

Institution: Anglia Ruskin University

Unit of Assessment: 24

1. Unit context and structure, research and impact strategy

Unit Context and Structure

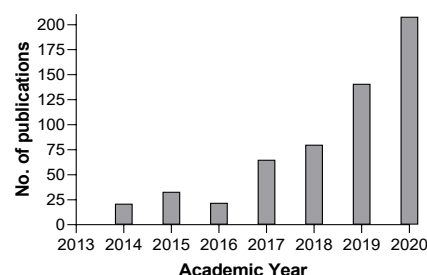
As a highly ambitious, emerging unit, this is UoA24's first REF submission. Our team encompasses a multi-disciplinary, collaborative research group under the umbrella title of the Cambridge Centre for Sport and Exercise Sciences (CCSES), within the School of Psychology and Sports Science, Faculty of Science and Engineering. Since 2014, our strategy has been to promote a coherent approach to research through interdisciplinary, developmental, innovative and community-based projects.

Our unit aligns with the institutional priority research themes of: Ageing; Vision; Entrepreneurship and applied innovation; and Social inclusion and marginalised communities. We have a growing network of local government and community-based agencies, as well as involvement in industry and public sector initiatives. Our research focuses on improving health and well-being through sustained engagement and safe participation in physical activity, including in workplace settings and by high-risk populations. Our research also places strong emphasis on coach education and experiential quality, aiming to improve coach-athlete-parent interactions and effective learning development.

Our strategy has been to conceptualise and develop three inclusive thematic areas based on staff expertise and institutional priority research themes: Health, Nutrition and Physical Activity (HNPA); Coaching and Management (CAM); and Movement, Vision and Injury Prevention (MVIP). The expertise of CCSES staff (highlighted in bold) ranges from strategies to reduce sedentary behaviour and supporting community-wide physical activity (driving our two Impact Case Studies; **Smith**) and healthy ageing initiatives, through to innovative applied, nutritional, psychological and behavioural approaches to improve exercise adherence, coaching initiatives and sports performance. Research is driven through a balance between qualitative, quantitative and epidemiological methodologies, with each thematic area assigned a research lead, to co-ordinate in-group discussion and facilitate project development. Our research strategy is managed locally by the CCSES Director of Research (**Smith**), in conjunction with the Head and Deputy Heads of the School of Psychology and Sports Science, and by the Deputy Dean (Research and Innovation) in the Faculty of Science and Engineering.

As an emerging unit, our collective achievements demonstrate considerable growth with the following notable highlights:

- Progressive growth in research active staff from 5 to 12 since 2014, including 4 ECRs, with University-driven initiatives for all staff leading to 1 Professor, 5 Reader/Principal Lecturer (now Associate Professor) and 5 Senior Lecturer appointments
- Significant University investment (£300k) to establish dedicated research facilities; and further sports therapy clinic investment in 2018 (£100k) to enhance research contributions beyond REF2021
- We have achieved an eight-fold growth in annual research outputs from 21 in 2014 to over 200 in 2020 (see graph, right). Overall, UoA24 has generated over 570 peer-reviewed publications
- We are now one of the fastest-growing units at ARU, with over 65% of outputs in notable journals (e.g. *American Journal of Medicine*, *International Journal of Behavioural Nutrition and Physical Activity*)



- We have an established income generation profile (£123,150), including current grants from external agencies (e.g. EU 'Cancerless project' funding, £306,130 and the Ministry of Defence, £100,485) supporting funded doctoral research
- We have developed and sustained a thriving postgraduate research culture, having established a unit-specific MSc Programme (annual cohort ~15) which contributes to both research innovation and peer-reviewed outputs. We have actively encouraged and grown our doctoral researchers (from 2 to 22) resulting in 5 completions, and establishing a framework for future progress
- Our team collaborates with researchers across the globe, including prestigious Institutions (e.g. Harvard University; University of Cambridge; University of Oxford; Kings College London; University College London; University of Paris-Saclay; University of Bologna; Universidade Federal de Minas Gerais; University of Murcia)
- Our research involves collaborations with external partners/charities and industry, generating impact through health and physical activity promotion regionally, nationally and internationally, including: Single Homeless Project Charity (REF2021 ICS1, **Smith**), Mitie Energy Ltd. (REF2021 ICS2, **Smith**), Ministry of Defence, Cancer Research UK, Cambridge County Council, Cambridge Commodities Ltd.

Research and Impact Strategy

During initial planning, our collective and strategic vision considered progress leading into and growth beyond REF2021 as follows:

- Current vision: To establish a regionally and nationally recognised research unit with a growing reputation for high quality research outputs, and sustained evidence of growth in terms of income generation, and external, community and industry-based research collaborations. Our research culture will provide a thriving and engaging environment driving innovative and exciting projects, generating purposeful impact within industry, workplace and charitable trust settings. Our research will align with institutional research priority themes and ARU research strategy by 'transforming lives' through innovative, applied and public-sector research-informed initiatives.
- Longer term vision: Our longer-term 5-year vision will be to grow research leadership within CCSES, enhancing our research excellence profile in building an internationally recognised integrated group, delivering multi-centre projects, addressing contemporary issues associated with health, physical activity and well-being. This will include growth in research council funding and industry partnerships, increasing postgraduate numbers and externally-funded research active staff, as well as generating wide-reaching impact, with a view to: i) informing clinical practice and occupational health settings (e.g. NHS); ii) providing evidence-based research informing regulatory practice and preparation strategies (e.g. International Olympic Committee); and iii) supporting educational strategies and policies pertinent to developing sustained and safe engagement in physical activity across the lifespan (e.g. Living Sport).

Our strategy involved achievement of the following aims (underlined), with progression monitored through scheduled team research days. Recruitment of research active staff was an important initial focus to ensure progressive broadening of appointments pertinent to physical activity, nutrition, environmental physiology, sports coaching and management, biomechanics, strength and conditioning and psychology to facilitate diversity of skills across the sports science/coaching continuum. This has led to a core team of 12 full-time staff enabling the development of overlapping research interests. Open team discussions supported conceptualisation of three thematic areas to align research interests and drive open-research interaction and innovation. From this, the HNP, CAM and MVIP areas (see above) were developed through consolidation of research interests (see Figure 1). This formed the platform for staff/postgraduate researcher alignment to specific thematic areas, with experienced staff leading in-area research innovation and progression meetings. This alignment process has been integrated within annual appraisal strategic planning.

