

**Impact template (REF3a)**

<p><b>Institution:</b> University of Leeds</p>
<p><b>Unit of Assessment:</b> UoA26 Sport and Exercise Sciences, Leisure and Tourism</p>
<p><b>a. Context</b>  This unit focuses on exercise, health and rehabilitation, which is delivered via 2 research groups (Cardiovascular and Exercise Physiology, and Motor Control and Exercise Psychology). Both have substantial levels of research activity that are strongly applied or interdisciplinary in nature, underpinned by world recognised basic science. Consistent with proposals from the 2012 House of Lords Science and Technology Select Committee report on the “robustness and translation of Sport and Exercise Sciences (SES) in the UK”, SES delivers impact in priority areas of health and related therapeutics, and education. The main non-academic beneficiaries of SES research leading to positive impact are <b>patient groups</b> (e.g. improving exercise and movement control in those with mobility disorders, cardiovascular or respiratory disease, and cancer), <b>industrial partners</b> (e.g. research and development of exercise- and environment-related pharmaceuticals and devices with Yorkshire Water, RedLedge, Gilead, MedImmune, High5, HC-PVE) and the <b>general public</b>, via public engagement activities to improve the understanding of exercise and physical activity. Research activities with impact include e.g. the development of: (i) criteria for clinical assessment and diagnosis in heart disease and Development Coordination Disorder (DCD) (Rossiter, Utley, Witte, including Case Study 2 on DCD); (ii) interventions for rehabilitation of patients with mild to severe mobility disorders (Astill, Ichiyama, Utley; including Case Study 1 on Spinal cord injury); (iii) exercise and related therapies for patients with cancer, respiratory, cardiovascular, and musculoskeletal disorders (Birch, Burke, Calaghan, Rossiter, Steele, Egginton).</p>
<p><b>b. Approach to impact</b>  Throughout the REF period, the Faculty of Biological Sciences (FBS) has employed a professorial level academic as Director of Impact and Innovation (0.4FTE), an innovation manager (0.6FTE) and core secretarial support (0.5FTE) plus a project support fund of £200k. At faculty level, this team supported impact in SES through an ‘Impact and Innovation Committee’ (IIC) which sponsored 5 SES projects and collaborated with SES to host exhibitions, open days and open innovation workshops at which new collaborations and consultancies with external organisations were formed. In 2012, the University introduced 14 sector-facing “hubs” (an investment of £6M), vehicles that provide a structure to channel larger scale support for activities with high potential for impact and innovation. These mechanisms combined have produced a marked rise in engagement by staff, from 10% in 2008 to 80% of SES research staff undertaking impact-related activities in 2013. SES impact is delivered via 5 pathways (below), which demonstrate: (i) engagement with public and special interest groups; (ii) collaborative work to generate new products, tools, and exploit IP; (iii) informing of professional practices and policy.</p> <p><u><i>Economic, commercial, and organisational impacts.</i></u> A key strategy of the SES group has been to proactively seek engagement with industrial partners to translate core research advances into new products and assessment tools. This includes the production of a hand wash compliance device with <b>RedLedge Ltd</b> for use in hospitals as part of infection control measures, which is based on SES research in perception-action coupling (supported by IIC award to Utley, 2011, patent application in progress). An innovation grant from White Rose Health Innovation Fund facilitated collaborative research into the role of broadband sound and its influence on movement including developing training aids for individuals with cerebral palsy (in collaboration with New York Institute of Technology; Utley, 2009), and assessment tools with the Psychological Corporation for DCD (Utley, Astill, 2008). This contributed to the development of two assessment tools used worldwide by health and education professionals. Our expertise in muscle physiology led to the development of a non-invasive imaging tool for the assessment of skeletal muscle oxidative capacity in partnership with <b>Novartis</b> (Rossiter, 2012) to monitor outcomes in clinical trials in cachectic patients. In addition, staff have engaged with the sector-facing “hubs” (Steele, Calaghan) and Industry (<b>Medimune</b>, UK) to develop novel methods of drug delivery (2012, patent application in progress). Engagement with commercial organisations has also informed sector policy, e.g. translational research funded by <b>Gilead Sciences</b> (Palo Alto, USA) identified the arrhythmogenic risks of environmental exposure to low levels of carbon monoxide e.g. via traffic fumes (Steele,</p>

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2012). Subsequent engagement with the Engineering sector (**HC-PVE**, Halifax, UK) informed new guidelines for carbon monoxide levels in underground car parks, thereby improving environmental safety. Utley in collaboration with Dr Saleh of Pinderfields Hospital Wakefield was shortlisted for the NHS Innovation prize for the design and development of the Yorkshire Micro Forcep to be manufactured by Phoenix Surgical Instruments.

