Institution: Middlesex University

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

1. Unit context and structure, research and impact strategy

1.1 The initiation of a research culture

Middlesex University's Sports Science department, the London Sport Institute (LSI), plays two significant research roles within the University: (1) as part of a University mission to rebuild sustainable STEM disciplines through synergies and collaboration, and (2) as a key component of an emerging regional development plan including the University, the London Borough of Barnet and Saracens RFC to improve the health and wellbeing of the local community in imaginative and technically enhanced ways. To support this, the LSI was transferred in 2014 from the School of Health and Education, to the Faculty of Science and Technology, enabling it to benefit from allied disciplines and research-intensive resources that could be shared.

The Faculty was asked to build upon the LSI's excellent advanced knowledge transfer, including partnerships with elite sports teams, to develop the research potential of the department and better align it to cognate STEM disciplines in the Faculty: Computer Sciences, Design Engineering & Mathematics, Psychology and Natural Sciences. A key aim set by the Faculty was to develop the LSI to the position of making a REF submission in 2020. To achieve this, a supporting structure existed within the Faculty comprising a Faculty Research Lead (Deputy Dean), representatives from each department (**Prof James,** Head of Research for LSI) reporting to the Faculty Research and Knowledge Transfer Committee. This enabled the LSI to benefit from the strong research leadership and culture across the Faculty, ensured sharing of resources and dissemination of areas for collaboration. An LSI Research Leadership Committee takes ownership of research within the LSI, reporting back to whole staff meetings and coordinating the development of research and the REF2021 submission. The Faculty also provided several opportunities for incubating and nurturing specific areas in collaboration with the department of Natural Sciences, where there was already a strong research culture and excellent research facilities available.

Coinciding with the move to the new Faculty in 2014, the University invested £650k in the Sports Science infrastructure to support research growth. This included new dedicated labs for Performance Analysis, Strength & Conditioning, Exercise Physiology, Biomechanics and Sports Rehabilitation. These were located in the East Stand of StoneX Stadium (formerly Allianz Park), home of Saracens RFC. This created the beginnings of an important local partnership between the University (LSI), Barnet Council, Elite sport and its International foundation - Saracens) and the local community. This is described below under our future plans.

In 2014 the LSI already had two key drivers for research. It was the first department in the UK to establish an MSc in Strength and Conditioning (2009) and a highly regarded MSc in Performance Analysis. These programs formed a natural focus for two research areas, providing a platform for researchers to engage and enthuse graduate students in their research interests and expertise. A departmental strategic plan was formed to bring together a group of scholars who had previously worked independently, in different sports science disciplines, into a cohesive group to conduct original, rigorous and impactful research. This plan focused on achieving a sustainable research enterprise, alongside growth in the number of researchers in the Department. In practical terms, this involved:

(1) Less experienced staff being encouraged and supported to undertake research development, including PhDs to enable progression from teaching only contracts to teaching and research contracts.
(2) Growing the community of PGR students by, first, increasing the number of staff eligible to supervise e.g. meeting the University requirements for training and experience, and then attracting students who will both benefit from, and add to, our research environment.
(3) More experienced staff being supported in their career progression with promotions based on research outputs.

(4) Supporting and encouraging staff to apply for funding to support research growth, recognising that this would need to balance short-term funding with aspirations for more major grants.

This plan was deliberately pragmatic, rather than highly aspirational, to ensure that it delivered.

The strategy identified Performance Analysis and Strength & Conditioning as its two core research areas that had potential to be world leading, with additional areas emerging slowly over time. In the short term (leading up to this submission) a concentration on research into physical and mental health was made, as this provided a unifying focus for emerging work. In order to achieve the overarching goals of original, rigorous and impactful research, staff established excellent working relationships with elite sports located in and around London from the outset. This included undertaking research that showcased and benefitted Olympic, Paralympic and female sports. The Department's research outcomes are continually introduced into its graduate programs, thus influencing a future generation of researchers and practitioners to further build upon the knowledgebase. The strong links between research and curriculum development has enabled the University and Faculty to support this area in ways that are sustainable and mutually beneficial.

Longer-term strategic goals (post REF 2021) are:

(1) To expand the breadth of sports science research to encompass the traditional subjects, such as Rehabilitation and Sports Psychology, beyond elite sports to include grass roots participation in sport, particularly through projects that align with the University's ongoing commitment to equality, diversity and inclusion.
(2) To continue to build research collaborations within the Faculty through areas such as data science and psychology linking to sports performance, biomedical engineering linking with sports biomechanics and biosciences working at the interfaces with sports physiology, nutrition and medicine.
(3) To build a sustainable staffing strategy for research through a combination of staff development from a strong practice base, new appointments and broadening our focus to include university-wide research collaborations.

Using the clustering of our three research areas (Performance Analysis, Strength & Conditioning, and Physical & Mental Health) we briefly describe the expertise and achievements of staff working these areas during the period below.

Performance Analysis
Professor **James** has over 20 years of applied research experience. He is a consultant for the English Institute of Sport and regularly advises top professional and elite teams (e.g., England Squash (2009-17), GB Canoe Slalom (2012-16). He has reviewed for 25 International journals as well as reviewing grant applications for the Austrian Science Fund (an International project grant for 295,347 Euros (2017) and an International Cooperation project grant for 337,341 Euros (2015)). He has also co-edited a book titled "The Science of Sport: Squash" (2016).