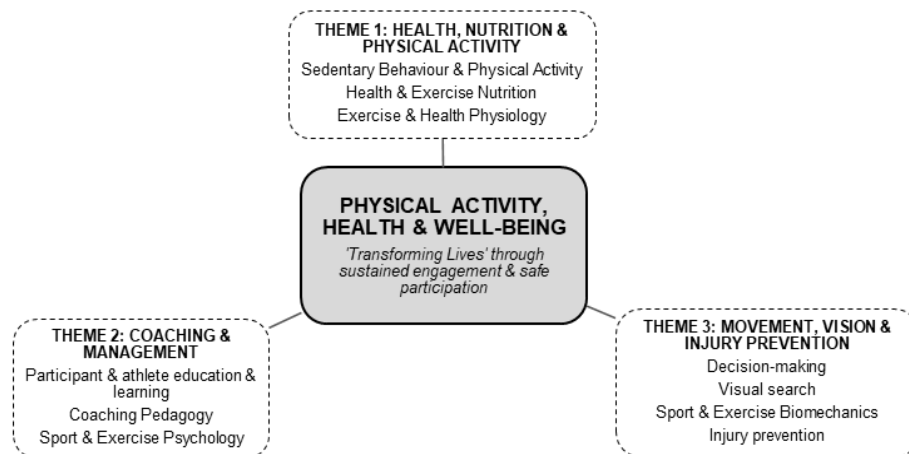


Figure 1: CCSES Research Themes

Furthermore, in creating a platform to drive qualitative research excellence, the launch of our 'ARQlab' (a strategic forum promoting qualitative research discussion and dissemination) and Coaching Network initiatives within CAM has supported student research development, and applied research dissemination with external coach partners. Staff expertise has been attained in areas pertinent to epidemiological research and public health, including systematic review and meta-analyses methodologies leading to extensive national and international collaborations and peer-reviewed publications (e.g. **Smith** et al (2019), "Telomere length and health outcomes", *Ageing Research Reviews* 15(51): 1-10).

ARU investment and resource provision (£300k) facilitated dedicated physiology and biomechanics laboratories, coaching and research testing areas. With further funding in 2018 (£100k) providing state-of-the-art sports therapy clinics, central institution investment has led to significant growth in research project and community-based initiatives, alongside growth in post-graduate numbers, and provides a future platform for research expansion e.g. injury prevention. Institutional investment has also led to the achievement of Laboratory accreditation with the British Association of Sport and Exercise Sciences in 2017, demonstrating attainment in high facility standards and physiological testing excellence.

The appointment of a Director of Research (DoR; **Smith**) in 2017 to co-ordinate and oversee research activities, shape strategic direction, provide on-going support to thematic areas, and manage research impact was also vital to our research strategy. This has led to providing support for early career researchers (ECR), through recognition of ECR staff requiring workload-balance guidance and mentorship and has been adopted within our annual appraisal system to include protected research time. There has also been a focus on nurturing a supportive environment for research active staff, through careful consideration of workload-balance in line with individualised research goals, access to mentorship programmes and career development workshops, and opportunities for grading reviews. As such, over half of staff have achieved senior lecturer grade or higher in this assessment period, in keeping with our longer-term aim of developing research leadership across thematic areas. In line with this, Faculty-mentoring and application guidance has led to three successful research sabbatical applications (resulting in four outputs, and large-scale funding, e.g. **Roberts**; Ministry of Defence, £100,485, to investigate dietary intake in new military recruits to enhance training adherence and minimise injury risk).

A highlighted unit aim was to improve research growth through funding applications and wider partnerships. Our unit utilised workshops provided by ARU's Research and Innovation Development Office (RIDO) for guidance on funding applications to support early project growth. This provided opportunities for staff to engage in different facets of successful grant writing and share knowledge/expertise relevant to developing cross-disciplinary grants. Our unit also implemented cross-Faculty 'sandpit' events and invitational research seminars to broaden our

network and explore cross-discipline interests. This has led to collaboration and project development internally with staff from the Vision and Eye Research Institute; Life Sciences; School of Medicine; the Global Sustainability Institute; and Sound and Game Engineering. Within CAM, our Coaching Network initiatives have facilitated staff to develop qualitative research projects in coach-education and learning; and develop research partnerships externally with Living Sport and Sport England to improve active participation and inclusion in sport.

In line with our unit's vision of 'transforming lives' through sustained and safe participation in physical activity, generating research impact centred around established published research in the field of sedentary behaviour reduction (**Smith**). This was based on institution-led workshop evaluation, in conjunction with RAND Europe, of potential impact studies aligned with our unit's central goal of improving health and well-being through increased physical activity. Our impact strategy has been to develop and sustain industry (e.g. Mitie Energy Ltd.) and charitable trust (e.g. Single Homeless Project Charity) partnerships. This has led to externally funded case-impact research-assistant support prioritising data collection on the benefits of an exercise intervention within a London-based homeless population (REF2021 ICS1, **Smith**), and strategies to reduce sedentary behaviour within the workplace (REF2021 ICS2, **Smith**). Faculty funding has facilitated further data collection, alongside dedicated staff research time for projects with national and European schools, aligned with ICS2.

Our strategy to deliver high quality research outputs initially focused on output quantity, with an initial goal of achieving >50 outputs in total by 2018, and an ambitious target of publishing over 50 outputs per annum by 2020. To achieve this, we created an interactive research culture, including a central point for collation of outputs, expertise around journal quality and integrity, advice on open access provision, and University funding support. Not only have we surpassed this target four-fold but we have contributed to over 570 peer-reviewed publications, making us one of the fastest growing institution-wide units. In progressing to an open research environment, we have sought to improve our research integrity and output quality through interaction with expert reviewers (including critical appraisal of publications and open dialogue around future project methodology), alongside thematic area staff discussion, and sharing of exemplar ideas when developing new projects. The majority of research staff (83%) have successfully applied for Open Access Funds (10 staff beneficiaries, 29 papers published, £38,862.60 spent), leading to high-quality publications in notable journals (e.g. **Barnett** (2015) "The Effects Of Inspiratory Muscle Training In Older Adults", *Medicine and Science in Sports and Exercise*, 47(4): 691-697; **Smith** (2016) "Context-Specific Associations of Physical Activity and Sedentary Behavior With Cognition in Children", *American Journal of Epidemiology*, 183(12): 1075-1082).

