Institution: University of Northumbria at Newcastle

Unit of Assessment: UoA 24 Sport and Exercise Sciences, Leisure and Tourism

1. Unit context and structure, research and impact strategy

Unit Context and Structure

The staff base submitted to this Unit of Assessment (UoA) has grown almost four-fold (from 13.8 FTE in REF2014 to 53 FTE in REF2021, 54 staff). This reflects a significant shift in the resources and energy invested to increase and enhance the quality of our research activity (**Figure 1**).

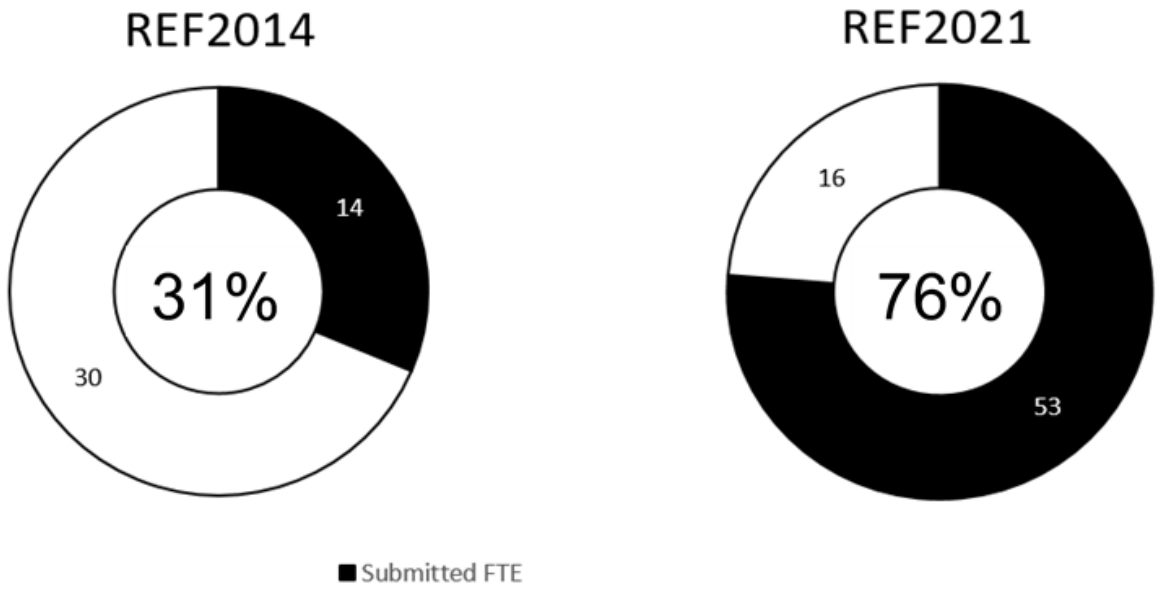


Figure 1. Staff (FTE) submitted to REF2014 and REF2021 demonstrating the growth and increase in the staff base and research intensity in this unit.

The Unit sits within the Department of Sport, Exercise and Rehabilitation, which has three core discipline areas (Physiotherapy; Sport and Exercise Sciences; Sport Coaching, Development and Management). Following the results of REF2014, the Unit critically reviewed its performance and made a concerted effort to transform its direction and research priorities to increase our **research power with concomitant quality**. This has been made possible by our long term vision and strategies that have transformed an academic community with high quality teaching and pockets of research excellence into a Unit renowned for its distinctive, pervasive and exceptional research.

Our research has three distinct themes that encapsulate the richness of the Unit. These inclusive themes recognise and support the breadth and depth of existing and emerging research excellence across all our disciplines. Importantly, these themes do not stand in isolation; whilst Unit staff might be more active in one theme, the overlap between themes encourages cross-boundary working (**Figure 2**).

Figure 2. A graphical representation of our three core themes research themes. Satellite balloons represent areas of existing and emerging research excellence.

- **Optimising Human Performance**

This theme, led by **Professor Howatson,** aims to improve our understanding of how the human body responds and adapts to the stress of exercise, and how we can manipulate exercise, diet and recovery strategies to optimise the exercise-recovery-adaptation process. The theme has developed an internationally respected reputation for: 1) the assessment of the neuromuscular system in response to different fatiguing exercise and other exercise training stimuli using sophisticated neurophysiological techniques; 2) the application of preventative and therapeutic interventions (including functional bioactives) to facilitate recovery from exercise; and 3) use of integrative physiology to understand sex differences to exercise and specifically female exercisers and older adults. The group has an excellent publication record of applied research, which has attracted significant interest with external end-users. Consequently, we established very strong relationships with elite sport partners, such as the English Institute of Sport (EIS), British Cycling, British Sailing, and British Gymnastics that have resulted in tangible impact (see REF3) and are continuing with additional projects (British Sailing and British Gymnastics).

- **Promoting and Preserving Health and Wellbeing**

In line with our intentions articulated in REF2014, this theme, led by **Professor Hettinga**, addresses the importance that physical activity and nutrition play in improving health across the life-span (from child health to modified physical activity for the elderly) and the prevention and treatment of deconditioning (through ageing and physical inactivity), and long-term medical conditions. The theme takes numerous approaches including systematic reviews, qualitative, observational and experimental studies. There is a particular reputation for delivering high quality randomised controlled trials in clinical conditions (e.g. cancer survivors, Parkinson's Disease, COPD, Crohn's disease, Multiple Sclerosis and cardio-respiratory diseases). Studies are informed by comprehensive patient and public involvement (PPI) to ensure that they are focused on outcomes of upmost importance to patients and their carers. This work is intrinsically linked to a University **multidisciplinary research theme** (**MDRT**) of Integrated Health and Social Care (see REF5a) which is led by **Professor Vogiatzis**. There are strong links with charitable trusts, health care trusts and harder to reach populations (such as those with learning difficulties), which has attracted substantial research funding (see Section 3).

- **Informing Practice and Policy**

This emerging research group was formally established in 2017 following the appointment of its lead, **Professor Potrac**, who has been instrumental in providing staff direction and cohesion. Research in this theme critically examines the challenges and dilemmas associated with professional practice, the formulation and enactment of policy, and the well-being of those working and participating in sport and exercise. Researchers in this group draw upon and integrate theory and methods from a variety of academic disciplines (i.e., sociology, social psychology, education and management). They have developed its reputation for publishing high quality research on a variety of topics including the social, relational and emotional dimensions of sport coaching; the enactment of sport, physical education, and leisure policies; and supporting the well-being and development of sport participants. The group has developed a strong relationship with external partners internationally (e.g., the European Union of Football Associations), nationally (e.g., The Football Association, Power to Change, The Talented Athlete Support Scheme, and the Scottish National Outdoor Training Centre), and regionally (e.g., Newcastle Falcons, Newcastle United F.C., and the Sunderland A.F.C. Foundation of Light). The group's research is being used to support organisational policy making and the development of groups and individuals (see REF 3).

Our interconnected approach empowers staff to engage in cross-fertilisation of research ideas and expertise, and hence the opportunity for Unit interdisciplinarity and collaborations across other Units and external partners. Each theme leader supports this development through mentoring, coaching, organising CPD events and providing discipline-specific leadership and expertise. This has been particularly important for engaging colleagues who were historically not research active

and also to enthuse newer staff and early career researchers (ECRs). We are now at a point where **~90% of staff** (compared to ~35% in REF2014) are involved with research activity and have contributed to at least one research output; **76%** (Fig. 1) having a *significant responsibility for research* (defined by the Code of Practice referred to in REF5a), with 9 further FTE engaging in doctoral studies.

The growth in research activity has been accompanied by a marked increase in the quality, rigour and profile of our outputs (**67% in upper quartile journals**), and in the volume of research across the Unit, much of which has translational impact. For example, the work in neuromuscular regulation, exercise recovery and clinical exercise physiology has global reach and significance to benefit end-users. Consequently, this submission represents a Unit characterised by vitality and vibrancy, that has seen major growth in the last cycle thereby achieving our strategic aim of increasing research power with quality.

