community Lincs to investigate combating loneliness and social isolation in rural Lincolnshire, including combating this via physical activity (£50,833), and funding from the European Regional Development Fund and Lincolnshire County Council was used to engage in research with business to produce new products (£82,659). For larger projects, two KTPs were obtained from the UK government's Innovate-UK program (£224,835 in 2018 and £261,009 in 2020, both spanning 3 years; see section 4d) and Higher Education Innovation Fund for the MoCap Hub to support innovation (£43,000 in 2020; see section 4c).

As the two research groups continue to develop and build international reputations for expertise in their areas, our intention is to meet aim E, to expand external income generation through research council funding, KTPs and other knowledge exchange streams, including with partners within and external to the University.

b. Infrastructure and facilities

The £1.9 million Human Performance Centre, which opened in 2010, houses the School and provides the high-specification facilities and environment conducive to conducting innovative research. The Centre comprises specialist laboratories and rooms for sport and exercise science, physical therapy clinic, meeting and interview rooms, computer suites, seminar rooms, and staff and PGR student offices. Three of the large open-spaced laboratories provide the latest technology for conducting research.

Equipment purchases have totalled £298,834 during the current REF cycle. Purchases focused on several key elements (in accordance with aim J) including:

1) Facilitate research. The topics of the research groups direct the purchase of equipment to ensure all equipment enhances the capacity to meet our research objectives (see section 1c).

2) Top-specification. Through our research, extant research and keeping abreast of industry developments, we keep ahead of the continually advancing specifications of equipment. Purchasing is geared to securing equipment that best matches research topics whilst also providing some of the leading technology to ensure our research remains at the forefront of the areas in which we work.

3) Portability. Much of our research can require flexibility to test in varying situations. The portability of our equipment ensures researchers can travel to any location, either at the convenience of participants or for the requirements of the research. This equipment, with both laboratory and field capabilities, provides the School with the flexibility to conduct research in locations more conducive to obtaining ecologically valid results. For example, the 29-camera motion capture system is portable, allowing it be transported to new locations (e.g. regular use in a warehouse for the trampoline research; see impact case study).

4) Upgrades. Whilst our equipment facilitates the research-group topics, as technology continually advances it has been beneficial to match these advances with equipment upgrades. For example, in studying muscle activity via electromyography (EMG), past research has predominantly analysed 'net' muscle activity, but with recent hardware and software developments, contemporary research focuses on measuring 'individual' muscle fibres. An upgrade to our EMG system was thus required. Such upgrades are hugely beneficial in keeping our research potential at the forefront, and in this instance it also led to external funding of a PhD from Delsys Europe Ltd to study the topic (see section 3a).

5) Customer support. It is vital that equipment is dependable. As such, comprehensive maintenance and upgrade agreements are secured for the majority of our equipment, with fees averaging £38,800/year. For the 29-camera motion-capture system (see next point 1 below), for example, this maintenance agreement includes: same-day dispatch of replacement cameras; upgrading software as soon as it is released; comprehensive, 24-hour hardware and software support, and; annual site visits. These site visits are excellent in capturing a large number of our users to receive further training in the use of the equipment.

Each piece of equipment requires specialist software, which includes a large number of licenses to allow multiple users in the laboratory, and for PGR students and staff to access the data in their offices or across campus such as in the library (e.g. biomechanics force platform software licenses). In addition, there are a number of University site licenses. The principal unlimited site licenses that we use extensively are for online surveys (Qualtrics), data processing (MATLAB with all toolboxes), qualitative data analysis (NVivo) and statistics (Stata, SPSS).

Within the School several key research facilities include:

1) Biomechanics Laboratory. This laboratory is a large open space measuring 13.5x17m, which includes equipment for measuring forces (e.g. 4 in-ground force platforms; 2 portable force plates; 1 pressure plate), muscle measuring systems (e.g. 16 unit 'net muscle' sensor system including triaxial accelerometers; 4 unit 'individual fibre' sensor system; 1 isokinetic dynamometer) and video cameras (e.g. 2 high speed video cameras with 2D and 3D-stereoscopic/single-screen video creation at up to 40,000 frames/second or 1,000 frames/second at full screen size). In addition, there is an impressive 29-camera real-time motion capture system, able to capture up to 10,000 frames/second, or 150 frames/second at full screen size (for examples of its use see section 4b). Throughout the REF cycle, this system has been expanded from 8 to 29 to meet the expanding research requirements.