A further strategic aim of increasing research dissemination has been achieved through staff being guided by the CCSES DoR to publish open access outputs on University and online platforms (e.g. Anglia Ruskin Research Online Repository (ARRO), Figshare and Symplectic, with 58% of our unit utilising ORCID digital identifiers). Our unit is proactive in working in partnership with the ARU Press Office to maximise public domain research dissemination (e.g. **Smith**, BBC Horizon documentary on public health as part of 'The Great British Intelligence test', 2020); and actively engages in public talks (e.g. Cambridge Science Festival, **Gordon**; and our own 'Train Smart' research seminars; **Roberts, Willmott, Gordon**) and workshops (e.g. Cambridge Coaching Network; **Stodter, Cavallerio**) which has facilitated wider delivery of research to various audiences. Within HNP, we have actively engaged with industry partners (e.g. Cambridge Commodities Ltd. and Biocare Ltd) to provide research-informed publications on the health benefits of nutritional products pertinent to exercise, for public, professional and commercial beneficiaries (**Roberts**). With MVIP, recognition of visual attention research has led to involvement within the regional Bikeability Scheme and further funding to improve hazard perception and developing safer environments for young cyclists (**Timmis, van Paridon**). We have also increased our participation in national (e.g. British Association of Sport and Exercise Sciences), and international conferences (e.g. American College of Sports Medicine, Qualitative Research in Sport and Exercise) operating a rotational system for staff to provide equal opportunity with effective use of School conference funding and travel bursaries.

Beyond REF2021, we have set an ambitious vision of establishing CCSES as an internationally recognised integrated research group developing and delivering effective, practical strategies to facilitate sustained engagement and safe participation in physical activity across the lifespan. We will achieve this through growing research leadership in each of the current thematic areas, working closely with our CCSES DoR, to strategically develop inter-disciplinary, multi-centre research projects focusing on social inclusivity within sport and exercise, occupational health promotion, active ageing and injury prevention. Our longer-term strategy will focus on enhancing research excellence through growth in research council funding (building on learnings from successful applications, and developing links with established partners e.g. University of Cambridge), with the aim of submitting total bids of >£1M per annum by 2025. To achieve this, it will be imperative for our unit to build on current European and international research collaborations to develop multi-centre grant applications. This will be attained, in part, through greater focus on quarterly writing retreats, experienced staff mentoring support for sabbatical applications, and greater inclusivity at international conferences and events to promote networking opportunities. Our research income will also be supported through widening industry partnerships, furthering current technology and nutrition-based connections (e.g. Cambridge Commodities Ltd.) and developing innovative strategies to integrate new partners within postgraduate research projects. Through prioritisation of research time towards funding applications and aligned project development, we will aim to increase externally funded research-active staff and postgraduate researchers across thematic areas to achieve this vision.

We propose to target staff expertise pertinent to psychology and injury management, with the aim of developing two new thematic research areas: behavioural psychology and exercise, and rehabilitation and injury management, to widen our capability in line with driving an inter-disciplinary approach to research. We will also sustain and enhance our research impact, through on-going data collation pertinent to exercise strategies to improve physical and mental well-being for homeless populations, with a view to extending community reach throughout the UK. In addition, we will continue to build our expertise in occupational strategies to reduce sedentary behaviour in the workplace, through international project development based on existing protocols. Finally, we will also develop three new impact projects centred around: 'functional ageing' (through epigenetic targeted exercise/nutrition protocols), 'participation and preparation strategies' (e.g. in conjunction with organisations such as the International Olympic Committee), and 'safe activity environments' (with a focus on social inclusion in physical activity across the lifespan).

2. People

Our unit is driven by enthusiastic, engaged and creative staff, working in synergy with a committed and vibrant student cohort. This energetic dynamic is at the core of our unit's achievements, with investment and support for our researchers being a central strategy towards our longer-term vision.

Staffing strategy and staff development

Our unit comprises 12 full-time staff, 25% are female, 25% are under 35, 34% are over 45, with 33% holding ECR status in this period. Our staffing strategy is focused on recruiting professionally qualified, research active individuals to diversify expertise in sports coaching/education (**Stodter, Dowling**), physical activity, health and nutrition (**Barnett, Roberts, Smith, Willmott**), applied biomechanics (**Morrison**) and psychology (**Cavallerio**) alongside existing staff. This created the platform from which our thematic areas and underlying research focus has emerged.

All staff have been recruited in accordance with the institution's Equal Opportunities policy, with research an essential requirement within job descriptions. From the 8 staff employed since 2014, there has been an equal balance between ECRs and more experienced researchers (50%) (with a track record of publications, income generation and active collaborations). This has been an important strategy facilitating an internal mentorship structure, with ECRs allocated an

experienced mentor to provide guidance and open discussion around research and career progression, in collaboration with the CCSES DoR.

As a growing unit, staff inclusivity is at the heart of our team dynamic. Not only has our recruitment strategy focused on a positive trend towards gender/age balance, but our structure provides support in terms of flexible working hours, particularly for those with parenting responsibilities. Whilst dedicated office space provides a positive environment for communal discussion and idea sharing, staff are also encouraged to work remotely to support individual requirements. All staff have access to remote desktop, IT and School Learning Technologist support. Faculty funding has enhanced accessibility for those with disability characteristics, including travel-to-work bursaries, specialised IT equipment and research assistant support. Likewise, Faculty funding has facilitated support for teaching cover for those staff on maternity/paternity leave.

CCSES staff are based in Compass House, Cambridge, a dedicated research facility with local technician and IT support. This has provided a favourable environment for staff-student interaction, project delivery and research discussion, creating a positive research culture. In enhancing this research culture, staff undertake yearly appraisals with allocated School line managers who facilitate open discussion around annual achievements, personal development, research planning and workload management. This generates open dialogue around individual objectives (including planned outputs, funding and supervision), in conjunction with the wider objectives of thematic areas. Recognition of time allocation (~30%) for staff carrying a significant responsibility for research, particularly ECRs, has been a contributing factor in our unit's achievements.