Strategy and Leadership

Changes in Unit leadership in 2014 led to establishing the *Research and Enterprise Strategy Group* (RESG). This group is responsible for the strategic research direction of the Unit with the aim to facilitate research excellence across all Unit themes. The increase in research leaders (**from 1 Professor in REF2014 to 7 Professors and 3 Associate Professors in this cycle; Figure 3**) illustrates our longer-term commitment to invest in the research agenda. An important role of the RESG was establishing the Unit's *Research and Innovation Strategy* to significantly build on results from REF2014. The strategy provided structure, focus and cohesion to grow our existing research excellence, and provides direction for nurturing emerging research excellence. This action is supported by the University's **'Vision 2030'** and **Strategic Outcomes** (presented in REF5a) and aligned with University Key Performance Indicators (KPIs) that aim to:

1. **increase proportion of staff with a significant responsibility for research by 60%**
2. **increase the research quality - 80% of staff producing 3* and 4* research by 2023**
3. **increase research and enterprise income (15% per annum to 2018 and 5% per annum to 2023)**

In the REF2014 submission, there were aspirations to expand the Unit's research base by developing people and investing in estates and external engagement, which aligned firmly with the University's 'Vision 2030. Achieving this has been made possible by academic staff (on average in the unit) having **40% of their workload dedicated to research**. The time and space available to pursue research is further maximised by identifying discipline-specific challenges and opportunities for more efficient working practices, providing relevant professional development (research and personal), raising aspirations of staff, targeting external funding opportunities, and other research investment (e.g., internal capital support).

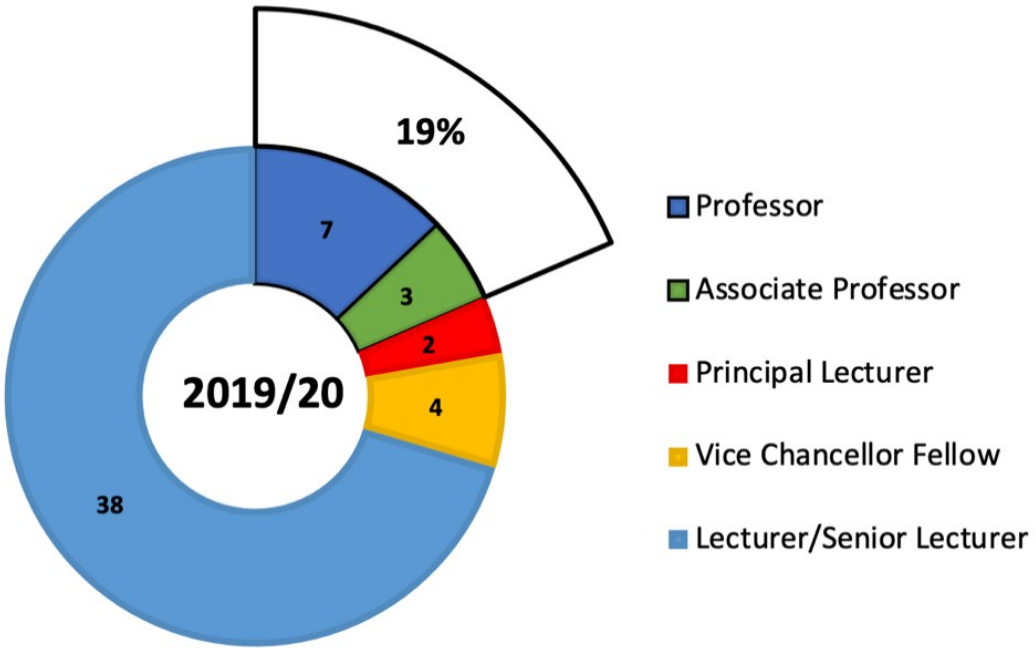


Figure 3. Unit growth in research leadership. At the time of submission, 10 staff (19%) are in research leadership positions compared to a single Professor in 2014.

Evidence of research growth in this REF period:

- The number of staff submitted to this Unit has increased **from 13.8 FTE to 53 FTE**
- Funding applications have seen an 8-fold increase since REF2014 (bid value >£7.5M in 2019/20) and the value of new research-related awards (n=61) in this REF cycle is >£4M (RGCI - £1.825M [July 2020], compared to £423K RGCI in REF2014).
- An increase in doctoral completions from 9 in REF2014 to 50 in the current cycle
- A total of 11 impact case studies are in development (5 selected for REF2021).

This substantial progress has been made possible by delivering on strategy goals to develop a positive and inclusive research culture across the Unit, which actively engages, and is supported by, vibrant and energetic staff. In addition to making sufficient space and time to conduct research, opportunities are also provided to engage in grant writing workshops, training (such as paper writing), away days, mentoring systems, seminars and journal clubs to facilitate the research culture and collaboration through relationship building. Funding for external activities is made possible by quality research (QR) funding (detailed in Section 2 and 4). Other developments since REF2014 include the expansion of bespoke laboratory spaces for neuroscience and clinical work to improve research relating to health and wellbeing (Section 3). Our suite of well-equipped laboratories has opened opportunities leading to numerous collaborations and high-quality outputs (i.e. published in upper-quartile journals) with world leading institutions (e.g., University of California, San Diego, University of Groningen, Imperial College London, KU Leuven, Monash University, University of Oxford, University of Zurich).

The research leadership team has emphasised a philosophy of continued improvement and academic excellence, which generates state-of-the-art research. Central to achieving the goals set out in the Unit's strategy is developing a culture based on *inclusivity* (e.g., increasing staff research engagement across the department), *excellence* (produce high-quality outputs) and *community engagement* (the co-production and translation of research for social and economic good). This philosophy evolved from an ethos that high quality education and research have equal importance and should have relevance to the wider community. This has been achieved by:

- **Increasing the number of doctoral-qualified staff with a significant responsibility for research** (offering staff the opportunity for doctoral study and recruitment of doctoral-qualified staff)
- **Increasing the quality and volume of research activity**
- **Increasing the number of doctoral students**
- **Increasing income generation from external sources**
- **Increasing the application of our work to the community** (impact)

Metrics for the above points have increased substantially (presented in subsequent sections) in this REF cycle and represent evidence of substantial Unit growth. This is made possible by increased Unit collegiality, national and international collaborations, and researcher autonomy to lead projects and increase income generation. This approach to research will ensure the sustainability of the Unit's work beyond REF2021. Whilst a strong emphasis has been to develop research quality, we have been mindful to provide the opportunity for colleagues to have a clear sense of belonging and being engaged in a continuing process of development. Importantly, our research themes allow for discipline diversity to contribute to central themes, but concurrently engage in research that is stimulating on a personal and a discipline-specific level. Overall, we believe this strategic approach has been vital to the Unit's growth in this REF cycle.

In addition to the Unit-specific themes, the University has invested in six **MDRT** (REF5a). This initiative has directly benefited the Unit by bringing researchers together to address complex societal problems. One of these MDRT, **Integrated Health and Social Care,** has significant contributions from this Unit; it is led by **Professor Vogiatzis** and >20 Unit staff contribute to its activities. Similarly, an interdisciplinary cross-University group with established expertise in different aspects of nutrition has integrated its activities to develop a nutritional trials unit (NUTRAN; https://www.northumbria.ac.uk/business-services/engage-with-us/research/nutran/). This group takes a molecules-to-man approach to develop interdisciplinary research relating to human health and performance and has substantial input from this Unit (6 staff).

The **Integrated Health and Social Care MDRT** has been enabled by significant University investment of **~£500,000 per annum in this cycle** and resulted in the recruitment of two research Professors, two Vice Chancellor's Fellows, the setting-up of a cellular and molecular laboratory

and the purchase of instrumentation such as *optoelectronic plethysmography* that supports Unit-related work (Section 3). Since the initial investment, the Unit has established strong research links with NHS trusts in the North East, Yorkshire and Cumbria, with prestigious research funding agencies (e.g. National Institute of Health Research, NIHR), and with national and international institutions and scholars. This has facilitated collaborative research projects and increased funding applications and success. For example:

- **Prestigious awards:** NIHR Health Technology Assessment, £1.47M; European Union, Horizon 2020, €423K
- **Increased research quality in clinically-related exercise science:** rehabilitation**,** cancer survivorship, COPD, multiple sclerosis, Parkinson's Disease, older adults, etc.
- **Publication of high-quality research in world leading journals**: The Lancet, European Respiratory Journal, European Urology, British Journal of Cancer, Journal of Physiology.

Impact Strategy and Research Infrastructure

Building from the strategy articulated at REF2014, the research conducted in this Unit has generated significant real-world applications and benefits. For example, stakeholder problems are addressed by delivering challenge-led research, where projects actively help to solve problems by directly applying the knowledge and evidence to impact the end user. In this REF cycle, a more focused and nuanced effort has been made to capture the impact of our research. The Unit staff have undergone substantial training, with support from research leaders and the University Research and Innovation Services (RIS), to embed and actively capture (intended and unintended) impact across the research lifecycle for wider socio-economic benefit beyond academia. For example, ongoing research collaborations with the English Institute of Sport and elite sport partners have led to several funded PhD studentships that are directly embedded within Olympic sports. The knowledge generated is underpinned by a formal memorandum of understanding to work co-operatively that directly leads to new research knowledge to be directly embedded in the sports, where it can have a performance impact for competing athletes (see REF3, where two impact case studies exemplify this approach).