2) Strength and Conditioning Suite. To support one of the specific research areas within the Performance research group, a purpose-built suite was designed and installed. Top-specification stack and free weight systems are in place to enable cutting-edge research in this area. In addition, innovative monitoring systems were bought to investigate underlying theoretical principles for their effectiveness in training (e.g. GymAware equipment).

3) Physiology Laboratory. This is a large laboratory with adjoining smaller rooms used to conduct several data collections simultaneously. In addition to standard ergometers for cycling, kayaking, rowing and running, there is specialised equipment including a swimming flume, curved non-motorized treadmill and cycle ergometers (e.g. SRM; AtomX Wattbikes). Data capture equipment includes a real-time expired gas system, and portable equipment versions, including those for measuring expired gases (Cosmed K4), 18-unit

team physiological monitoring (Zephyr bioharnesses), and blood (Analox GM7). The laboratory work complies with the Human Tissue Authority license, and has equipment and trained staff for the appropriate sampling, preparation and storage of human tissue samples.

4) Interview Rooms. Throughout the Centre there are a variety of rooms purposefully designed for conducting focus-groups and one-to-one interviews. These rooms are private with good lighting, decorated minimally and furnished with a mix of soft and hard furnishing, all of which make a comfortable environment beneficial for developing rapport and conducting effective interviews, including on sensitive topics.

5) MoCap Hub. The Hub principally supports funded research with businesses (see section 4c), and is based away from the main campus. It comprises of an 11x6m open space facility with 16 of the motion capture cameras housed there long-term, and other equipment from the other facilities used there as required for short term projects.

Technician support of 5 FTEs provides expert support for staff, PGR students and collaborators to conduct research in the laboratories. Over the REF cycle technician numbers have increased from 2 to 5 FTE. One FTE is dedicated to work in the MoCap Hub (see section 4c). Technicians undergo continual training in advanced equipment and software use, enabling them to pass on this knowledge to facilitate and support research by others.

Safety of working environment is maximized through University and School policies. At a University level, there are extensive policies on all research-related work including risk assessment, and working on/off campus and ethics (see Institutional Environment Statement). For example, all research must be approved by the University Human Ethics Committee, of which Prof Mullineaux has been the Chair since August 2018 to present. At School level, there are extensive research policies (e.g. working-alone; risk assessment of all activities) that are stored for easy access on the School's computer network.

The University supports the School in external income generation (aim E) through the Research and Enterprise Office, working closely with the College's Research Officer and Enterprise and Impact Manager, to help identify opportunities for funding and collaborative ventures, and to enhance the standard of grant applications (see Institutional Environment Statement). This combination of staff at University and College levels ensures that approaches are well-structured, coordinated and effective. In addition, the College has a Director of Research, with dedicated administrative support, to lead and encourage a strong research culture. For example, all administration of the two KTPs is managed centrally, which frees up the academics and company to work on the research within the partnership.

We optimise use of the many wider University support systems for staff and PGR students (see section 2a), including extensive online and physical library facilities, information-technology resources and support from the Doctoral School (see Institutional Environment Statement). Several specific policies and systems exist to support research, including the Awards Management System (centralised database for costing and management of financial resources), and Research and Enterprise Services (e.g. managing legal, commercial and industrial relationships; providing independent specialist consultant support on bids; providing impact-related support pre- and post-award). There is also central funding for making publications open access (e.g. Mullineaux and Irwin 2017, <https://doi.org/10.1080/23335432.2017.1348913>).

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

a. Research collaborations, networks and partnerships

Collaboration has been a key focus of the research strategy (see aims A and G), and is a continually developing strength of the School, with demonstrable benefits locally, regionally, nationally and internationally. Examples of these collaborations are through the following mechanisms.

Joint doctorates are a key element of the strategy to develop international collaboration. Through partnerships with international institutes, there have been benefits in

sharing knowledge, undertaking comparative analysis, increasing pool of supervisors, and cost-sharing. There has been 1 completed and 3 ongoing international joint doctorates with the University of Copenhagen, Denmark, and Southern Cross University, Australia. This work has supported the research agendas of the groups, and resulted in additional benefits from subsequent collaborative research.