Together, **James** and **Parmar** have collaborated with colleagues at other HEIs to produce 20 SCI journal papers published since 2014, involving 22 non-UK collaborators from 9 different countries. This international reach has included PhD completions in Spain (n=2) and Slovenia (n=1) as well as students studying in the UK from abroad (PhD completions in this period from South Korea (n=1) and Hungary (n=1) as well as current students from South Korea (n=2).

They are also currently supervising 4 UK PhD students (with 3 UK student completions achieved in this period). Working within the departmental goal of developing research of practical value for elite sport, **James** and **Parmar** have developed funded research collaborations with several organisations, although the funding is frequently through channels such as direct studentships and not reflected in our formally returned income. These collaborations include:

(1) English Institute of Sport (PhD completions entitled "Profiling elite male squash performance using a situation awareness approach enabled by automated tracking technology," (October 2018); "Applied performance analysis in canoe slalom," (October 2018) and "The use of performance analysis in Olympic and Paralympic sport: The perspectives of coaches and analysts," (December 2020). These projects have so far resulted in 6 SCI journal papers and form the basis of one of our case studies. An MSc by Research project using computer vision (joint supervision with Computer Science) to track GB Olympic boxers is ongoing.
(2) Leicester City FC 1 MSc student completion who has gone on to be one of 2 funded PhD students working with the football analytics and performance analysis teams to better inform and improve the first team's performance.

Our research continues to inform our teaching to support a world leading MSc in Performance Analysis. This MSc also acts as a platform for sustaining our research by engaging professional sports whereby the organisation sponsors student's tuition fees in exchange for a high-quality work research placement that undertakes Performance Analysis in an elite environment producing a research-based dissertation, solving an applied problem generated by the organisation, thus enabling our teaching to inform our research. The high-profile organisations that have undertaken these partnerships are England Rugby (n=3), GB Hockey, Leicester City FC, Queens Park Rangers FC, DMP Sharks Women's RFC and England Football. These partnerships have totalled £73k income in the last two years and has also led to funded PhD collaborations (n=2). This model of funding meets our stated aim of achieving short-term funding while we grow capacity for making more conventional funding applications.

James and **Parmar** have acted for the International Society of Performance Analysis of Sport (Chair and Secretary since 2013). In these capacities they have organised and acted on the scientific committees of 4 International conferences (since 2014) and formalised a business structure for the society (2020). During their tenure they have created a new committee structure which has redesigned the accreditation process to become competency based, developed a new web presence and are currently implementing robust procedures to upgrade the society into one that will serve and protect analysts working in both academia and industry.

Strength & Conditioning
This area is led by Dr **Turner** who began consulting for British Fencing in 2009, the resulting research studies helped GBR's medal winning achievements at London 2012 and Rio 2016 (detailed in one of our case studies). Alongside Dr **Bishop**, further collaborations with Queens Park Rangers FC (ongoing since 2014); academy through to the first team) and the British Army (2019) on a funded project (in collaboration with Chichester and Salford Universities) investigated novel training strategies to improve performance. Currently, **Turner** and **Bishop** are supervising 6 PhD students with 2 completions ("Physical Preparation in Olympic Fencing" and "Inter-limb Asymmetry: Longitudinal Monitoring and Associations with Speed and Change of Direction Speed in Elite Academy Soccer Players" in this period. This world leading research has informed the very popular MSc in Strength & Conditioning and has contributed to the expansion of staff (n=6) and promotion to Associate Professor for **Turner** (2018). The team has co-authored papers with over 100 external authors from 35 different Universities (25 of which are International) and over 25 sports organisations (5 of which are International) to produce over 300 research outputs and two books.

Physical & Mental Health
This area builds upon previous excellence in practice within sports, and also benefits from major synergies with other areas in the Faculty including biomedical science, biomedical engineering and psychology. It has strong links with both strength and conditioning and performance analysis, but is not constrained to grow in these directions.

A cluster of work around exercise, medicine and health brings together researchers who had previously worked independently and is led by Dr **Papadopoulos** (HCPC registered physiotherapist with focus on sports injuries) and Dr **Smith** who specialises in Physical Activity

and Health. Having previously been an NHS honorary researcher for 5 years **Papadopoulos** has 21 peer-reviewed academic papers (since 2014). **Smith** has worked with the London Borough of Barnet, the Saracens foundation, Public Health England and England Athletics. Dr **Cohen** (Chartered Psychologist through BPS) works closely with the Psychology department (Psychology in Action research group) on research projects in extreme sport, dementia and physical activity of carers. Dr **Wilson** is an ECR specialising in Exercise Physiology whose main research is on exercise induced muscle damage, its impact upon performance and the implementation of recovery strategies. Her research with Dr **Dimitriou** has utilised world leading biomarker detection in collaboration with Biomedical Sciences and our Strength & Conditioning staff. Much of our work in exercise Physiology research revolves around the systemic and/or local (i.e., airway, musculoskeletal and periodontal) inflammatory processes that occur due to different modes of training (**Wilson**, **Dimitriou**); air pollution, and chronic pathologies such as asthma, osteoporosis, osteoarthritis and periodontitis (**Dimitriou**), Additionally we are exploring how different recovery (i.e., cryotherapy) or nutritional (i.e., natural anti-inflammatory and antioxidant supplements and caffeine) interventions can improve physical performance, muscle function, sleep quality, quality of life, immunity, inflammation and disease management. **Dimitriou** has also undertaken research projects with some of the world's leading arts institutions and sports organisations including Saracens RFC, British Olympic Fencing, the Royal Ballet Company, British Triathlon, GB Lightweight Rowing and the Greek and Portuguese National Swimming Teams. This area currently has 2 PhD students and two completions in this period. They collaborate closely with the Natural Sciences department within the Faculty, Biomedical Engineering and Biomechanics (research submitted to unit 3), as well as performance analysis and strength & conditioning.