All research is conducted in accordance with ethical standards that are underpinned by the Faculty and University research ethics procedures and, where necessary, IRAS for activity with clinical populations and the NHS. These ethical standards are supported by excellent standards of care and maintenance of our laboratories (as evidenced by **British Association of Sport and Exercise Sciences [BASES] Laboratory Accreditation**), which include established operating procedures and rigorous health and safety standards (**endorsed by the HSE**). In addition, many staff hold **professional accreditations** (e.g., BASES, UKSCA, BPS) and **chartered or HCPC status** (exercise scientists, physiotherapists and psychologists).

The Concordat to Support Research Integrity is made clear to all staff at an early stage of the research journey (new arrivals, ECRs and PGRs). Research integrity is an expectation for all staff and PGRs within the appropriate *Code of Conduct*. In addition, we adhere to the REF open access policy and the University's Research Data Management policy that requires the retention of data for up to 10 years. There is a resource of ~£100K per annum for fees associated with Gold Open Access that is managed by the library and can be applied for with support from the Unit's RESG. Research data can be stored on the University secured server and other University supported infrastructure (e.g. figshare) that will make these data accessible (unless otherwise restricted). The Unit also supports the accessibility of meta-data, and complies to the *FAIR* guidelines (**F**indable, **A**ccessible, **I**nteroperable; **R**eusable) for research data, particularly when it assists the content of a research output. Additionally, many protocols are publicly available through open access clinical trials registries, such as *clinicaltrial.gov* and *ISRCTN*. RIS and the University Library also provide a plethora of resources to help researchers to make judgements on data accessibility to increase transparency and reproducibility of information.

Looking Forward

Moving beyond REF2021, under the leadership of **Professor Potrac,** the emerging excellence of the **Informing Practice and Policy** theme will continue to grow in both the number of research active staff and the quality of the research that is produced. Our **Optimising Human Performance and Promoting and Preserving Health and Wellbeing** themes will consolidate their position by continuing relationships with elite sport partners, charities and health care trusts that yield high quality work with direct application to the end users. Given the more recent appointments to the Unit, we envisage particularly strong additions to our current portfolio of work with clinical populations. Our current position has set the strong platform for further growth that will afford greater sustainability with vitality of research beyond 'Vision 2030' (REF5a).

We will increase funding applications across our staff base targeted to RCUK, charities, defence and industry partners. The continued growth of the PGR community is vital to our future success. This will be facilitated through a combination of internal awards and, increasingly, through externally funded, collaborative, self-funded and joint-award PhDs. Collectively, we will continue to grow our research power with quality and use this research to benefit the regional, national and international community. The planned growth (summarised below) will provide new opportunities for our students, research-informed teaching, increase expertise in those research topics, and ultimately generate new knowledge and beneficial impact beyond academia.

Strategy – Building for the Future:

- To ensure sustainable growth of existing and emerging research excellence. This will be achieved by supporting and mentoring ECRs and more established colleagues; increase the number of post-doctoral researchers from external funding sources; further collaboration with internal and external partners
- To establish our themes as field leaders in the relevant disciplines. This will be achieved by working collaboratively with internal and external stakeholders to address complex issues that have reach and significance beyond academia. A good platform is now set for further growth in Practice and Policy and Promoting & Preserving Health and Wellbeing, in particular
- To grow income generation from external sources (RCUK, charity, industry NGBs) that support basic and applied research activity that can be translated to achieve impact
- To maintain the number of doctoral researchers through external and University collaborative (joint-funded) initiatives and self-funding PGRs
- Increase the opportunities for staff to complete research-related sabbaticals
- Maintaining a balanced portfolio for all staff to engage enthusiastically in the research agenda in an energetic manner that explores new knowledge in mechanistic, applied and translational research for the benefit of end-users.

Summary

Collectively, this vibrant Unit has substantially grown **research power with quality**. Our research has gained international recognition across all our themes, particularly in the exercise sciences, coaching science and in clinical populations. This has been made possible by the development of our existing staff base, investment in estates and equipment, recruitment of high performing research-active staff, retention of existing high-quality staff, and support from our research leadership team. As a result, we have a robust, sustainable foundation that produces research excellence across all facets of the Unit. Central to the achievement of our ambitious research goals is a culture based on inclusivity, quality and community engagement.

2. People

Overview of Staffing Strategy

This Unit has 54 staff (53 FTE) that is comprised of 4 Vice Chancellors Fellow, 38 Lecturers and Senior Lecturers, 5 Associate Professors/Principal Lecturers and 7 Professors; 19 (35%) of these staff are ECRs. Approximately 40% (22) of the staff base has changed during the course of the cycle, which is attributable to Unit growth, retirement, geographical moves and voluntary severance. All new appointees have been selected for their positive influence on our research environment. Of particular note is the increase in the research leadership, where the Professoriate has grown from a single Professor in REF2014 to seven in the current submission. The increase in senior staff has been an integral part of the research journey by providing direction, leadership and mentoring across the Unit's diverse activities. The rise in senior research leaders is

attributable to new arrivals following central investment (**Hettinga, Potrac, Saxton, Vogiatzis, Wagner**) or promotion from within the existing staff base (**Caplan, Howatson**).

Professoriate-enabled opportunities that were not previously available:

- **Co-supervision of PhD students - particularly with high profile partners** (e.g., Multiple Sclerosis Society, GSK, Sunderland AFC - Foundation of Light, GB Cycling, EIS, British Gymnastics, British Sailing, QPR Football Club)
- **Co-investigator roles on grant applications in different areas of exercise, health and sport** (e.g., NIHR; Cherry Marketing Institute; Naturex and other prestigious health charity funding streams)
- **Introductions leading to new relationships with external partners for research and knowledge exchange** (e.g., The RFU, The FA; GSK, NHS Trusts (regional and national), EIS, Ministry of Defence)

These senior appointments have increased the appetite and energy for research and innovation within the Unit, to the point where it is part-and-parcel of academic life. Collectively, the recruitment of high quality, research-active staff and the development of existing colleagues through mentoring, doctoral study and research inclusivity have driven our expansion. The return on this investment is evident in that our teams have produced **>950 research outputs (FWCI: 1.42) in this cycle, compared to 192 (FWCI: 1.14) in the previous cycle**. Importantly there has been a concomitant rise of research with quality; **567** (**67%) of all papers appeared in upper quartile journals**. Further, **55% of all papers were co-authored with international collaborators, as opposed to 26% in REF2014**.

Growth has been made possible by refreshing the staff base through a natural turnover, reducing the staff-student ratio, increasing research investment from internal and external sources, and increasing time to engage in research. When recruiting new staff, a strong emphasis has been placed on recruiting doctoral-qualified, higher-performing researchers, and talented ECRs. Appointment decisions are strategic and based on synergy with the existing research portfolio and hence align with our strategy and themes, and importantly our culture of vitality and vibrancy.

Post-doctoral Staff

The increase in external income generation coupled with central University investment has allowed this Unit to employ significantly more post-doctoral researchers (15 across this REF cycle compared to 1 in REF2014), who are important in contributing to the Unit's ambitions of growth and research culture. Over the course of the REF cycle, six of these post-doctoral positions are Vice Chancellor's Fellows. These highly competitive 3-year posts attract high-calibre candidates because of the very light teaching and administration loads that allow researchers to rapidly gain research independence and progress to a full-time, permanent academic post.

Staff Development

The spirit of the Concordat to Support Career Development of Researchers is central to the cultural principles of the Unit's leadership in order for the researcher to flourish. All new staff have a research induction overseen by a relevant senior research leader, where detailed discussions and actionable plans are initiated in collaboration with the line manager. All research-related targets such as outputs, PGR supervision and funding applications feed into the individual's probationary plan and subsequent annual appraisal, which is the process to support all Unit staff to deliver research and impact. Research support infrastructure and opportunities are signposted, and research mentors are sought and assigned. In addition, the research leadership teams identify existing research synergies to support colleagues in making links with internal and external collaborators.