International collaborations on research have further enhanced the School's research through the sharing of knowledge, subject-expertise, and resources. This has resulted in a myriad of publications, increasing from 12% of papers with international collaborators in REF2014 to 45.6% of papers on Scopus with international collaborators in REF2021. We have collaborated with institutes in 11 countries, with examples including:

- University of Copenhagen, Denmark, for joint funding for 3 doctoral studentships (1 complete; 2 ongoing) and long term collaborative research.
- Links with institutes across Europe as part of an ERASMUS+ funding project on women in science.
- Harvard University, USA, for long term collaborative research, resulting in publications and staff exchanges.

There have been many international initiatives and cultural exchanges. This includes Memoranda of Agreement being established (e.g. Czech Republic; United States; Singapore; Hong Kong; Australia), outgoing staff exchanges (e.g. Harvard University, USA; Highpoint University, USA) and hosting international scholars (e.g. visiting researchers from University of Tasmania, Australia; University of Jyväskylä, Finland; University of Turin, Italy). These opportunities are opened to all staff, and both experienced and ECRs have been involved, and have provided benefits including publications and enhancing staff professional development.

b. Relationships with users, beneficiaries and society

Through research collaborations, the research groups have national and international external members thus providing practitioner and scholarly expertise to contribute to enhancing our research profile. External non-academic membership includes colleagues from, for example, Golf Foundation, Local Authority Public Health, Community Lincs and Australian Motor Neurone Disease Association.

Motion Capture facilitates collaboration with businesses. The MoCap Hub has a remit to support businesses in using research to create new products. This industry engagement was facilitated through external capital income from the European Regional Development Fund, Lincolnshire City Council and University of Lincoln (see section 3a). There have been packages of 12-hours free support provided to 30 companies, which has resulted in 6 companies following up with government or self-funded follow-up work. In particular, the MoCap Hub has facilitated the award of two KTPs totalling £485,844 (see section 3a). Such projects have given ECRs and newer investigators the opportunity to develop key research management skills, such as negotiating the needs of businesses, and to devise studies with a more immediate impact on businesses' working practices (for example, see section 4d). Since March 2020, £43,000 Higher Education Innovation Fund and matched £43,000 University in-kind funding was used to establish a second MoCap Hub in its own premises employing 1 FTE technician with a remit to generate income to support industry, enterprise and innovation. The MoCap Hub links with the Impact strategy (see section 1d), and has included externally funded research with small local companies (e.g. Tended Ltd in personal safety technology) and larger international companies (e.g. McLaren Racing in Formula 1 racing).

c. Wider activities and contributions to the research base, economy and society

Our contribution to the community and society is reflected in aim H, primarily achieved via the School's impact strategy (see section 1d). Evidence of the reach of our work into the research base, economy and society are exemplified by the following examples:

- **Play trampolines design and safety** (see Impact Case Study). A partnership was developed with Plum Products Ltd, the world's leading manufacturer of trampolines for the toy and leisure industry. The initial work on human interaction with trampolines

demonstrated potential methods of monitoring the safety specifications of trampolines with the aim of improving safety. This work formed the basis of a £224,835 KTP funded by the government's Innovate-UK scheme.