A strategic goal of the LSI was to develop sustainable research areas that have the potential to be world leading. This strategy will enhance our ability to attract International students to the University, support the development of junior staff in specific research areas, facilitate our ability to work with elite teams and diversify into recreational sport and exercise. Success in this area can be evidenced by the recruitment of staff in our three areas: **Bishop** in Strength & Conditioning, **Parmar** (ECR) in Performance Analysis and **Papadopoulos** (ECR), **Smith** and **Wilson** (ECR) in Physical & Mental Health. The development of substantial research projects, studentships and knowledge transfer partnerships with industry has enabled the progressive expansion of research within the department. To help develop research opportunities we have:

- Encouraged staff to self-identify research and consultancy opportunities during the annual appraisal process and supported them by, for example, arranging meetings with potential collaborators, using existing links to support growth.
- Provided access to departmental and Faculty funds to support attendance/presentation of research at conferences.
- Provided a time allowance for research on work programmes for all staff on research contracts.
- Provided Faculty support for research studentships with industry, typically supported on a match funded basis.
- Contributed to the annual 2-day institution wide research student conference, so that sport is embedded in the wider culture and our PGR students experience peer-reviewed activities.
- Developed discipline specific conferences in strength and conditioning and performance analysis.
- Developed sports staff research days, bringing everyone together regularly to develop our research culture, disseminate ideas and build collaboration.

All postgraduate research-led courses are directed by research active academics and consequently have been rated as outstanding in the two recent postgraduate student satisfaction surveys (overall 92 and 93%). The students often undertake research placements with elite sports teams, many providing funding, with some developing into full PhD studentships. Our staff have developed these collaborations systematically and deliberately as part of our strategy, frequently through consultancy appointments. Through their involvement with these research projects our students often gain full time positions upon completion of their courses, furthering

our collaborative network. Our alumni now hold prestigious roles such as “Head of Performance Analysis” with the English Institute of Sport, “Head of Innovation and Research Advisory Group” with High Performance Sport, New Zealand, many roles with elite teams in multiple sports around the world as well as using the skills learnt in professional positions with organisations such as the NHS, Nike and Adidas.

1.2 Future research aims and strategy

Under the leadership of our new Vice-Chancellor, Nic Beech, Middlesex University is currently formulating its ambitious 2031 research strategy. Within this plan the University has committed to investing in outstanding areas of excellent research and is contributing £21.5 million into the redevelopment of the West Stand of StoneX Stadium, in partnership with Saracens RFC and Barnet Council, which forms part of a wider council ‘master plan’ to redevelop the surrounding area and develop a world class multi-sport facility, including a new base for the LSI, with a new suite of laboratories and specialist sport facilities to support our research. The master plan includes the development of a digital green ‘health and well-being’ corridor linking the main Hendon campus with StoneX Stadium as part of a wider initiative to understand the role of green space as a community asset, exploring the use of the green spaces linking the two areas. This cross-university initiative integrates expertise from colleagues in several disciplines (e.g. sports science, social sciences, environmental studies and digital design), and provides an excellent platform for future developments in Physical & Mental Health research.

The Faculty research plan stresses the importance of collaboration and research that makes a difference, both important features of our work in sport. The Faculty will continue to support research in sport through funding, infrastructure and high levels of leadership support.

The LSI Research Leadership Committee (**James**, **Turner**, **Papadopoulos** and **Parmar**), in collaboration with the head of department (**Cohen**), has authored a new research and impact strategy (2021 – 2026) that is aligned with the Faculty and University research strategies. This committee meets quarterly to assess progress on the key aims which are to develop, promote and foster a long-term research and impact culture within the LSI which aspires to recruit high research potential staff and retain by incentivised opportunities for staff. Increase impactful research & knowledge transfer partnerships and develop traditional grant applications through staff training and contact with the RKTO. Research staff outputs to be reviewed annually by LSI Research Leadership Committee. Promote Equality, Diversity and Inclusivity with a focus on women in sport, disability and BAME. Specific goals have been identified in terms of increasing research staff and outputs for Performance Analysis, increasing the frequency of outputs in Q1 journals for Strength & Conditioning and strengthening the research area of Physical & Mental Health.

A new programme to improve the support for PGR students is being led by **Turner** and incorporates a new mentorship scheme, the promotion of internal and external conference presentation opportunities and the development of PGR research seminars. The LSI Research Seminar Series has also been refreshed by **Parmar** to place more emphasis on external researchers with research interests that could promote collaborative research within and between departments in the Faculty.

2. People

2.1 Staffing strategy

In 2014 the LSI had 23 members of academic staff at grade 7 or above engaged primarily in teaching alongside professional practice. To increase the research activity, two main subject areas were prioritised (performance analysis and strength & conditioning) for development, although staff were also recruited to strengthen research in Physical & Mental Health (exercise physiology, biomechanics, rehabilitation, psychology, and physical activity). In the intervening 6 years the strength of the LSI has resulted in 18 current (17.6 FTE) academic staff. Eight staff (8

FTE) are on teaching and research contracts and returned here, including three ECR staff. Ten (9.6 FTE) are primarily practitioners and currently on teaching and practice contracts. In addition, the department, in line with Faculty trends, has appointed 5 associate lecturers, who are not category A staff being below the grade threshold, but contribute to our research environment by assisting with research studies through PhD programmes. Currently there are 2 senior managers (HOD and Professor), 1 Associate Professor, 6 Senior lecturers and 9 lecturers.