New staff have a **reduced administration and teaching load** for their probation period, which is designed to help gain momentum in meeting research ambitions. New and existing staff, particularly ECRs, are very well supported in establishing their research careers (see Researcher Support), which leads to greater Unit sustainability. As recruitment is designed to have strong alignment with existing and emerging research excellence, newer staff can be readily aligned with more senior colleagues. These actions support our collegiate approach for research productivity, PGR supervision support, and strengthens our ECRs position to becoming independent researchers that can contribute to research excellence.

Researcher Support

The Research and Innovation Service (RIS) supports Northumbria University's research community. The focus of an individual's research is identified with RIS funding managers, who inform on appropriate funding streams, set up alerts with platforms such as *Research Professional* and identify expertise that might lead to collaborative funding applications. RIS provides further support services such as training staff in grant costings and approvals, report writing, and financial management from pre-award through to post-award and completion. There is a dedicated research impact team that has grown 4-fold in the last REF cycle to support staff on how to develop reach and significance and collate evidence to best show-case impact material. For ECRs, there is the added benefit of the ECR Forum that hosts career level-specific conferences, additional training and development sessions, guest lectures, and funding opportunities. For those looking to become leaders within the institution, the University organises a *Future Leaders Course* and a *Next Generation of Large Award Holders Programme*.

The Unit offers away days, a seminar series, ECR representation on the Faculty R&I committee, and promotion of opportunities for working parents, those in career breaks and staff with protected characteristics. The Unit has a dedicated individual (**Peart**) responsible for identifying staff CPD

needs, who in collaboration with the RESG, deliver solutions to address those needs, such as one-to-one mentoring, external training, attendance at conference, seminars and workshops.

To support our research aspirations, we aim to achieve (on average) a 40:40:20 ratio of activity relating to research and scholarly activity, teaching and learning, and administration, respectively. The **Unit achieved this split in 2020/21, in comparison to 28% research time in 2013/14**. The Unit has further supported staff to maximise this time by managing their workloads to generate blocks of time to engage in research. For example, staff might have a busier teaching semester or part of the week, which gives greater freedom at other times. Fractional and fixed term staff also have the same research allocation within their workload and are fully integrated in the day-to-day business of the Unit (meetings, away days, resource allocation, for example).

We strongly promote collegiality, which is achieved in several ways. Firstly, we have a transparent system of workload, so all staff are aware of the indicative work associated with each staff member. This gives colleagues a greater understanding of the "bigger picture" beyond teaching and consequently staff are supportive of colleagues. Openness and transparency regarding the goals, aspirations and challenges facing the sector, and specific to the University, are communicated regularly along with the contributions the Unit can make in achieving these ambitions. Post-doctoral researchers, research fellows, ECRs and technical staff are integrated to all activities the Unit offers that include training, workshops, access to resources, facilities and social activities. Technical staff also have the opportunity to have 30% allocation of time dedicated to part-time doctoral study, currently two technical staff are enrolled in part-time PhD programmes.

The activities of the RESG are instrumental in providing strategic direction for team efforts. In addition to QR-supported monthly seminar events with invited speakers, there are regular MDRT seminars, theme-specific journal clubs and social events. The Unit's QR (~£57K per academic year) supports conference travel and other research-related activities (consumables, for example). QR also supports each research theme to have up three away-days per annum, which is complemented by a whole Unit away-day where staff, PGRs and technical staff are invited to attend broader themed activities (funding, communication, and supervision, for example).

Beyond the Unit-specific and RIS supported activity, there is an extensive suite of staff research training and CPD opportunities run by the Faculty and the wider University. These include paper writing workshops, writing retreats, ECR forum activity, hosting conferences, training, and development sessions, guest lectures and ECR-specific funding opportunities, impact case study workshops, media training, fund specific forums and sand-pit events, and PGR supervision workshops. We have a strong focus on supporting ECRs and mid-career staff re-engaging or starting their research journey, which is critical in meeting the ambitions of our Unit.

Progression/Promotion and Sabbaticals

Staff are key to achieving our vision to be recognised as a research-rich, business-focussed, professional University with a global reputation for academic excellence. The aforementioned staff development opportunities allow researchers to progress their careers to a point where they can apply for academic progression to Associate Professor or Professor. The academic promotion opportunities are annual, and not based on a quota system, but rather recognition of academic achievement and research excellence. The threshold for promotion is high and the criteria are intended to identify the increasing standards of academic excellence over a sustained period. In the last REF cycle 7 staff (13%) have successfully transitioned to Associate Professor or Professor. These opportunities, along with the recruitment strategy, are central to the succession planning that is building our next generation of research leaders and provide greater sustainability for the Unit's future. Furthermore, the introduction of a three-band Professorial progression scheme enables the recruitment and retention of outstanding researchers (including three level 2 Professors in this Unit).

All staff are informed of the annual opportunity to apply for sabbatical leave (one can be taken every 6 semesters), where a period of defined research/impact activity (that would not otherwise be possible) can be completed. Only one sabbatical period was taken in the previous REF period whereas 13 staff have taken research sabbaticals in this cycle. Examples of the work that has been achieved during sabbaticals include the setting-up and/or delivery of large scale, multi-site projects (**Caplan, Saxton, Tew**), development of international collaborations (**Howatson;** Jyvaskyla University, Monash University, Michigan State University), completion of substantial research projects (**Baker, Naisby, Findlay-King**), develop research output following extended periods immersed in teaching activity (**Scott-Bell, Partington**) and collating impact case study material (**Hall**). Prospectively, the Unit has produced a rolling 5-year sabbatical plan to manage staff/areas for prioritisation, ensure equitability and encourage participation with the aim of doubling sabbaticals in the next REF cycle.

Postgraduate Doctoral Researchers (PGRs)

The PGR community is highly valued in this Unit and there has been significant growth since REF2014, with 50 completions (n=4; 8% international) compared to 9 at REF2014.

*Year-by-year cumulative doctoral completions (*indicates one Professional Doctorate that year)*

2013/4	2014/5	2015/6	2016/7	2017/8	2018/9	2019/20
10*	14	17	27	29*	37	50

The University supports internally funded (fees and stipend) doctoral studentships through the Research Development Fund (REF5a). This Unit has received 26 of these studentships in this

REF cycle (equating to **>£1.5M central investment**). In addition, the University offers a matched funded (up to £10.5K per annum) collaborative PhD studentship programme with an external partner. We have been particularly successful in securing PGRs through this initiative, having received 22 studentships during this REF cycle (representing an investment of **~£1.3M**). The scheme provides a low-cost, low-risk investment in research with external partners that can embed new knowledge to directly impact the end-users (section 4) and improve day-to-day working practices. Projects of this nature enhance our institutional reputation and hence we have seen an **increase in self-funded PGRs (n=15)** in this cycle, **compared to zero in REF2014**.

The combined increase in PGR opportunities and Unit reputation attracts high calibre doctoral candidates, selected from very competitive pools of applicants, across all research themes. Many of these high performing PGRs are involved in adjunct research that is enabled by our collegiate approach. This results in PGRs gaining additional training, greater experience and the potential to graduate with more publications, which increases employability. Our PGRs produce excellent outputs (for example, **American Journal of Clinical Nutrition, British Journal of Sports Medicine, Journal of Physiology, Sociology of Sport Journal**) and complete in a timely fashion (**100% timely completion rate**). Our PGRs secure excellent employment (in academia, elite sport and industry). According to the latest Postgraduate Research Student Experience Survey, Northumbria was rated at 84% for overall satisfaction, comparing favourably to the Global mean and Russell Group Universities (82% and 71%, respectively). Furthermore, staff not previously qualified to doctoral level have the opportunity to engage with in-service doctoral study. Currently **8 staff have completed in-service doctoral training** and are submitted in this Unit; overall, 100% of submitted staff are qualified to doctorate level. A further **9 staff** are enrolled in doctoral study and so do not yet have significant responsibility for independent research (and so are not submitted, as defined by our Code of Practice), although they are expected to enhance the pool of research staff in the next REF period. Likewise, **two 'Graduate Tutors'** (teaching staff on 'tenure track' for appointment as lecturers) are enrolled as part-time PGR and are expected to become independent researchers in the next REF period.

Yearly growth of doctoral students enrolled for full or part-time study in this REF cycle

2013/4	2014/5	2015/6	2016/7	2017/8	2018/9	2019/20
44	48	50	54	48	60	53

Doctoral students are provided with their own office space with individual IT provision and the relevant bespoke software. This is coupled with 'hot-desk' spaces for those predominantly based off-campus (non-staff, part time and externally-based PhD students). In addition, there is a dedicated space in the library *Research Commons* that is available 24 hours a day for PGR study, meetings rooms and academic-related gatherings.