In recognition of the enthusiasm and drive within the unit, our staff have proactively pursued grading review applications as part of appraisal plans and career progression. This has included engagement in institution support workshops (outlining criteria and examples of good practice), as well as aligned mentor schemes (particularly for those pursuing Reader/Professor grades). This has resulted in the successful attainment of 1 Professor, 5 Readers/Principal Lecturers (now Associate Professors) and 5 Senior Lecturers for our unit; and provides the foundation for leadership development in line with our longer-term vision.

As a platform for research development, staff are required to complete institutional courses in research integrity, ethical practice, data protection and risk assessment. There is a plethora of institutional opportunities for professional and research development, particularly through the ARU Staff Researcher Development Programme. This includes sessions aligned with the Vitae's Researcher Development Framework including writing and publication, engagement and impact, working with businesses, research methods, leadership and management, career development and personal effectiveness. Staff have been proactive in personal development opportunities, collectively engaging in 51 sessions in this period. Institutionally, RIDO plays a fundamental role in enhancing our unit's adaptability, knowledge-base and research skills pertinent to grant writing. Alongside promotion of the ARU ECR Charter, RIDO has supported staff development in the unit through regular updates on both ECR and theme-specific funding opportunities.

Allocation of School funding has led to the establishment of a unit-specific Research Funding Scheme, which provides staff with opportunities to apply for small grants (<£2,000) to support various development and research initiatives including: individual staff training and development; ECR and thematic area funding (with equal distribution of funds between ECRs and experienced staff); conference and research dissemination; research and impact case development; consumable and equipment funding; developing international collaborations; and research internships. Applications are encouraged across the year and involve a peer-review process with equal consideration to funding across thematic areas. As an example, this has facilitated implementation of our ARQlab initiative. Funding has also been obtained by 8 staff, for 17 research internships supporting exploratory work leading to postgraduate research project development. Furthermore, with conference and travel bursaries operating on a rotational basis, this has facilitated wider equality in funding distribution, resulting in all unit staff participating in

both national and international conferences. This has further supported staff development through engagement in keynote invitations and conference presentations (e.g. American College of Sports Medicine, **Smith**; International Council for Coaching Excellence, **Stodter**).

Institution QR funding has also supported staff and research-skill development through engagement in external CPD courses (e.g. statistics, grant development, research training skills), and doctoral studentships (e.g. VC funded doctoral programmes). In addition, with the introduction of the ARU Doctoral School, there has been strategic support for staff in terms of postgraduate supervision training. This has included annual monitoring review and viva-voce preparation training, which has been essential in guided administration and support for our postgraduate researchers.

Our annual Faculty Research Conference, unit-specific research away-days and Faculty-level networking events facilitate broader dissemination of research ideas and interests and showcases research excellence via staff presentations and highlighted research cases. Staff meetings within thematic areas have been positive in terms of identifying research and/or professional development requirements. By example, this has resulted in the conception and integration of our ARQlab within CAM, promoting collaborative discussion pertinent to qualitative research methodologies. Additional support for development is provided through School funding for strategic writing retreats to complete peer-reviewed articles, develop collaborative funding applications, or for specific professional development/grading review applications. Since 2016, 13 writing retreat places have been completed by 7 unit staff, leading to 5 publications, 4 successful grading review applications, and 2 grant applications.

CCSES staff are also encouraged to pursue career and research development, adding to the objectives of thematic areas through our annual sabbatical scheme. Support includes advice from senior management on application-makings, through to mentor advice from successful applicants. Our unit has achieved 3 sabbatical applications, which has brought about further external partnerships and successful grant applications (e.g. Ministry of Defence, £100,485 to develop doctoral research investigating nutritional strategies to minimise injury risk with military recruits, **Roberts**). This scheme has also facilitated 4 research outputs and supported staff doctoral research development.

Research students

Alongside growth in staff numbers and institutional resource provision, our unit has focused on developing postgraduate research (including support for 2 current staff undertaking doctoral research). In achieving our aim of validating two postgraduate courses (MSc Sport and Exercise Sciences/Sport Coaching) this has formed a platform for postgraduate research growth. We now have a sustained annual cohort of ~15 MSc

students which underpins our postgraduate research delivery, and strategically feeds forward into doctoral project development through developing critical, independent thinking, methodological considerations and data evaluation. Funding bursaries, including subsidised registration costs for postgraduate studies permits wider access to our MSc and PhD programmes. Additionally, through advertised doctoral programmes (e.g. FindaPhD), cross-faculty collaborations (e.g. Vision and Eye Research Institute), successful attainment of 2 ARU VC funded studentships (**Gordon, Smith**) and external funding (e.g. Ministry of Defence grant, £100,485, **Roberts**), we have increased doctoral student numbers from 2 (2014) to 22 (2020). There have been 5 PhD completions in the assessment period (see Table 1), with 4 in current submission. There have been prestigious employment achievements from our unit (e.g. **Caddy** (supervisors: **Gordon, Timmis**), now Lead Project Engineer for the British Cycling Development Programme). Our current students also contribute to cross-faculty research development (e.g. **Trott** (supervisors: **Smith, Johnstone**) is now a research assistant within the Faculty of Health, Education, Medicine and Social Care).

Table 1: UoA24 Doctoral degrees awarded

Year	Doctoral degrees awarded	PhDs awarded
2013-14	0	0
2014-15	0	0
2015-16	0	0
2016-17	1	1
2017-18	1	1
2018-19	1	1
2019-20	2	2
Total	5	5

This has created positive momentum within our unit, resulting in a 50% increase in applications to the unit in 2020 from national and international candidates. The appointment of a Director of Postgraduate Research for the School (**Aspell**) has facilitated this process through application screening, alignment with supervisory team expertise, and research proposal assessment. Our research students are provided with exceptional support, including allocation of supervisors with subject expertise and skill-base, who provide unit-level support in terms of research structure and objective planning, integration to our ARU 'Progress Platform' virtual monitoring environment and frequent guidance and feedback on thesis development. Aligned with this, in structuring supervisory teams, our unit has focused on maximising experience and mentoring opportunities to ECRs to facilitate growth in supervision capability in line with our longer-term vision.