This strategic environment led us to a research approach of developing small, coherent, and cognisant research groups with dedicated leadership given the explicit task of developing staff inexperienced in research into functional researchers, usually building on excellent practice, who collaborate on research projects with colleagues within the University and externally. This has been achieved through strategic cross-collaborations within the Faculty. Furthermore, other colleagues who have collaborated with us for PhD supervision and other research projects include staff from Psychology, Computer Sciences and Natural Sciences. Two of these staff (**Dimitriou**, **Hearne**) are part of this REF submission.

This strategic aim from 2014 has developed during the current REF period leading to a revised strategy, in line with the recent University strategy change, to become more holistically research focused during the next REF cycle. This includes appointing mainly staff on teaching and research contracts with some on senior positions in disciplines lacking leadership currently. To complement this strategy, we are looking to appoint visiting professors to supplement and strengthen the research areas identified by the LSI Research Leadership Committee. It is envisaged that this will contribute towards a research culture within the LSI, and that ECRs and junior members of staff such as associate lecturers will be supported to develop their research career at Middlesex, with a particular focus on producing high quality outputs and research impact, demonstrating vitality within the department.

Staff development
All staff are provided with a mentor within their discipline when they join the department. This key role helps inexperienced staff integrate themselves within the department as well as aiding the navigation of University procedures. This includes the various software platforms supporting staff in their academic role (a remit of the University wide mentorship programme). In addition, staff are aligned to research areas, under the guidance of the research leadership. This leadership role includes developing teaching expertise that utilises current research, both within and external to our department, spreading a genuine research culture rather than building an isolated research enterprise. Through this mentorship inexperienced staff will develop their research interests, to become active researchers embedded in our culture and ethos. In many cases programmes are devised to support staff members to develop collaborations using the contacts and track records of existing staff to broker and support meetings. Some more junior staff, through their excellent practice contacts, are encouraged through this process to share contacts enabling all to benefit.

All staff have access to a Faculty Research Development Fund for presenting at research conferences and workshops as well as consumables and support for empirical studies, with an expectation that the staff member will present their research (ideas, results or failures) to the department (preferably Faculty level). This funding is approved based on an appropriate level of rigour, developing standards expected externally, but less time consuming. In addition, there is a Staff Development fund (departmental) where staff can get funding for more generic activities such as attending conferences, gaining additional skills, engaging with professional bodies and access to training for staff who are in the process of developing their ideas.

Staff are also supported to attend University staff development workshops which are regularly run by the University and cover diverse topics from managing workloads to applying for research grants. For example, the University runs a ‘Research and Enterprise Development Programme’ which cover a broad range of topics for staff.

Staff are encouraged to enrol on University run courses e.g., MSc or PhD with the support of the Head of Department and the LSI Research Leadership Committee.

2.2 PGR – Support Mechanisms and Training/Supervision support

A key aim that has enabled the growth of research activity in the department was the growth of staff (currently n=7) eligible to supervise PhD students with 4 having become eligible since 2014). These staff are all supervising PhD students with 5 acting as Directors of Study. Over the census period there have been 10 PhD completions in the department (Table 1). Students mainly contribute to our strategic aim of "undertaking research of relevance to elite sport, implement these findings within these elite sports and finally, publish the findings to increase our visibility and credibility.

Table 1 – PhD students enrolled and awards by year and subject

	2014/ 15	2015/ 16	2016/ 17	2017/ 18	2018 /19	2019 /20	2020 /21	**Awards**
Performance Analysis	7	7	7	7	5	4	6	**5**
Strength & Conditioning	1	1	2	1	2	7	6	**2**
Physical & Mental Health	4	8	7	6	4	5	4	**3**
with main focus on:								
Exercise Physiology	*3*	3	3	2	1			(2)
Psychology		1	2	2	1	1	2	(1)
Biomechanics		1	1	1	1	1	1	
Physical Activity		2	1	1	1	3	1	
Rehabilitation	1	1						
Total	**12**	**16**	**16**	**14**	**11**	**16**	**16**	
Awards			**2**	**1**		**5**	**2**	**10**

To facilitate growth of PGR and the quality and value of supervision within the LSI several new departmental initiatives have been developed. To promote a research culture, regular opportunities to present, discuss and listen to our research have been provided through, monthly 'research clubs' for presentations and feedback and more frequent 'research coffee days' where supervisors and students meet for informal conversations. Staff have developed an innovative self-paced research methods online system, aimed at producing resources, such as video tutorials, to support both PGT and PGR students through research proposals, research design, literature reviews, conducting appropriate statistical tests and undertaking appropriate qualitative data collection and analysis methods. More specifically, step by step videos, with specific datasets, allow the tasks to be undertaken at a self-directed pace simultaneous to viewing the tutorial videos. This innovative approach (led by **Parmar**) has provided high quality online learning materials, available at any time to suit individual needs, and has been extremely well received by students, particularly those working with elite sports teams who cannot easily attend formal sessions on campus and need access to support on demand. The culmination of these micro cycles in the yearly development has been the opportunity for students to present research at a Summer Research conference, a cross-Faculty conference involving all PGR students at the University. Finally, our Faculty and department support all PGR students to present their work at external conferences if they have engaged in the other research processes listed above, the minimum requirement being to have presented their work at the departmental level. These activities complement the University comprehensive training programme for PGR students including specific support for students whose first language is not English and sessions relating to all of the generic aspects of research.

All PhD students have desk space, laboratory facilities, a computer and free printing including free inter-library loans.