The Graduate School deals with all aspects of doctoral degree governance and provides supervisors with mandatory postgraduate supervision training every three years. We ensure multiple staff members are included on supervisory teams (minimum of 2, and where possible, ECRs) to promote collaboration, project resilience and breadth of expertise. This is supported by an online platform that records monthly meetings, progression points and training throughout the course of study. There is an allocated staff member in the Graduate School that works closely with Unit doctoral students and supervision teams to ensure the right support is provided for timely thesis submissions.

Unit investment in the development of doctoral students by:

- Providing supervisory teams that combine experience and subject expertise
- Providing extended support via the Graduate School to provide mandatory and elective CPD and training activities such as ethics, health and safety, viva preparation
- Providing teaching training that can lead to HEA associate membership
- Facilitating co-supervision of UG and PGT students by PGRs

Doctoral candidates are actively encouraged to present their work at internal and external conferences, which can be financially supported by grants from the Graduate School, external awards or other resources at the disposal of the supervisor. Participation in the Unit's monthly seminar series and journal clubs, as well as a seminar series run by the MDRT, are strongly encouraged and are well attended**.** These are valuable platforms for PGRs to share their work, receive critical evaluation and critically evaluate peers and staff in a supportive environment.

The PGR Programme Leader (**Barry**) and relevant research leads from RESG hold monthly meetings with doctoral students as an additional training opportunity. These **"PG Tips"** sessions are a forum where students are able to engage with peers and research leaders about areas of interest or concern, for example: conducting peer reviews; preparing manuscripts; viva preparation; dealing with difficult participants; mental health; grant applications; discuss and share challenges; shared experiences from previous PGR students.

In addition, PGR students are encouraged to be involved with UG and PGT teaching activity (when the requisite support training is completed) e.g. as demonstrators or leading specific sessions where they have subject expertise. This is a vital component of the PGR experience to increase confidence, communication skills and teaching experience that can lead to Associate Fellowship of the HEA and hence increase employability.

Equality, Diversity and Inclusion (EDI)

Building on our Code of Practice and the mandatory core training for all colleagues, the Unit is committed to advancing equality of opportunity and eliminating all forms of discrimination. We

recognise the significant EDI challenges facing UoA24 nationally and the wider HE sector. Consequently, under the leadership of the Director of EDI, we have striven to integrate the EDI into all that we do. For example, we actively promote gender equity in our Unit culture through language choice such as 'parent' instead of mother/father, 'Equity' as well as 'Equality' & 'They' instead of 'He/She'.

The EDI Group and RESG consist of a diverse staff make-up that includes balanced gender, age and representation from varying career stages (including post-graduate students, early- and mid-career researchers, and Professors). Reflecting our commitment to EDI, the Department recently applied (December 2020) for the Advance HE Athena SWAN Bronze Award. As part of the staff survey to understand working conditions, 88% agreed or strongly agreed that it is a good place to work for women and men. All Unit staff complete institutional professional training and development related to EDI annually. Furthermore, all line managers and Unit leaders complete non-mandatory unconscious bias training and across the last two years, 9 female and 12 male staff have been supported through internal researcher development courses. The Unit is committed to promoting equality of opportunity and hence the principles of the Athena Swan Charter are embedded in the promotion policy such that, any special circumstances affecting an individual are considered whilst ensuring the required quality and impact of achievements are demonstrable.

Every effort is made to attract staff from groups with protected characteristics, who are typically underrepresented in discipline areas linked to our Unit. For example, compared to sector benchmarks in Sports Science and Leisure, we have a higher proportion of female staff (40%). Research leadership in the Unit is provided by seven professors (three with protected characteristics), which is a higher proportion compared to data from the most recent Advance HE Staff Statistical Report. Since REF2014, 8 female and 10 male permanent staff, and 6 female and 8 male fixed-term staff have joined the Unit. We have increased the number of **female staff submitted ~5-fold from 4 (25%) in REF2014 to 19 (35%) in the current cycle**. Importantly female staff make significant leadership contributions to the Unit leadership (6 females and 4 males).

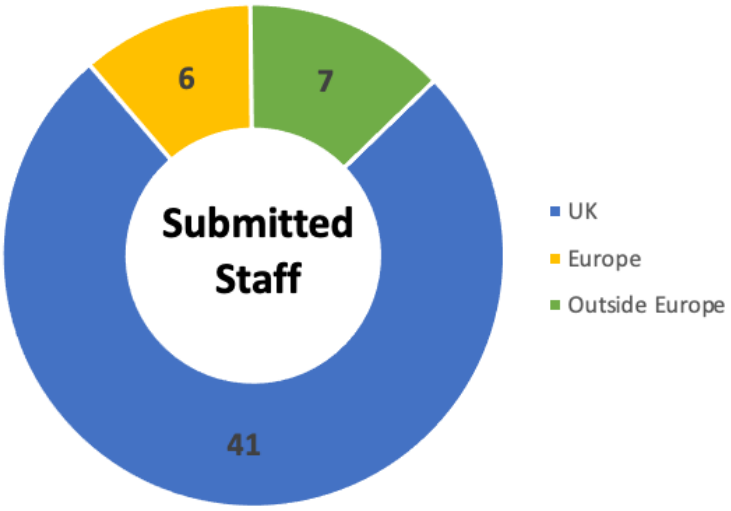
The Unit strives to achieve a positive work-life balance through workload management, so that individual wellbeing is maintained to support the Unit's culture of vitality and energy for delivering sustainable research. For example, we have enabled 10 Unit staff to share the raising of children more equally. Wherever possible, we hold team meetings between the hours of 10AM and 3PM to enable staff to accommodate family commitments. All meeting minutes are uploaded to a secured online SharePoint site; relevant meetings during the COVID-19 restrictions are recorded so staff with responsibilities in the home can review their content at a time convenient for them.

Four male and six female colleagues have been supported through parental leave since 2014, and additional staff have been supported through shared parental leave.

The EDI Director facilitates activities (e.g., wellbeing training days, mental health first aid) to help maintain a vibrant, productive and contented community. Staff are actively encouraged to make use of the University's flexible working policy and where necessary, to discuss workload concerns with line managers where pragmatic solutions can be explored. Staff work with line managers (6 female and 4 male, grade 8/9) and mentors through the annual appraisal process to set actionable work plans that reflect their career aspirations. Those staff with underlying conditions or declared disability (5 FTE; ~10%) have reasonable adjustments made to the workload to allow them to balance personal challenges and work demands.

We are proud to celebrate an inclusive, equitable and diverse Unit, including the achievements of colleagues from groups with protected characteristics who are recognised as role models. For example, **Dr Hicks** was named by *The Chronicle* as a **Rising Star for females in STEM subjects in the North East**. We also have a wide international influence that enriches the Unit's research, where **~24% of Unit-submitted staff** originate from countries outside of the UK (Figure 4), including: Brazil **(Cucato**, **Wilhelm-Neto);** Canada **(Temesi);** China **(Zheng);** France **(Avner);** Greece **(Vogiatzis);** Hong Kong **(Ling);** Ireland **(Keane);** Italy **(Angius, De Martino);** Netherlands **(Hettinga);** Russia **(Batuev);** USA **(Wagner).**

*Figure 4. Number of international (24%) staff in this REF period; **NB:** 4 international staff have joint nationality.*



Research by staff in this Unit (**Allin; Ansdell; Avner; Boocock; Durbaba; Findlay-King; Goodall; Hall; Hicks; Howatson; Potrac; Scott-Bell; Thomas**) is concerned with understanding, and positively impacting, the experiences of those from groups with protected characteristics. This underlines our continuing commitment to addressing societal equality and includes research outputs submitted regarding sex differences in fatigue and performance; gender

inequalities and older adults; women's leadership in Outdoor Education and Adventure Sport; Intellectual Disability and Equal Opportunities for Active and Long-term participation in Sport (Erasmus PLUS); coaching in elite female sport teams. Our monthly research forums include topics that intersect with themes of EDI that help highlight and educate staff on these issues, such as presentations addressing *older adults* and *harder-to-reach* populations (socially deprived, mental and physical impairment), *sex differences* in performance, *clinical populations and disability physical activity*.