Centrally, the ARU Doctoral School provides an institutional platform delivering training and support services for our research students and supervisors. For doctoral students, this includes mandatory research skills development through online and workshop-based training sessions (e.g. introduction to research ethics and integrity; working with human subjects; presentations and academic writing skills; thesis production and examination preparation) at strategic points across the doctoral programme. The ARU Doctoral School facilitates annual monitoring reviews via student/supervisor guidance, and assessor panels, independent to the supervisory team. This supports student progression in an open, non-biased manner in preparation for final examination; and has provided a constructive mechanism in timely doctoral completions within our unit.

Our dedicated research facility provides students with on-site access to ample working areas, meeting spaces, laboratory equipment, technician support and learning resources, as well as local access to main campus student support, study skills and library facilities. This provides a unique and engaging environment for MSc and PhD researchers to interact with supervisors regularly, creating a positive space for cross-discipline research discussion and peer socialisation. Our unit has also created local networking opportunities and peer-support connections to promote researcher inclusivity and drive a thriving research culture. Our quarterly research seminar series, for example, provides students the opportunity to present project findings, and openly discuss research methodologies. With the innovation of our ARQlab, students also interact with staff and external collaborators in exploring qualitative methods and real-world coaching applications. Postgraduate students also actively engage in collaborations with staff projects to further develop practical and problem-solving skills relevant to their research (e.g. integration of 4 postgraduate students to support data collection for funded research investigating cardio-metabolic health benefits of polyphenol-rich nutrition products in overweight adults, **Roberts**).

Research students are encouraged by supervisors and the Director of Postgraduate Research for the School to actively engage in our Faculty Annual Research Conference, to promote project dissemination, openly network, and integrate with other student researchers and staff across the institution. This has provided a platform for doctoral students leading to conference presentations. Students are supported through our unit-specific School Research Funding Scheme to present at national and international conferences across their doctoral journey. This has brought about highlighted research achievements e.g. **Strongman** (supervisor: **Morrison**), 2019 British Association for Sport and Exercise Sciences Annual Conference, winner for 'best research poster'. Our unit-specific School Research Funding Scheme also provides avenues for students to engage in further skill development (e.g. article writing, statistics courses, laboratory testing skills). The drive within our unit to build a thriving research culture has led to research students contributing to over 25 peer-reviewed publications in this assessment period (e.g. **Trott** (2020) "A comparative meta-analysis of the prevalence of exercise addiction in adults with and without disordered eating", *Eating and Weight Disorders*, 1-10; supervisor: **Smith**; **Strongman** (2020), "A scoping review of non-linear analysis approaches measuring variability in gait due to lower body injury or dysfunction", *Human Movement Science*, 69; supervisor: **Morrison**; **Wiffin** (2019), "Effect of a short-term low fermentable oligosaccharide, disaccharide, monosaccharide

and polyol (FODMAP) diet on exercise-related gastrointestinal symptoms”, *Journal of the International Society of Sports Nutrition*, 16:1; supervisor: **Roberts**).

3. Income, infrastructure and facilities

Income

As an emerging unit, we have achieved a research income of £123,150, mainly across the second half of the assessment period, reflecting initial establishment of facilities and research infrastructure, and development of projects. 49% of this income was attributed to UK-based charities via open competitive process and UK industry, commerce and public corporations. However, our recent progress reflects successful applications and current projects with external agencies contributing to future income (e.g. Horizon 2020, Cancerless project – developing and implementing a new cancer care pathway for the homeless, **Smith**, total value £2,500,000, with £306,130 awarded to our unit; and Ministry of Defence, funded doctoral programme to investigate nutritional strategies to reduce injury risk and support training adaptations in UK military recruits, **Roberts**, £100,485).

We have taken a pragmatic approach to our income strategy, with initial focus on applying for seed-funding, ECR development, and small-medium grants (e.g. Physiological Society, £9,500; Determining the effectiveness of a practical, inexpensive heat therapy treatment method for reducing the risk of pre-cardiometabolic disease, **Willmott, Roberts, Gordon**; Sport Scotland, £13,720 to develop coach-athlete education programmes, **Stodter**; Spencer Foundation, \$22,671; Using ethnodrama as an educational resource to encourage transformative learning, **Cavallerio**), whilst building experience with larger-scale applications (Innovate UK, £300,000; The use of hydrogen-rich water in conjunction with physical activity: impact on exercise adherence and health benefits, **Roberts, Smith, Johnstone, Gordon**). This originated from discussions within thematic areas, coupled with advertised funding opportunities (e.g. Research Professional communications) aligned the unit’s research goal of ‘transforming lives’ through promotion of sustained engagement and safe participation in physical activity. In doing this, we sought unit-specific training from our Research and Innovation Development Office (RIDO), with tailored advice from our Faculty Research Income Managers (**Abbott, MacCormac**) in funder identification, grant costing and application review and submission.

This has led to a number of successful small-medium grant applications for our unit, including UKRI (e.g. MRC Public Health Intervention Development, £4,177 to develop an intervention to reduce sitting time among office workers (the ReSit project), **Smith**) and Charitable Trust funding (e.g. Cancer Research UK, £20,000, Stealth project, Promoting physical activity across the life course through play, **Smith**; Chartered Institution of Highways & Transportation (CIHT) Foundation, £7,880 to explore visual attention and hazard perception in young cyclists, and develop a virtual reality game to improve hazard perception in young cyclists (**Timmis, van Paridon**). This has led to further funding to evaluate specific Council schemes (e.g. Essex County Council, 2020, £10,000 to evaluate Bikeability Training programmes in the region, **Timmis, van Paridon**) which will be progressed in line with our longer-term vision of informing policy change and regulatory practices.

Strategic planning and monitoring around income objectives features within staff appraisals. Senior management provide support through consideration to workload balance, connecting staff with experienced Faculty collaborators, recommendations for funding streams, and connections with advisors in relation to prospective KTP projects. Staff engagement in RIDO research seminars has supported unit awareness and understanding around the grant writing process, with guidance on winning successful bids, and working with collaborators. Where discussions have been held with prospective industry partners, collaboration with our RIDO-based Faculty Partnership Development Manager (**Kritzinger**) and Business Support Manager (**Glendinning**) has been instrumental in liaising with external partners, supporting full economic costings and formalising terms of agreements.