- **Police health and wellbeing** (see Impact Case Study). Our outreach research found that wellbeing through GP Exercise Referral Schemes, although successful, was restrained by structural issues and, importantly, by ineffective interactions between various stakeholders. The Police force was experiencing analogous teething-problems with its wellness initiatives, and subsequently recruited staff from the School to apply research-based evidence to improve the structure and success of the well-being initiative. Police management has found this highly successful, and has subsequently provided follow-on funding to buy in School support, including vis-a-vis rolling out findings nationally.
- **Load-bearing clothing.** Through a partnership with Arktis Endurance Textiles Ltd, our aim is to use scientific principles and biomechanical analysis techniques to enhance the research and development process for police, military and outdoor load-bearing equipment, principally with measureable benefits of improving performance and reducing injury risk. This work is facilitated through a £261,009 KTP that commenced in 2020.
- **Addressing loneliness in rural areas.** In rural-isolated areas, there is a propensity for certain social groups to experience loneliness and social isolation. Through a £50,833 grant from Community Lincs in 2019, our research was to investigate a range of initiatives around physical activity to combat loneliness and social isolation in rural Lincolnshire.
- **Biomechanical research on elite canoeists.** This has two main facets. The first, in conjunction with total funding of £84,000 (in equal parts from GB Canoeing, English Institute of Sport and University of Lincoln) was to fund a doctoral student. The project involved biomechanical research to: address coaches' understanding and applications of biomechanics; investigate the benefits of boat, crew and other equipment benefits, and; specifically to investigate changes in paddle set-up on performance. The second facet has been physiological, whereby the GB development squad, funded by £3,334 from GB Canoeing, has undergone periodic laboratory performance assessments. This has led to evaluating the efficacy of both training and measurements, which coaches have used to modify their training practices.
- **Leading a Food Strategy for the City of Lincoln.** Through competitive internal funds (£43,342), the School led a multidisciplinary consortium researching the role that food has to play in food security/management and health. The strategy resulting from the research was adopted by the City of Lincoln Council, and has been used to inform the operation of local and regional groups such as the East Midlands Regional Big Food Project, Lincoln Food Partnership, and the Lincoln Food Summit.
- **Knee surgery effectiveness via multi-site research.** In collaboration with United Lincolnshire Hospitals NHS Trust, Portsmouth Hospitals NHS Trust and University of Portsmouth, a multi-site study was established to investigate biomechanical measures that could aid surgeons in refining operations and improving prognosis. This was initiated through the competitive internal Research Investment Fund for a post-doctorate (£44,384) and the external University Alliance provided through the University's Lincoln Institute for Health funding for a doctoral student (£60,000). One doctoral student has completed, one external doctorate is ongoing, and further national sites for this longitudinal study are being negotiated. Arranging such a multi-site study was a success, hence further multi-site studies are being explored with additional partners.
- **Assessing benefits of physical activity on Macmillan Cancer Support.** With Macmillan as the UK's leading cancer charity, a partnership agreement between the charity and the University was signed in 2013 for the University to coordinate activities across three key areas of volunteering, student experience, and research. The School has been integral in this partnership, including through £9,600 to deliver research on the benefits of physical activity and evaluation of delivery of such schemes across the UK. The impact from this partnership features in an impact case study with collaborators in Allied Health (UoA3).

Contributing to the wider academic base nationally and internationally. This has been achieved by staff contributing to a range of activities, including: **external doctoral supervision** (e.g. University of Portsmouth; University of Exeter; De Montfort University; Cardiff Metropolitan University; Ping Inc, USA; English Institute of Sport); **external advising and research council reviewing** (e.g. Economic and Social Research Council; Wellcome Trust; National Institute for Social Care & Health Research, Wales); **editorships and editorial board membership** (e.g. Sociology; Sociology of Sport Journal; International Review for the Sociology of Sport; Qualitative Research in Sport, Exercise & Health; Journal of Contemporary Ethnography; Sociological Research Online; Leisure Studies); **external MD and PhD examining** (e.g. Universities of Brighton, Hull, Newcastle, Salford and Western Australia, and The Open University and Leeds Beckett University); **invited professional expertise** (e.g. British Psychological Society assessor for Chartered Sport and Exercise Psychologists); **invited speakers** (e.g. Caribbean High Performance Summit; webinar to the discipline's professional body, the British Association of Sport and Exercise Sciences; keynote at the Physiological Society); **consultant** (e.g. work of the Gatorade Sports Science Institute at Manchester City Women's Football Club), and; **positions within professional organisations** (e.g. Continual Professional Development Representative for the Division of Biomechanics and Motor Control, British Association of Sport and Exercise Science; Member of the Scientific Committee, International Society of Biomechanics in Sport).

Contributions to Equality, Diversity and Inclusion (EDI) agenda have been pursued by several researchers through mechanisms including: **national and international committee leadership, mentorship and membership** (e.g. Joint Lead for Equality and Diversity on the Football Collective's management board; mentor for the Women in Sport and Exercise Academic Network (WiSEAN); member of the Poundbury clinic for Women in Exercise Research (POWER) group, affiliated to the National Institute of Women's Health and Performance (NIWHP); member of the diversity committee for the North American Society for the Sociology of Sport conference); **authoring EDI strategies** (e.g. for the UK Football Collective); **hosting international visiting scholars** for gender research (e.g. from University of Tasmania), and; **international partnering in funded research** (e.g. Supporting Women in Achieving their Goals, (SWinG), which involves investigating a pan-European Mentoring Programme for Sports ERASMUS+ funded programmes). SWinG provides mentoring by industry experts to support women's movement into positions in sports governance globally, with our research examining participants' experiences of the programme and perceptions of its effectiveness.