3. Income, infrastructure and facilities

Income

The Unit's external research-related awards for this REF period is **£4.1M** (£1.85M RGCI), which **represents ~10-fold increase** from the previous REF cycle (£423K). For example, 72 applications for >£100K have led to **12 large awards** in this REF cycle. This income has come from a variety of sources, including the Research Councils, industry and charities, that we will increasingly target in the future. This success is the result of an increase in high quality applications (193 in total), with a total application value in 2019-2020 of >£7.5M. Examples of major prestigious awards include two from the NIHR Health Technology Assessment programme:

- **£1.47M** for The Gentle Years Yoga Trial; a multi-centre randomised controlled trial assessing the effectiveness of yoga for improving quality of life in older adults with multimorbidity. This is the UK's largest ever trial of yoga, and it will help to inform if yoga should be used routinely in the NHS. (Principal Investigator: **Tew**)
- **£1.9M** for the PREPARE-ABC trial; a multi-centre randomised controlled trial assessing the effectiveness of pre- and post-operative exercise training on post-operative morbidities and quality of life in people with colorectal cancer. This is the UK's largest ever trial of pre-habilitation and will inform policy and practice in the NHS (Co-Principal Investigator: **Saxton**)

Other major awards include:

- Research England **(£361K; Vogiatzis)**
- GlaxoSmithKline **(£158K; Howatson**)
- UK Space Agency **(£283K; Caplan)**
- European Space Agency **(£171K; Caplan)**
- Naturex **(£144K; Howatson)**
- PepsiCo **(£108K; Stevenson)**
- Yorkshire Cancer Research **(£238K; Saxton**)
- MS Society **(£100K; Saxton)**

The substantial increase in research income has allowed realisation of the Unit's research strategy (outlined in Section 1) and hence increased capacity through the growth of research staff (PGR students, post-docs and other RAs), resources for research (such as equipment and

consumables), further expansion of working partnerships, and staff development from project involvement and dissemination of the work to the scientific and wider communities. Furthermore, the Unit has received **£650K of in-kind payments** to directly support research activity; for example, these in-kind payments allowed work with the UK and European Space Agency (ESA) to access the ESA bed rest study and Zero-G aviation flights to test exercise intervention in microgravity and prolonged deconditioning paradigms. Activities and initiatives that supported the success of external income generation include:

- Setting ambitious individual application targets (to achieve a year-on-year increase in income across the Unit of 15% per annum)
- Regular and frank communication of targets and expectations to Unit staff
- Ensuring protected time for research in all academic workloads
- Providing training and support for grant writing (e.g., targeted funding courses, research mentoring, internal peer review of draft applications)
- Pump-priming of preliminary studies that inform grant applications (e.g., via QR budget)
- Ensuring that all new staff appointments have a track record or the potential to generate external income
- The growth in research leadership, alongside the above activities, have been critical to providing staff with confidence to be ambitious and apply more widely and more frequently.

The research income from this period has enabled the generation of many high-quality research outputs and meaningful impact beyond academia. For example, funded research from the European Space Agency (**Caplan**) examining postural control and rehabilitation in micro-gravity has been published in the **Journal of Applied Physiology**. In Optimising Human Performance, two funded PhD studentships (with EIS) embedded in elite sport directly explored performance-related questions to improve peak power output in elite sprint track cyclists; this work has now been applied to enhance the performance of the Great Britain Olympic Track Cycling Team (see impact case study). Similarly, the Informing Practice and Policy theme secured an award with Sunderland A.F.C Foundation of Light charity to fund a PhD studentship to assess the influence of various community sport interventions aimed at overcoming social isolation, reducing crime, and re-engaging people in education or further training. In Health and Wellbeing, externally-funded research (**Tew**) has led to the development of novel NHS-based services in the North East of England that improved patients' readiness for major surgery (e.g., PREP-WELL; see impact case study). Collectively, these examples provide evidence that funding application success has strengthened our research reputation, increased excellent outputs, and had impact beyond academia. Importantly for the future, the change in culture around funding applications will support sustainability and growth of research into the next REF cycle.

Infrastructure

Institutional-level services that support the Unit's research and impact activities include RIS, Business & Enterprise Services, Library Services and IT Services (REF5a). Since 2014, there has been **>£330K investment** in books and access to journals and databases specific to this Unit, which also benefits from wider multidisciplinary resources (e.g. Web of Science; journals such as Nature, Science), with a total investment **>£6.4M across the REF cycle**.

Since 2014, the development of a structured research strategy within the Unit (Section 1) has improved research cohesion and function to allow greater access and cross-fertilisation of knowledge and resource across the Unit and wider University, particularly with colleagues in UoA3 (Applied Health Professions) and UoA4 (Psychology). The inception of the **Integrated Health and Social Care** MDRT, led by **Prof Vogiatzis**, has complemented our research strategy and encompasses areas of mutual research interest, expertise and excellence. For example, the nutritional influence of polyphenol-rich fruit juice on human health has been studied using multiple methodologies from a range of disciplines, including metabolomics, vascular physiology, biochemistry, cognition and exercise capacity. This has resulted in high quality publications e.g. American Journal of Clinical Nutrition and European Journal of Nutrition.

There are annual opportunities for staff to request capital equipment and estates development where prioritisation of ECR and new appointees is made to gain research momentum. The Unit has successfully secured **~£630K** in this REF cycle; examples include £96K for DEXA; £35K, laser Doppler; £108K, performance analysis instruments; £56K, optoelectronic plethysmography; £110K, cardiorespiratory monitoring; £56K, wireless EMG and high density EMG; £23K, biochemistry equipment; £57K, optoelectric plethysmography. This is coupled with a QR annual budget of ~£57K to help staff with research-related costs such as consumables, travel and dissemination of research.

In addition to the support outlined in Sections 1, 2 and in REF5a, the Unit is well supported by seven technical staff. The technical team supports all aspects of laboratory-based and field-based activity within the Unit (e.g. health screening, analytical chemistry, physiological and biomechanical assessments). The Unit also has access to a wider technical and academic team within the Faculty that has expertise to facilitate specialist analytical procedures such as high-performance liquid and gas chromatography, mass spectroscopy, molecular biology, cell culture, metabolomics, proteomics and meta-genomics. These resources and methodologies help provide mechanistic insight to our work; collectively, this enables ambitious collaborative projects across the Faculty (colleagues in UoA3 and UoA4, including cognition and sleep research) that lead to higher-quality research outputs across multiple Units.

Facilities

The Unit benefits from having large and well-equipped laboratories for conducting research in sport, exercise and rehabilitation that compare very favourably with other internationally competitive facilities. This is the result of significant and sustained investment from both the University and from externally funded grants. The Unit's research facilities are based at two areas of the University's City Campus, notably Sport Central and Northumberland Building. These laboratory spaces have been accredited by BASES since 2009, which represents the gold standard in quality assurance in this field. In addition, all staff have dedicated office spaces that are equipped with the appropriate hardware and specialised software such as Matlab, R and Spike2. Our facilities are supported by an Estates service that delivers IT, maintenance, technical and non-technical support.

Completed in 2010, Sport Central is a £30M state-of-the-art facility that incorporates a range of Unit-specific laboratories and research suites. These include:

- 50 metre running track (force plate configurations along its length)
- Strength and Conditioning suite (extensive resistance training equipment)
- Gait Laboratory (Cybex isokinetic dynamometry, 5 floor-embedded force plates, EMG)
- Biomechanics Laboratory (14 camera Vicon system, 5 floor-embedded force plates)
- Performance Analysis Suite (16 station bespoke performance analysis software)
- Metabolic Nutrition Laboratory (food preparation and analysis)
- Physiology Laboratory (treadmills, cycle ergometry, online gas analysis, blood sampling)
- Integrated Performance Laboratory (6 independent stations, each with cycle ergometry, gas collection and analysis, cardiorespiratory and electrophysiological monitoring)
- Laboratory preparation areas

Other parts of Sport Central that are used to support research include a sports arena, sports hall, swimming pool, squash courts, climbing wall, fitness suite and meeting rooms. The research potential of this facility was not fully realised at REF2014, but it has since allowed the Unit to evolve and maximise its research capacity.

Ten research-specific laboratories located in Northumberland Building house a broad range of activities, such as biochemistry, exercise testing and measurement of cardiorespiratory function. Specialised laboratories are dedicated to an environmental chamber [heat, cold and hypoxia], biochemistry analytics, cell culture work, body composition (DEXA), metabolic nutrition, neurophysiology and sleep science (a fully equipped two-bedroom apartment for polysomnography analysis). The biochemistry laboratories allow the processing of cellular and

acellular human material (adipose tissue, blood, faeces, muscle, saliva, sweat, tears), which are stored in a Human Tissue Bank under licence from the Human Tissue Authority. The investment in these facilities and their supporting infrastructure has established a sustainable foundation for innovative and impactful research at Northumbria for many years to come. Importantly for the Unit, it has enabled extensive collaboration and access to research infrastructure from elsewhere in the University, the UK and internationally (Section 4).