On-going support provided by these managers in terms of project monitoring, invoicing and provision of quarterly progress reports to funders has facilitated project quality and delivery. This has led to progressive development over the assessment period, evidenced through our unit successfully achieving numerous industry and collaboration-based funds (see Table 2). Outputs from exploratory research funding (e.g. ReSit project) has led to partner discussions to deliver evidence-based projects within charity and corporate sectors. This has brought about further research and consultancy funding aligned with impact case development e.g. Single Homeless Project Charity, £33,190, 'Promoting physical activity in the homeless' (REF2021 ICS1, **Smith**), and Mitie Energy, £25,833, 'Promoting physical activity in the workplace (REF2021 ICS2, **Smith**).

Table 2: UoA24 Industry and Collaboration-based Funding Examples

Industry-based Projects	Collaboration Funding
Institute of Nutrition and Fitness Science, £8589, 'Satiating effect of high protein diets on resistance trained individuals in energy deficit', Roberts	University of Cambridge, £20,700, 'Adaptation, Dispersals and Phenotype: understanding the roles of climate, natural selection and energetics in shaping global hunter-gatherer adaptability', Gordon (Co-I; part of £1,911,485 European Research Council grant)
Biocare Ltd., £8197, 'Effect of green tea strategies on fat oxidation and body composition in overweight individuals', Roberts	University College London/ British Heart Foundation, £9705, 'GlycA as a novel biomarker linking bacterial-mediated inflammation to adverse cardiometabolic and cardiovascular traits in the young', Roberts
Cambridge Commodities Ltd., £4963, 'Assessing the impact of a natural food ingredient on vitamin D levels in healthy volunteers', Roberts	University of Cambridge, £3983, 'Validation of a novel instrument for monitoring energy expenditure in humans through the assessment of body temperature and sweat rate', Gordon
MRC Industry Collaboration Funding Agreement, £5333, 'V-engage: Using Virtual Reality exergaming to engage adolescents with physical activity'; Smith (Co-I; part of £150,000 grant)	

Institutional funding support has provided a strong platform facilitating research initiatives, staff development and doctoral funding. Successful application for School Learning and Teaching awards (£3,372, **Cavallerio, Stodter, Dowling**; £3,123, **Cavallerio, Timmis**) has driven start-up and maintenance funding to implement our ARQlab project, increasing awareness and dissemination of qualitative research methods. This has also provided funding means to support research assistant costs in evaluating project effectiveness and sustainability. Our unit has secured 3 staff sabbaticals across the assessment period, which has facilitated successful grant applications (e.g. Ministry of Defence, £100,485, **Roberts**), and supported staff doctoral progress. We have also achieved 2 ARU VC doctoral studentships ('Physiological and metabolic responses to exercise programs based on genotype', **Gordon, Roberts**; 'Developing digital behaviour change intervention to increase physical activity in isolated older adults', **Smith**) which is shaping future doctoral programmes.

Looking ahead, our income strategy will focus on building research excellence through consolidating unit efforts, sharing successful application approaches, and obtaining strategic advice from external HEI-collaborators. In doing so, we will aim to: develop joint projects with cross-Faculty and cross-HEI collaborators; increase our experience with Research Council and larger-scale funding; and increase the number of cross-HEI collaborative applications in line with our longer-term vision. We have already secured a number of research grants creating the foundation for this strategy (e.g. Action Bladder Cancer UK, £9,944, Promoting physical activity to bladder cancer survivors, **Smith**; European Commission, £21,066, WE project – Investigating the effects of discrimination on health in LGBT, **Smith** (Co-I), part of larger £250,000 award; Fattoria La Vialla, Italy, £18,500, industry funding investing the impact of a natural antioxidant food product on exercise-induced oxidative stress in adults, **Roberts**), as well as applications in final submission (e.g. ESRC Healthy Aging Catalyst Awards, £62,000 to develop a cycling intervention scheme encouraging older adult activity, **Timmis, van Paridon**).

Infrastructure and Facilities

Our unit has flourished over the assessment period following institutional funding (£400,000) and team relocation to dedicated research facilities. This has shaped the research identity and

culture within our unit, based on central location, resource accessibility, team integration and provision of ample laboratory and research space. Our laboratory suites include a customised 267m² 'multi-purpose laboratory' (MPL) with dynamic capability for a diverse range of activity-based projects, coaching initiatives and innovative developmental work (e.g. 3D motion analysis, strength and conditioning monitoring, gait assessment, neuromuscular evaluation, eye tracking monitoring). Institutional QR funds have facilitated resource development, including: a state-of-the-art Vicon motion capture system, floor integrated force plates, Olympic lifting platforms/ Smith machine, and an Isokinetic dynamometer. The MPL is widely used for multiple research projects integrating physiology/nutrition/biomechanics/psychology and coaching disciplines.

Our facilities also include a suite of research laboratories permitting a wide range of research initiatives. The 118m² Human Physiology Laboratory provides a thermo-neutral controlled environment in which research involving cardio-respiratory, metabolic and biochemical assessment occurs. The addition of an environmental heat tent, portable sauna units and cooling bath has facilitated expansion of project areas associated with pre-cooling and heat-related adaptations, largely brought about through Faculty resource provision for ECRs. This has led to development of grant applications (e.g. Physiological Society, £9,500; **Willmott, Roberts, Gordon**) to pursue innovative environmental-exercise strategies to minimise cardio-metabolic risk in adults, and build on research aligned with the English Institute of Sport preparations for the Tokyo Olympics. Our ambition is to progressively expand this emerging research area leading towards infrastructure funding for a purpose-built environmental chamber.

The main Performance Testing Laboratory provides a 34m² facility dedicated to research, as well as consultancy income pertinent to physical activity and athletic support. In achieving national laboratory accreditation with the British Association of Sport and Exercise Sciences, demonstrating testing and operational excellence, we have utilised this area as a central location for researcher training and skills development. CCSES research activities are supported by a dedicated full-time Laboratory Technician (**Thompson**) centrally-located within the laboratory complex, who oversees laboratory use, provides specialist equipment training and technical expertise. This has been fundamental to the efficacy of both research student and staff project delivery.