2.3 Equality and Diversity

Middlesex University have signed up to the Athena SWAN charter to recognise the commitment to advancing the teaching and research careers of women in STEM in the HE sector and are working towards the Bronze Award. Middlesex University became the first university to be awarded 'Gold' status by the UK Investor in Equality and Diversity (UKIED) Charter Mark in 2018 following a rigorous evidence-based assessment of the universities equality and diversity policies and procedures. Inexperienced staff undertake mandatory training on equality and diversity when they join the University and are encouraged to refresh yearly. The LSI have an Equality Diversity and Inclusivity working group consisting of both research (**Cohen**, **Parmar**) and practice (Edwards) staff, they are currently working on an EDI strategy, including making unconscious bias training mandatory, improving leadership opportunities, ensuring recruitment, PGR and examination panels are diverse with effective procedures to ensure applicants and students are not biased against. **Parmar** also contributes to University wide equality initiatives on the University's working group for the Race Equality Charter submission.

The University is a member of the Stonewall's Global Diversity Champions programme and were praised for their contribution to LGBTQ+ inclusion in the workplace, rising 24 places in Stonewalls Annual Equality Index in 2019. There is a LGBTQ+ forum and special events which are regularly run for staff.

To support women gaining leadership roles, the University sponsors 12 staff annually (LSI n=1) to complete the HE's 'Aurora Leadership' programme. A similar programme for BAME staff called 'Diversifying Leadership' is also offered by Advance HE, the LSI has one staff (**Parmar**) enrolled).

The University offer a wide range of arrangements to staff to ensure that they are supported regarding absence and leave (including career breaks, parental leave and sabbaticals) and actively promotes a work-life balance (including flexible working) and supporting staff with childcare policies. Students have access to confidential individual counselling, mental wellbeing, disability and dyslexia support including a care and concern policy where anyone can report and gain support. Finally, the University subscribe to several online wellbeing platforms for students to access including an evidence based mental fitness app called Fika, mental health training and lifestyle support. Staff have access to the Employee Assistance Programme which aims to promote a high-performing work culture by helping staff to be more engaged, resilient and productive. This confidential support is available 24/7 and includes face to face counselling and support, dealing with workplace issues and career changes.

Before selecting outputs for this REF submission, a UoA 24 working group was selected. Nominations were sought at Faculty level for a head of this group and Prof **James** was subsequently appointed. He then asked for volunteers from all LSI staff to populate the group. All interested staff were subsequently appointed along with an independent member of staff from the Faculty, determined at Faculty level to be a Professor from Psychology. All members of the UoA 24 working group then undertook the University training to ensure that all decision-making supported the principles of equality, diversity and inclusivity. Leadership roles for the group were determined with staff asked to identify possible case studies to be presented at Faculty level. This process resulted in the required two case studies being selected on the basis that they best satisfied all criteria necessary for a successful outcome. The development of the two case studies were led by the principal researchers involved (**James** and **Turner**). The environment statement development was led by the one ECR member (**Parmar**) of the group, mentored by Prof **James**, on the basis that this would aid progression and vitality within the LSI research environment. Output selection was overseen by **Papadopoulos** such that the four sports science members of the group had a leadership role. Regular meetings of the working group ensured that both Professors, and the rest of the working group, were able to offer/receive mentorship and guidance throughout the process. Given that this is the first REF submission for the department a key goal was to develop staff to encourage sustainability and vitality. Staff were supported throughout by the Faculty and University.

The UoA 24 working group asked individual members of staff to rate their publications in rank order for originality, rigor and significance. This allowed the working group to independently review the top five papers (where applicable) for each staff member using the same criteria, awarding a score for each category. These scores were then averaged over the 5 members of the working group for each category such that a fair and transparent selection could take place. When a paper was authored by a member of the working group this member did not review the paper. This procedure was undertaken following a consultation at Faculty level whose remit was to follow the University codes of practice. The finalised submission by Faculties were then debated at Faculty and University level and agreement given to selection criteria. For the LSI this meant that papers were ranked independent of author (gender or ethnicity) and the final selection of papers included 7 outputs from 3 ECR staff (28%). The breakdown of papers included 7 (28%) from female staff and 3 (12%) from the 1 BAME member.

The breakdown for the staff in the LSI in terms of research engagement is as follows; 66.7% of staff over 45 (n=3) are research active (n=2). Younger staff are less likely (25% 31-35; 42% 36-40) or as likely (50% 25-30) to be research active but changing this to be more positively weighted towards research is a strategic aim of the department. Females are slightly more likely to be research active (50%) than males (43%, 6/14) but if part-time staff are excluded then 66.7% (4/6) of females are research active. Both senior managers are research active and 44.4% (8/18) of academic staff are research active. We currently have one BAME staff member on the research route and one on the teaching and practice pathway.

3. Income, infrastructure and facilities

3.1 Income

Research in the unit has largely been funded through mechanisms not formally captured here, such as studentships paid directly to students or consultancy for staff. The primary source of formal research funding was industry-based (Table 2) that included funded PGR studentships (Arsenal and QPR football clubs, GlaxoSmithKline) and research project costs for studies in “Hormonal Responses in Premiership Football Players” and “Strength and Conditioning” (Saracens RFC). UK government bodies also funded a PhD studentship to evaluate performance analysis feedback mechanisms in Olympic sports (English Institute of Sport) and contract research to provide “novel strategies to improve exercise training prescription”. UK based charities supported projects for “Range of physical fitness tests for 30 regional/national swimmers” (Harrow Swimming Club) and “Evaluation of an Active aging project in the Jewish community” (Interlink foundation) “the effectiveness of outreach on attendees and their carers of a coffee club/cafe for dementia sufferers” (Saracens RFC and Dementia club UK).