International: More than 20 visiting researchers (e.g. California, Groningen, Jyväskylä, Monash, Nuremberg, Saskatchewan, Nicholas Institute of Sports Medicine and Athletic Trauma) have spent time working on collaborative research projects. Examples include:

- **Kidgell and Frazer**, who visited for 1 month from **Monash University**, Australia and worked with Unit colleagues (**Ansdell, Goodall, Howatson, Thomas**). Neurophysiological techniques were shared between colleagues during the visit, and the group collected data that examined alterations to the neural system following resistance training that has subsequently been published (Experimental Physiology, Sports Medicine, European Journal of Applied Physiology). As a direct result of this relationship, we have been able to contribute to work at Monash University and hence expand the facilities the Unit can access for mutual benefit that makes a positive contribution to the field.
- **Professor Hortobagyi** and PhD candidates Zult, Menting, Liutkute, Kuhdair from **University of Groningen** have collectively visited for >2 years. These visitors worked on projects with Unit colleagues **Goodall, Hettinga, Howatson** and **Thomas**) to examine the use of mirror training to enhance strength adaptations and the influence of pacing manipulation to improve cycling performance. Outputs from these collaborations include publications in Sports Medicine, Medicine and Science in Sports Exercise, Journal of Neurophysiology.

National: collaboration with NHS Trusts has expanded the Unit's capabilities in terms of exercise training and testing with clinical populations (e.g. **Vogiatzis** with Prof Stephen Bourke and Northumbria NHS Trust to assess COPD patients with co-morbidities in a clinical space that can support testing of vulnerable populations). Our extensive collaborations with industry partners and sports teams (Section 4) have also permitted access to special populations and facilities (such as MRI scanners and bespoke exercise instruments). Several individuals have also worked with the UKCRC Registered Clinical Trials Units (e.g. Newcastle, York, Norwich, Sheffield) to support the running of clinical trials (e.g. NIHR-funded projects of **Tew** and **Saxton**).

Internal: collaborations with colleagues in UoA3, UoA4, and UoA20 have widened our engagement in interdisciplinary work, which is partly made possible through the Integrated Health and Social Care MDRT. For example, our interventional research projects have incorporated analytical techniques such as metabolomics, HPLC, flow cytometry and cell culture (e.g. to assess

the influence of nutritional interventions), whilst concurrently assessing cognitive function with colleagues in the Brain Performance and Nutrition Research Centre (UoA4; **Goodall, Howatson, Keane, Peart, Walshe**).

Enabling impact

The infrastructure, facilities and expertise of this Unit have allowed a broad portfolio of challenge-led research to be developed in collaboration with industry partners and other stakeholders. Specifically, we direct research efforts to have an impact on human performance, improving health and wellbeing in clinical and the wider population through physical activity and by using sport and exercise to impact the psychosocial aspects of elite sport, exercise and physical activity participation. By its nature, such research is geared towards generating impacts beyond academia. For example, based on our specialist facilities and equipment, coupled with expertise, a global natural ingredient company (**Naturex**; **£144K**) collaborated with the Unit to investigate the efficacy of a food extract on exercise performance and recovery. Data from these studies has contributed to portfolios of evidence used to make European Food Standards Agency claims.

The researchers are the primary drivers of research impact, but there is significant infrastructure and assistance to support impact generation. Funding is available to support academic staff increase the reach and realise the significance of their work. One example is where **Hall** was granted a semester-long sabbatical to develop research impact by delivering CPD material to hundreds of coaches in the UK and across the world (see impact case study material); this would not have been possible in the normal allocated workload.

Other examples where infrastructure, facilities and expertise support impact:

- Appropriate planning of staff workloads to ensure time is protected for such activities
- At least two staff collaborate on impact material to ensure continuity and sustainability of impacts
- Impact Officers and Managers from RIS provide support around generating and measuring impact (one Impact Officer is specifically allocated to UoA24)
- Impact training courses and individual and group workshops delivered by RIS and **Professor Mark Reed** (Fast Track Impact)
- The Unit-run bi-monthly 'Impact College' co-ordinated by the impact lead (**Goodall**) where staff share impact related challenges, successes and ideas
- Internal funding to support reach and develop the significance of impact to stakeholders
- Staff delivery of consultancy and CPD services
- Public engagement through exhibits and public lectures (see Section 4)

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

Research Collaborations – A Global Network to Deliver Excellent Research

Academic staff from this Unit have established collaborations with academic and industry partners at an international, national and regional level, as demonstrated by co-authored research outputs

(55% co-authored with international collaborators) and funding applications (n=193). Our integrated research themes promote multidisciplinary and interdisciplinary research that combine our expertise with that of our partners for the benefit of specific projects.

International Collaborations

In this REF cycle our staff have collaborated with academic colleagues worldwide, including: *Africa (South Africa, Zambia, Congo); Asia (China, Russia, Hong Kong); North America (United States, Canada); Europe (France, Greece, Netherlands, Sweden); Oceania (Australia);* and *South America (Brazil).*

Specific examples include:

- Africa (North West University, University of Johannesburg)
- Asia (Hong Kong University, Hong Kong Baptist University, National Taiwan University)
- Europe (University of Athens, University of Ghent, University of Groningen, The Hague University, Jyvaskyla University, Karolinska Institute, KU Leuven, Palacky University, Politecnico di Milano, Vrije Universiteit, University of Zurich).
- North America (University of British Columbia, University of California, Harvard University, New York University, Saskatchewan and University of Utah)
- Oceania (Deakin, Edith Cowan University, Griffith University, James Cook University, La Trobe University, Monash University, University of Queensland, University of Sydney)
- South America (University of São Paulo, Federal University of Rio Grande do Sul Universidade Federal do Amazonas

Collaborators from these universities have played an important role in the growth and development of our own research by increasing expertise on specific projects to allow for: 1) greater depth and breadth of expertise across and between disciplines to be established; 2) bi-lateral visits to facilitate knowledge sharing and training opportunities; 3) publication of higher quality research; 3) collaborative PhD studentships; 4) the formal development of Memoranda of Understanding (Jyvaskyla University, Monash University, Palacky University, North West University, University of Michigan) to work across research and enterprise activity.

Other projects with external partners include those with **Danone, European Space Agency GSK, Naturex, NHS Trusts, PepsiCo, The FA, UEFA** and prestigious charities, such as **the Cancer Research, Movember, Multiple Sclerosis Society, Yorkshire Prostate Cancer Charity**. Notable examples are a European Union funded project (**Horizon 2020 – MOBILISE-D**) to the value of **€43m comprising 34 international partners** and 8 pharmaceutical companies **(Vogiatzis, €423K to Northumbria**), which connects digital mobility assessment to clinical outcomes for regulatory and clinical endorsement in five clinical populations. This work utilises expertise from physiology, nutrition, public health, information technology, health economy, epidemiology and psychology. In another example, work led by **Caplan** secured **UK Space Agency** funding **(£283K)** to investigate microgravity countermeasures on the ZERO-G "vomit comet". This work was supported by the **European Space Agency (ESA)**, who subsequently

selected and funded **(£171K)** work to be included in the **ESA and NASA Bed Rest Study** to use exercise countermeasures in microgravity.

An important part of our collaborative efforts has been the investment in the aforementioned (Section 2) Collaborative Doctoral Studentship Programme. The scheme has enabled the establishment of international and national partnerships that directly inform the end-users. This is direct evidence that our staff have a trusted reputation to attract, and work with, high profile external partners.

Examples of collaborative studentships include:

- European Space Agency
- Freeman Hospital Heart and Lung Transplant Association
- MS Society
- EIS x3
- GlaxoSmithKline x2
- Cherry Marketing Institute x2
- Newcastle United Football Club x2
- British Sailing
- British Gymnastics
- Queens Park Rangers Football Club
- Sunderland A.F.C Foundation of Light

Looking forward, we envisage 1) making greater use of the collaborative studentship resource, 2) work with colleagues across the university for interdisciplinary Doctoral training though Leverhulme and other schemes; and 3) will exploit opportunities for joint Doctoral awards with international collaborators.