The inclusion of a category 2 Human Tissue Laboratory within our laboratory areas has increased our potential to collect biological samples. This has brought about positive collaboration with the ARU Biomarker Lab, within the Faculty's Science Centre, not only through on-site assessment of various health biomarkers, but through provision of longer-term storage capability under Human Tissue Authority licence. This has generated considerable research interest from external and industry-based partners (see Table 2), and has provided scope to pursue advanced methodologies, resulting in successful funding applications (e.g. Ministry of Defence, ARU VC Studentships). Our facilities provide an attractive, professional and well-resourced environment to expand project opportunities, as demonstrated by research ventures with the University of Cambridge (**Gordon, Roberts**), University College London (**Roberts**) and Brunel University (**Willmott**).

Our future ambition will be to expand our biochemical and exercise testing laboratories, including an environmental extremes laboratory, and develop a marketing portfolio to promote our research capabilities to prospective HEI-collaborators. We have already instigated this through recent institution funding for a microbiological safety cabinet (£8,500), increasing our independence and capability; and will further pursue this to expand our assay testing capacity, whilst working in greater synergy with the ARU Biomarker Lab to develop consultancy research activities. This will enable us to specialise in developing methods pertinent to metabolic testing, immune and inflammatory profiling and connect with other leading experts to develop multi-centre projects in line with our longer-term vision. We also aim to expand our sports therapy clinic area, obtain accreditation for clinical gait analysis, and develop this as a platform to enhance injury prevention research.

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

Collaborations

Our unit has been highly proactive across the assessment period in instigating and sustaining numerous collaborations aligned with government, charitable trusts, industry and commerce; as well as establishing research partnerships with academic collaborators and world-leading experts. In achieving our goal of demonstrating growth with 'external, community and industry-based research collaborations' we have generated 'purposeful impact within industry, workplace and charitable-trust settings'. This has largely been determined within thematic areas based on strategic alignment to the unit's goal of improving engagement and participation in physical activity across the lifespan, as follows:

Health, Nutrition and Physical Activity – with established published work in the field of sedentary behaviour reduction and physical activity (**Smith**), our focus has been on pursuing collaborations to drive impact in this area. QR funding to support travel costs led to distinctive partnerships being established with Mitie Energy Ltd (to improve physical activity in the workplace) and Sport England (in funding the Single Homeless Project) resulting in the successful implementation of two impact projects. Further reach has been achieved through developing new (e.g. the Purfleet Trust) and existing (**Smith**, with University of Murcia, Spain) collaborations to expand projects in wider settings (e.g. support for homeless individuals in the East of England, and reducing sedentary behaviours within school settings). Unit staff have also collaborated with prestigious institutions to explore evolutionary aspects of human development aligned with physical activity (**Gordon**, with University of Cambridge) which has further generated cross-HEI collaborations, post-graduate project development and resource-sharing.

Our staff also collaborate with industry partners to design and implement studies evaluating the health benefits of nutritional products. Awarded sabbatical funding facilitated discussions with prospective partners, including resource and consumable provision specific to study delivery. This has resulted in centrally placed industry partners working in synergy with unit staff to generate research programmes with consideration to evidence-based and market-level applications (**Roberts**, with Cambridge Commodities Ltd., Biocare Ltd., Bayesian R&D Ltd., Netherlands, and the Institute of Fitness and Nutrition Sciences, India). This has further facilitated cross-HEI and NHS Foundation Trust collaborations (**Roberts**, with University of Cambridge, and the NIHR Cambridge Biomedical Research Centre, Core Biochemical Analysis Laboratory, Addenbrookes Hospital).

Staff aligned with HNSA have also established European and international partnerships to develop cross-discipline physiology research interests with applications to improving cardio-respiratory health, which has led to on-going internships, resource sharing and doctoral supervision (**Gordon**, with University of South Paris, France, and Universidade Federal de Minas Gerais, Brazil). Cross-HEI collaborations have been established to investigate applications and health benefits of leisure activities pertinent to physical activity engagement; as well as the use of digital technologies and heat acclimation relevant to exercise adherence and occupational health (**Willmott**, with University of Brighton, Brunel University). Our institutional affiliation with our ARU Biomarker Lab has driven promotion of resource capability, leading to collaborative funded research (**Roberts**, with University College London) to investigate novel gut-related inflammatory biomarkers associated with metabolic syndrome development in children. This is a promising area of research aligned with physical activity promotion, with further research studies being explored.

Coaching and Management - unit staff have developed a wide-reaching network of HEI-collaborators, including support for staff on a mentorship basis. For example, research exploring sport policy and governance, and organisational frameworks pertinent to sport and exercise have led to national and international partnerships being established (**Dowling**, with Loughborough University, Manchester Metropolitan University, University of Alberta, Mount Royal University, Canada). The innovative conceptualisation and implementation of our ARQlab initiative, including School learning and teaching funding support, has resulted in our unit

collaborating with leading experts to deliver specialist seminars pertinent to qualitative research methodology (**Cavallerio**, with Swansea University, Laurentian University, Leeds Beckett University and the University of Birmingham), and enhance qualitative research in sport injury psychology and coach-athlete dynamics (**Cavallerio**, with University of Portsmouth, University of St. Marys Twickenham, University of Chichester and University of Toronto).

QR funding has supported the development of the 'Street Games' and 'Play with Pride' initiatives to increase inclusivity within physical activity and sport programmes. These have led to government interactions via Living Sport and Cambridge City Council (**Stodter, Cavallerio, Dowling**), with additional Faculty post-covid funding (£2,800) to support the development of 'Play with Pride' through an evaluation of an LGBTQ+ inclusive coaching initiative (**Stodter**). With on-going research exploring effective coach learning and education, our staff not only interact with other leading HEI-collaborators (**Stodter**, with Liverpool John Moores University, Oxford Brookes University, Loughborough University) but are innovatively developing models to understand and enhance learning in sports coaching. Unit staff have also been involved in research investigating head injuries and training in women's rugby, leading to the development of a consortium of HEI-collaborators (**Stodter**, with University of Exeter, University of Swansea, Cardiff Metropolitan University, Waikato University, and Auckland University of Technology) and successful sabbatical application to further this research.