Table 2 – Income during the REF period

Row Labels	Sum of Total Income over REF period	REF Income by Funding sector
EU Government Bodies	15,132	8%
UK Based Charities	6,771	3%
UK Government Bodies	62,238	31%
UK Industry	115,935	58%
Grand Total	**200,076**	**100%**

In addition, an exciting new MSc by Research studentship (£20k) was developed and funded by UK Sport and the English Institute of Sport to develop the use of computer vision in Olympic sports (initial project in boxing). In physical activity and health, a £10k project (2019) with the London Borough of Barnet, the Saracens Foundation, Public Health England and England Athletics was secured to assess the impact of the Mayor’s Golden Kilometre on the physical literacy of primary school children. **Dimitriou** was the principal investigator for a £5k grant to investigate via clinical trial the combined anti-inflammatory and analgesic effect of Boswellia

Serrata, Curcuma Longa and Vitis Vinifera (OMNI ONE) in patients with osteoarthritis. She also received £5.6k from Cheribundi Ltd. and IPRO Ltd. to investigate the influence of a Montmorency Cherry Juice blend on indices of exercise-induced stress and upper respiratory tract symptoms following marathon running.

To help staff develop their research capabilities and gain research funding several initiatives have been instigated at University, Faculty and Departmental levels. The University Research and Knowledge Transfer office provides guidance and training for all staff with a dedicated Impact Officer (since 2014) to advise on collaborative projects. A Yammer community is also used to share relevant information and act as a conduit for discussion. The Faculty has a Deputy Dean of Research and Knowledge Exchange who directs and determines policy. This has included the provision of support for all research active staff and students to enable expenditure on equipment, consumables, travel and conference participation.

3.2 Infrastructure & Facilities

Investments in infrastructure and facilities have continuously improved the research environment within the LSI. There is a Faculty-wide technical team of 15 supporting all aspects of computing infrastructure and wet laboratories, all used by the LSI, with 2 dedicated technicians explicitly supporting the LSI facilities at the StoneX stadium. The University has continued to build research capacity in the LSI annually through Faculty or capital spend. There are now dedicated laboratories in StoneX for Exercise Physiology which includes a DEXA scanner, breath by breath analysis, Velotron cycle ergometer, Telemetric EMG, Heamatology and Clinical Chemistry analysers, Flow cytometry, Electron Microscopy, Near-Infrared Spectroscopy; Kistler force platforms, Isokinetic Dynamometry, Non-Invasive and Invasive Determination of Intramuscular Temperature, Whole-body cryotherapy, Hot and Cold Water Immersion techniques, Pulmonary Function Testing, Eucapnic Voluntary Hyperpnea Challenge, Bronchodilation Reversibility Testing, Sputum Induction via Ultrasonic Nebulisation, Fractional Exhaled Nitric Oxide testing via NIOX. Biomechanics has a state of the art 24 camera 3D motion capture system, a two-camera live marker capture system, embedded and portable force plates and one large strain gauge force plate as well as a Biodex isokinetic dynamometer and sEMG system. A full Sports Rehabilitation suite includes therapeutic and diagnostic ultrasounds, electrotherapy units, g-studio gait analysis units, anatomy, muscle and motion software. A Performance Analysis laboratory has a full suite of high specification Windows and Mac computers, tablets and high-quality video capture devices, including industry leading software Hudl Sportscode, Dartfish, Focus and Quintic. The Strength & Conditioning laboratory has Olympic weights and equipment including embedded force plates under the lifting platforms. These new labs supplement shared facilities based at the Hendon campus. This includes Clinical Exercise Physiology Suites, Nutrition Lab, Psychology and neuroscience Labs, Computer science and artificial intelligence labs, a Sports Rehabilitation Suite and a Fitness and Conditioning Suite.

The above infrastructure has involved substantial capital investment for both facilities and equipment with the aim of enabling high quality research and knowledge transfer projects. This expenditure includes recent updates for state-of-the-art performance analysis equipment (£101,677), strength and conditioning facilities (£72,444) and exercise physiology equipment (£90,675). On the Hendon campus, investments have also been made to the Shaftesbury Barnet Harriers Clubhouse (£72,000), AstroTurf (£1.565m), fitness equipment and facilities (£551,263.24) and Real Tennis/Studio development (£1,228,376) which included refurbishing the performance analysis equipment on the real tennis court.

The University is investing a forecasted £21,500,000 in infrastructure and facilities for a new West Stand at StoneX Stadium, due for completion in 2021 but delayed by COVID. This investment aligns with the wider ‘master plan’ being developed by the university with Barnet Council and Saracens RFC. Additional benefactors include local sports teams including Middlesex CC, Middlesex Lions FC, Shaftesbury Barnet Harriers, Mill Hill RFC and Hendon RFC, thus aiding our strategy of expanding our research to grass-roots sport and the

community. This will include repurposing surrounding land into a multi-sport area with dedicated stadiums and facilities for football, rugby, cricket, golf and other sports, expanding the sports science facilities available to the LSI, with a focus on enhancing and supplementing existing resources to facilitate high quality research.

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

4.1 Research Collaborations, Networks and Partnerships

Staff within this unit make a significant contribution to the Sports Science discipline and regularly collaborate with researchers internally (both within and between Faculties) and external to Middlesex.