National and Regional

Staff within this Unit collaborate with colleagues from over 30 institutions throughout the UK (for example, **Bath, Durham, East Anglia, Edinburgh, Essex, Exeter, Imperial College, Loughborough, Newcastle, Oxford, Sheffield, Sheffield Hallam, Stirling, Surrey, York**) and with colleagues across 12 different departments in all four faculties of the University. Evidence of this is given in Section 3, where this Unit has led nationwide, multi-site, exercise interventions with clinical populations and older adults (**Saxton, £1.9M**; **Tew, £1.47M,** respectively). We also have substantial relationships with commercial (**Newcastle Clinic, Glenmore Lodge in Aviemore**; industry (**GSK, Naturex**); elite sport partners (**Newcastle United FC, Queens Park Rangers FC, AFC Sunderland, British Cycling, British Sailing, British Gymnastics**) and non-government agencies (**EIS, UK Space Agency**).

Academic Exchanges

As further evidence of collaboration to enhance the local research environment, the University makes honorary appointments (Visiting Fellow and Professor). These appointments are to

support academics and industry partners to contribute to research activity in the Unit. In this REF cycle there have been 12 such appointments including **Prof Peter Wagner** (University of California, San Diego); **Prof Tibor Hortobagyi** (University of Groningen); **Prof Malachy McHugh** (Nicholas Institute of Sports Medicine and Athletic Trauma, New York, USA); **Prof Deiary Kader** (South West London Elective Orthopaedic Centre, UK); **Prof Simon Evetts** (Blue Abyss, UK); and **Prof Ken van Someren** (GSK). These individuals, along with others, contribute to the research culture across many areas. One stand-out example is **Prof Wagner,** who has visited us annually for 1 week at a time over the last 4 years and supported Unit research leaders in delivering research workshops, peer reviewing grants applications and shaping papers in preparation. This has supported ECRs and PGR students, as well as more experienced researchers to develop research skills and knowledge. His substantial contribution to the Unit (during both his visits and remotely throughout the year) has culminated in his appointment as 0.2 FTE staff, which will shape the future development of the Unit in the next REF cycle.

During this cycle our collaborators have exchanged students and staff to conduct research in our laboratories or travel abroad. In addition to those given in Section 3, examples of visiting scholars to conduct research include **Drs Dawson Kidgell and Ashlyn Frazer** (Monash University, Australia); **Prof Malachy McHugh and Susan Kwiecien** (Nicholas Institute of Sports Medicine and Athletic Trauma, USA); **Dr Alessandro Del Vecchio** (Imperial College, London); **Dr Simon Walker and PhD candidate Gomez-Guerrero** (Jyvaskula, Finland); **Dr Cas Fuchs** (Maastricht, The Netherlands); **Dr Jakob Skarabot** (Loughborough).

Esteem Indicators

The international reputation of the Unit has advanced greatly since REF2014, reflecting the strength of our new appointments and the fruition of projects led by established staff, such that our staff are recognised as leaders in their fields. Many Unit staff have served on grant committees (**eg. Saxton, Cancer Research UK, Yorkshire Cancer Trust, MS Society; Tew, Dunhill Medical Trust; Moore Stuart, NIHR; Morris, Parkinson's Diseases UK**). **Potrac** was appointed as a Full Visiting Professor at University College Dublin in 2017 and **Howatson** has been a Visiting Professor at North West University, South Africa since 2015. Many staff contribute to the discipline through scholarly society committees (see *Beyond Northumbria* below) and in 2020 **Howatson** was appointed as a Sub-panel member for UoA 24 in REF2021. Furthermore, our Unit staff were invited as external examiners for 69 doctoral degrees (27 abroad, e.g. Australia, Finland, France, New Zealand, South Africa Sweden), which demonstrates the valued expertise of our staff by peers internationally.

All staff members actively engage in peer review for journals and edited books that contribute to the field. Thirteen staff hold editorial positions on 23 high profile journals (e.g., **Dixon** and **Hayton,**

Managing Sport Leisure; **Hettinga,** Int J Sports Physiol and Perf; **Howatson,** Scand J Med Sci Sports; **Goodall,** Med Sci Sports Exerc; **Potrac,** Sports Coaching Review; **Stuart,** Gait & Posture; **Thomas,** Eur J Sports Sci; **Vogiatzis,** J Appl Physiol and Resp Physiol & Neurobiol; **Wilkinson,** J Sports Sci).

Staff in this Unit have given >100 invited international keynote/plenary/symposia sessions and contributed to >300 other conference presentations in the UK and internationally throughout this REF cycle at American College of Sports Medicine (ACSM), European College of Sports Sciences (ECSS), BASES, European Respiratory Society and Physiological Society. One such presentation won the ECSS Young Investigator Award (**Ansdell**) for outstanding work as an ECR and was also awarded the *Experimental Physiology* Inaugural Review Prize (2020 by the Physiological Society. In addition, several staff have been awarded Fellowships of learned bodies and societies for their contributions to the relevant fields (BASES: **Saxton, Howatson, Tew**; ACSM: **Howatson, Hettinga**; ECSS: **Hettinga**; European Respiratory Society: **Vogiatzis**). Many staff members have also contributed to other scholarly outputs in the form of 85 narrative and systematic reviews (including Q1 journals such as Cochrane Reviews, European Respiratory Review, Sociology of Sport, Sports Medicine, Sport Management Review), 72 book chapters, 6 monographs and 5 edited books.

Beyond Northumbria

Staff in this Unit make significant contributions beyond Northumbria. Evidence of contributions further afield is demonstrated through active membership of advisory panels, learned societies, international and national committees, honorary positions in other institutions and secondment.

Notable examples of wider contributions:

- World Health Organisation, Development Group for the Rehabilitation Programme; British Thoracic Society (**Vogiatzis**)
- Independent Advisory Panel for British Army; GSK Scientific Advisor; EIS Research & Innovation; The Football Association; BASES Lab Accreditation Chair (**Howatson)**
- UK Space Agency Life - Biomedical Sciences Association and UK Space Environments Working Group; European Space Agency (**Caplan**)
- National Institute for Health Research (NIHR) Cancer and Nutrition collaboration: Population Health: Cancer Prevention and Early Detection Committee; National Cancer Research Institute (NCRI); Yorkshire Cancer Trust (**Saxton**)
- Dunhill Medical Trust Research Grant Committee; Older Adults Expert Working Group for the 2019 UK Physical Activity Guideline Update (**Tew**)
- Secondment to the Swedish Ski Federation for 9 months to conduct applied research and data analysis on world class winter sport athletes (**Jones**)
- World Rugby Science Network and UK Coaching Talent Research Hub (**Hall**)
- Physiological Society Early Career Research Theme Lead (**Ansdell**)

Other advisory roles include: Active Edge Nutrition, Danone, England Rugby, EIS, For Goodness Shakes, GSK, Ministry of Defence, Multiple Sclerosis Society, Naturex, Newcastle United FC,

NIHR, PepsiCo, Sunderland AFC, Yorkshire Cancer Trust. Many of these relationships have informed practice and future direction in the fields of these organisations; some have led to securing the aforementioned research-related funding.

Northumbria as a Hub

The Unit hosted the International Sport and Exercise Nutrition Conference (2014, 2015), the International Sports Science and Sports Medicine Conference (2014, 2015), the BASES Student Conference (2018), and the World Transplant Games (2019). The dissemination of our research to the wider population has been achieved in numerous ways; one recent example is the contribution to **BBC Television series "The Truth About…"** series where Unit staff (**Goodall, Howatson, Keane**) provided examples of how various interventions can be used to improve recovery following exercise. In addition, public exhibitions at the Centre for Life (Newcastle), public lectures and engagement with younger adults have been delivered. For example, based on our UK and European Space Agency funded research examining the spinal health of astronauts, **Caplan, Winnard** and **De Martino** have developed a permanent exhibition within the "*Space Zone*" at the Centre for Life showcasing an interactive astronaut rehabilitation area.

Based on our research expertise, other Unit staff routinely contribute to professional development activities for professional sporting bodies. Examples include, **Avner, Boocock, Hall, Potrac** involved with instructor/coach education in adventure training activities, Rugby, Kayaking and Football. Others (**Goodall, Hicks, Howatson, Thomas**) deliver workshops and seminars to the EIS, The FA and Newcastle United FC.

Another example area of outreach has been the **IDEAL ErasmusPlus project** ("Intellectual Disability, and Equal opportunities for Active and Long-term participation in Sport"), which bring our scientific knowledge into practice in hard-to-reach communities. Organisations like The International Paralympic Committee, Special Olympics and World Intellectually Impairment Sport, along with European collaborators, have developed a series of resources (https://www.idealproject.org/) and organised events in different countries to promote inclusivity to those with intellectual disabilities. To further maximise reach, we translate our work to Polish, Swedish, Icelandic, German, Dutch and Spanish to make the content accessible to international audiences, such as those in the coaching field.