Movement, Vision and Injury Prevention - research in this area has largely focused upon visual hazard prevention and road safety with young cyclists. Established links with the Cambridgeshire Bikeability Scheme and Essex Highways, along with staff proaction in applying for funding from the Chartered Institution of Highways and Transportation has resulted in public and government body collaborations to explore visual attention in hazard perception (**Timmis, van Paridon**). This supports the unit's interest in creating innovative strategies to improve safe participation in physical activity across the lifespan. Strategic alliance has been formed with cross-Faculty collaborators (**Timmis, van Paridon, Morrison**, with the ARU Sound and Game Engineering Research Group) to develop a virtual reality game to improve cycling skills in children, along with facilitating doctoral research investigating driver cyclist conflict. Unit staff have established other institutional and wider HEI-collaborations (**Timmis, van Paridon, Morrison** with the ARU Vision and Eye Research Institute; **Timmis**, with University of Bologna and University of Essex) to explore visual search behaviour in exercise and health settings, including the risks associated with mobile phone use and physical activity. Our staff have also collaborated with the Professional Golfers Association to restructure their education programme based on established research (**Morrison**, with the University of Ulster), and scientifically evaluate golf equipment alongside the R&A Rules Ltd., to promote sustained participation in physical activity.

Contributions

The culture within the unit is synonymous with research dissemination and public engagement largely based on the importance of physical activity for health and well-being, and wider community, industry and media interest. Our staff are professionally supported through our Press Office (**Green, Forsyth**). Engagement in high-profile media activity has included television appearances (e.g. BBC's *The Truth About...* series, exploring Mental Health, **Smith**, and Impact of diet on health, **Roberts**; BBC's *The Great British Intelligence Test*, and Good Morning Britain, **Smith**), newspaper articles (e.g. *Metro*, **Smith**; *Daily Mail*, **Smith, Roberts, Timmis**; and the *Guardian* and *Daily Telegraph*, **Timmis**), and online media (e.g. ScienceDaily, **Smith**). This has extended to numerous articles on online platforms (e.g. *The Conversation*) with global reach to public and academic audiences (i.e. article on fat-burning and exercise achieving over 1,300,000 reads, **Roberts, Gordon, Willmott**). Our staff have been proactive with radio and podcast interviews creating wider interest around the health benefits of exercise (e.g. the Naked Scientist, **Gordon**), and nutritional applications within sport (e.g. Athlete Evolution, **Roberts**).

Our unit has been proactive with public engagement events, including the Cambridge Science Festival, the British Science Festival and the National Cycle Conference, facilitating wider dissemination around visual perception research (**Timmis, van Paridon**), and health benefits of

exercise (**Gordon**). We have also instigated our own public forum to actively share ideas around exercise training and health (e.g. ARU Train Smart seminars, **Roberts, Gordon, Willmott**). Staff research has also been actively used within various media and charitable campaigns. By example, biomechanical expertise on gait analysis has been utilised to promote physical activity in children (**Morrison**, with StartRite/The Daily Mile Foundation). Coach-education research has been utilised by the Open University and Sport England to deliver open online courses (**Stodter**, contributing to over 1,400 accesses). Partnership with Para-Monte, the UK's only Altitude Awareness Charity, has been instigated by our unit (**Willmott**) to promote safe participation in activities involving high altitude, with online research dissemination inform public awareness.

Unit staff have also been instrumental in establishing research groups, steering committees and conference organisation. Expertise in systematic and meta-analyses review methodologies has resulted in staff co-ordinating internationally leading groups (e.g. European Society of Geriatric Medicine Group in Systematic Reviews and Meta-analyses, **Smith**) including numerous HEI-collaborators and health service providers (**Smith**, with Yonsei Medical School, University of Padua, Alberta Health Services). Staff are involved with the Cluster for Research into Coaching (CRiC) Steering Committee (**Stodter**), and actively support conference organisation. Building on knowledge gained through involvement as a member of the Organisation Committee for the International Conference of Qualitative Research in Sport and Exercise, has led staff to organise and chair the first online ECR and student conference for the International Society of Qualitative Research in Sport and Exercise (**Cavallerio**), with engagement from current ARU doctoral students.

In promoting physical activity, health and well-being, our staff have contributed to numerous national and international conferences across the assessment period, as well as delivering professional webinars and keynote lectures. This has facilitated wider dissemination of thematic area research and active promotion of the unit through invited presentations and personal communications. Highlighted invitation and presentations have included: the International Sports Medicine and Sports Science Conference, Malaysia (**Willmott**, exploring the development and implementation of heat alleviation strategies to enhance athletic performance); the International Conference on Olympic and Paralympic Sports, Brazil, and the International Conference on Sport and Exercise Sciences, University of Paris-Saclay (**Gordon**, exploring limitations to human performance); the International Society of Sports Nutrition Conference (**Roberts**, exploring dietary applications within exercise settings); and the International Society of Biomechanics Conference (**Morrison**, exploring human movement, player surfaces and biomechanics). Dissemination of staff research promoting physical activity in the workplace has also been carried out at public exhibitions (e.g. Leisure Industry Week) and academic forums (e.g. European Physical Activity Network, **Smith**).

Staff contribute to a wide number of academic societies and professional bodies, through active membership, conference attendance (with support from our unit-specific School funding scheme) and online communications promoting research and employment opportunities. This includes the British Association of Sport and Exercise Sciences (with 50% of unit staff as members); the British Psychological Society, the British Association for Nutrition and Lifestyle Medicine; the European College of Sports Science, the European Association for Sport Management; the UK Sport Development Network; the UK Strength & Conditioning Association, and the American College of Sports Medicine. Furthermore, staff support governing bodies through professional and public sector research promotion (e.g. **Roberts**, Editor-in-Chief, Nutrition Evidence Database).

Our unit staff contribute to over 40 peer-reviewed journals, supporting international research quality and dissemination, in the capacity of Editorial Board members (**Dowling, Gordon, Roberts, Smith**) and expert reviewer roles. Our breadth of contribution to the academic community covers all aspects of physical activity, health and well-being, with journals ranging from: *The Psychology of Sport and Exercise Science*; *Qualitative Research in Sport, Exercise and Health*; *Journal of Sport Management*; *Sports Medicine*; *International Journal of Sports Nutrition and Exercise Metabolism*; and *Optometry and Vision Science* as examples. Finally, our

staff have contributed to over 15 doctoral examinations, developing wider collaborations with over 7 HEIs.