Performance Analysis research area
Excellent research environments foster collaboration, both within and between institutions. Performance analysis has embraced this ethos by collaborating with colleagues within the LSI (strength & conditioning, physiology, psychology and biomechanics) whilst also between departments within the Faculty (Natural Sciences, Design Engineering & Mathematics and Computer Sciences) on research projects including research papers and supervision of research students. In addition, staff have collaborated with other HEI institutions within the UK including Universities: Leeds Beckett; Cardiff Metropolitan; Swansea; Institute of Technology Carlow; Imperial College London; University College London; Bath. We also have many international academic collaborations including Universities of Madrid, Ljubljana, Belgrade, Niš, CIDESD (consortium of 10 institutions), Zagreb, West Hungary, Grand Canyon, Queensland, Valencia and Beira Interior.

A real strength of this research area has been the focus on funded research partnerships with industry. The English Institute of Sport has contributed to 3 PhD completions; Fulham FC, England Football, England Rugby, GB Hockey, Queens Park Rangers FC and Leicester City FC have funded MSc, MSc by Research and PhD students. This approach has also helped develop long-term relationships where research projects have evolved over time, helping drive innovative research that is practically relevant.

Strength and Conditioning research area
Strength & Conditioning has extensive collaborations with Natural Sciences and Psychology resulting in multiple research outputs. There are also multiple external partnerships with UK Universities: Loughborough, Salford, Leeds Beckett, Chichester, Suffolk, Gloucestershire, Manchester Metropolitan, Hertfordshire and international Universities: Blanquerna, Murcia, Isabel, Tras-os-Montes e Alto Douro, Federal do Pampa, Primorska, Technological and Higher Education Institute of Hong Kong, San Jorge, EUSES, Autonoma de Madrid, Catholic University of Murcia. Given the applied nature of strength and conditioning, external partnerships with professional sporting organisations have always been priority with strong relationships forged with British Fencing, the Football Association, Arsenal FC, Brighton FC, Millwall FC, Queens Park Rangers FC, Milton Keynes Dons FC, Stevenage FC, Saracens RFC, Middlesex County Cricket Club and Nottinghamshire County Cricket Club. International relationships have been formed with Sevilla FC, Brazilian Rugby and Spanish Basketball.

Physical & Mental Health research area
Projects with a main Psychology theme, in conjunction with physical activity, strength & conditioning and rehabilitation, as well as the Psychology and Computer Science departments have conducted collaborative research with the RFU, Saracens Rugby, London City Lionesses, Watford FC and GB Rowing. In addition, there have been collaborations with Brent Council and a national charity (Dementia club UK).

Projects with a main Physiology theme have primarily been undertaken with Natural Sciences along with staff from strength & conditioning and performance analysis. External partnerships

have been developed with the Universities of Oxford, University College London, Queen Mary, Kingston, St Mary's, Newcastle, Northumbria, Wolverhampton, Leeds Beckett and Swansea. International collaborations with the Universities of Porto, Thessaly, Polytechnic Institute of Porto, Ljubljana, Instituto de Investigação e Inovação em Saúde and the Rey Juan Carlos. Research outputs have been generated in collaboration with UK partners, the English National Ballet, UK Athletics, British Triathlon, British Canoeing, England Women's Football, GB Lightweight Rowing, Queens Park Rangers FC, Saracens, the British Army, West Ham United FC, University College London Hospitals, NHS Foundation Trust, Royal Brompton Hospital, Ipro Interactive Ltd, National Institute of Dance Medicine and Science and the Royal Ballet Company and International collaborating organisations, Greek and Portuguese National Swimming Teams, Sydney Orthopaedic Research Institute, Australia, and the Lenox Hill Hospital, New York, USA.

4.2 Contributions to the research base, economy and society

National/International Leadership
James is presently Chair of International Society of Performance Analysis of Sport (ISPAS) having been elected in 2013. Similarly, **Parmar** was elected Secretary of ISPAS in 2013. **Bishop** is currently Chair of United Kingdom Strength and Conditioning Association (UKSCA), having been elected in 2018.

Conference & Event Organisation
The "Student Strength and Conditioning Conference" held at Middlesex University since 2010 regularly attracts over 100 participants. In 2017, we hosted the 7th ISPAS International Performance Analysis Workshop attracting over 80 attendees including students and academics from the UK and abroad and practitioners from professional clubs, NGBs and other sporting organisations. In 2019, a workshop for sports science practitioners and students presenting different analysis methods for athlete data was held with proceeds donated to the mental health charity CALM.

External Conference Organisation
James and **Parmar** have been members of the Scientific and Organising committees for 7 World Congresses and International Workshops/Conferences (ISPAS World Congress of Performance Analysis of Sport XIII, Vienna, Austria, September 2021; 8th International Society of Performance Analysis of Sport Conference & Workshop, Budapest, Hungary, September 2019; ISPAS World Congress of Performance Analysis of Sport XII, Opatija, Croatia, September 2018; ISPAS World Congress of Performance Analysis of Sport XI, Alicante, Spain, November 2016; 6th International Society of Performance Analysis of Sport Workshop, Carlow, Ireland, April 2016; ISPAS World Congress of Performance Analysis of Sport X, Opatija, Croatia, September 2014 and the 5th International Society of Performance Analysis of Sport Workshop, Manchester, England, April 2014). **Turner** was appointed as UKSCA conference director in 2019. **Papadopoulos** was a member of the scientific committee of the 4th pan-Cyprian physiotherapy conference (2014).

Consultancy and External Roles
James has been appointed as a Visiting Professor at the University of Zagreb (Croatia, 2015) and acts as an academic consultant for the English Institute of Sport. **Turner** is a consultant for British Fencing, Denmark Fencing and the British military. He initially worked with the British Army physical training corps (2009 – 2012) before working with the special forces (2014 to present). The Army currently employs two full-time external coaches, both former students of **Turner**. He is also a consultant to Queens Park Rangers FC and was head of physical training for Saracens Women's RFC before passing responsibility to a current PhD student.

4.3 Contributions to Disciplines

Performance Analysis
James and **Parmar** have been leading an overhaul of ISPAS, developing governance documents, incorporating the society and formalising it as a legal entity. In addition, they have

led on the redevelopment of the accreditation system for both academics and practitioners within performance analysis. A new competency-based accreditation process is being developed with industry stakeholders including English Institute of Sport, Ireland Rugby, England Rugby, the Premier League, the Football Association and the Lawn Tennis Association. In addition, they have introduced a competitive bidding process to ensure regular ISPAS international and national conferences and workshops are organised, with increased participation from academics, students and practitioners. This has led to the development of academic and professional steering groups within ISPAS which both **Parmar** and **James** lead on.

Strength and Conditioning
Bishop has been leading the UKSCA's partnership (since 2016) with the Chartered Institute of Management in Sport and Physical Activity (CIMSPA) to professionalise the strength and conditioning profession. Two sets of 'professional standards' have been produced in conjunction with employers in the sector. This has enabled the endorsement of courses and university degrees ensuring content maps to the knowledge, skills and behaviours outlined in the professional standards documentation. This has led to the development of a Chartership for accredited members of the UKSCA in partnership with CIMSPA, who have permission to use the Privy Council's Royal Charter. Whilst this is still being developed over the next five years, it represents a huge contribution to the discipline, enabling strength and conditioning coaches to demonstrate their expertise in practice. **Bishop** also sits on CIMSPA's newly formed Professional Development Committee for High Performance Sport to ensure continued development and professionalism for all job roles in the high-performance sport sector i.e. Sport and Exercise Science.

Physical and Mental Health
Cohen acts as a visitor for the Health Care Professions Council (HCPC) and sits on the Saracen Women's Advisory board. She is also a supervisor for students undertaking doctoral research towards a Stage 2 Psychologist license with the British Psychological Society (n=1 completion, n=2 current). **Cohen** is the research coordinator for the Psychology of Sport Injuries, Extreme sport research group for the International Network of Sport Health Scientists.

4.4 Public Engagement

The University runs annual STEM Festivals events (The World skills UK Live at the NEC, the New Scientist Live at the ExCel centre, London and a campus event). LSI staff run an exhibitor stand at each of these events to promote the research base in sport and exercise science to the community. **Smith** appeared as an expert on a BBC4 documentary 'Can science make me perfect?'. **Cohen** has appeared on a BBC Inside Out programme on Dementia (2020) and on 60 Minutes' Don't look Down International programme to discuss research on extreme sport (2014). **Cohen** has also contributed to newspapers and magazines (Telegraph, Guardian, Daily Mail, RedBull, Metro, NHS magazine) including a monthly "ask the expert" for a National magazine focused on Women's Running. **Dimitriou** gave a talk "Exercise-induced asthma/bronchoconstriction. Causes, treatment and implications for participating in sports" for the NHS Foundation Trust's Asthma and Wheezing Awareness Day (2018).

Expert Reviewing Positions
James has acted as an expert reviewer for two major Austrian Science Fund International projects worth 295,347 euros (2017) and 337,341 euros (2015).

Editorial Positions
Bishop and **Turner** are Associate Editors for NSCA's Journal of Strength and Conditioning Research. **Bishop** also acts in this capacity for the Strength and Conditioning Journal whilst **Turner** was a guest editor for both Frontiers in Sports and Active Living (section on Elite Sports and Performance Enhancement) and Sports, editing a special edition on research in Soccer. **James** is a Review Editor for the International Journal of Performance Analysis in Sport, an International Scientific Advisory board member for the Serbian Journal of Sports Sciences and, with **Parmar** have edited a special edition "Applied Sport Science for Performance

Improvements in Football" of the International journal Frontiers in Psychology. **Papadopoulos** is an editorial member of the International Journal of Perceptions in Public Health (IJPPH).

Invited Keynotes
James has given 22 International keynote presentations since 2014. **Turner** has been invited to deliver 8 conference presentations (3 International including the 7th Strength and Conditioning Forum in China (2019) to honour the translation of one of his textbooks. **Parmar** has delivered 3 keynotes (2 International) at conferences.

International Teaching
Turner delivered a series of lectures and practical workshops over 2 days at the National Taiwan Sport University (2017) which led to several Chinese students studying at Middlesex (MSc and one PhD). **Parmar** teaches (since 2019) on an annual performance analysis module on the MSc in International Basketball Coaching and Management (run by the Lithuanian Sports University and the University of Split, Croatia). **James** ran one day workshops in performance analysis for analysts working for the Malaysian Institute of Sport (Lankawi, Malaysia; 2014, 2017).

Peer Review
LSI staff have been regular reviewers for International academic journals over their careers (**James** 25; **Turner** 20; **Parmar** 10; **Dimitriou** 8; **Cohen** 4, **Smith** 1).

The LSI is committed to embedding its research work, and researchers across all levels and locations. We offer services in areas such as rehabilitation at major sporting events (London Marathon). Moving forward we are developing major community engagement through the creation of a green space corridor joining the StoneX stadium with the main campus as a smart environment where communities can come together to enjoy outdoor activities but also form a testbed for some of our research developments.