*Impacts on health and welfare.* Our research is translated into products and guides for clinical rehabilitation and the maintenance of good health. Major SES impacts on health are presented in detail in the case studies, e.g. on the clinical definition of paediatric movement disorders (Utley, case study 2); and on a novel combined therapy to recover locomotion after severe spinal cord injury that has impacted clinical practice and has been translated into human patients with dramatically positive results (Ichiyama, case study 1). Other highlights include a project engaging with **AgeUK** (supported by an IIC award), which utilised the expertise of SES members to produce a booklet explaining the benefits and practicalities of exercise for elderly and frail individuals. The booklets (2000 distributed) also provided information about local facilities and services to support participation to promote physical activity in the elderly. Astill (2011) led this work with contributions by 12 SES researchers and materials were distributed to the community via AgeUK. SES also engages with healthcare organisations and charities to educate and promote health through physical activity e.g. providing the scientific basis for pulmonary rehabilitation to the '**Better Breathers**' club (based in California USA) for patients with chronic obstructive lung disease (Rossiter, 2013) and engagement of post-menopausal women with diabetes in physical activity via the **British Menopause Society** (Birch, 2012). We have also engaged with **Ikaria Inc.** (USA), and **Hamamatsu Photonics K.K.** (Japan) providing guidance on study design for patients with pulmonary disease and in intensive care (Rossiter, 2013), and on exercise in cancer recovery for the **Royal Alexander Hospital** (Burke, 2012). Outreach to users and stakeholders in SES research also resulted in a relationship between SES and a charity **Cyclists Fighting Cancer** who are co-funding a master's studentship alongside IIC (Led by Burke with Utley, 2013). Egginton serves on the **Danish Council for Independent Research** (Medical Sciences) to aid translation of basic science into clinically relevant areas.

*Impacts on practitioners and professional services.* SES staff have developed new clinical diagnostic tests from original translational research observations. Rossiter and Witte (2011) developed and deployed an advanced cardiopulmonary exercise test as a diagnostic tool for cardiac patients. This project (supported by an MRC studentship) has been implemented in local NHS clinics and by healthcare clinics at the National Heart and Lung Institute at Imperial College London, and the Wilhelmina Children's Hospital in Utrecht, Netherlands. More than 250 patients have been recruited to a 5-year follow-up study to measure the sensitivity for prognosis of this new exercise test compared with current standards.

*Impacts on public policy and education.* SES provides research-based evidence for public policy and educational bodies via involvement in the development of training materials, expert reviews, and external advisory visits. Examples of this include working with the **British Council** and **Council of Europe** to develop teacher-training materials addressing inclusion (Utley, 2004-2008). Following this, training in the SES-developed course was made compulsory for **all teachers in Malta and Brazil** (a total of 600,000 trainee teachers, 2008-13). Other areas of education impact include: contribution to public understanding of the use of drugs in sport as panel members of the **Royal Institution's** 'Great Debates' prior to the London Olympics (Rossiter, Ferguson, 2012); advising the **Football Association** on mixed gender football (Utley, 2010); contributions to the national curriculum for medical schools (Rossiter, 2010); and contributions to the **Diabetes Society** development of exercise guidelines for diabetic patients (Birch, 2012).

*Public engagement.* SES members actively seek to deliver wider benefit from their research via public engagement. This activity includes public talks, engagement with the media, and expert reviews, e.g. the **Olympic Programme at the University of Leeds**, which started in 2008 has attracted over 3000 participants and has delivered high-profile public lectures and engagement activities covering sport, exercise, and health (Burke, Rossiter, Utley, 2010-2012). The "**Meet the Scientists**" open public forum engaged patients, caregivers and scientists in research advances

in spinal cord injury (Ichiyama, 2011). National and international **media coverage** also came from research on the psychological benefits of scaling Mt. Kilimanjaro among injured war veterans (Burke, 2012), and the influence of medieval armours on mechanical efficiency (Askew, 2011). Our research has featured in outlets such as The Times, Financial Times, Daily Telegraph, CNBC, ITN News at Ten, ITV Calendar, BBC Breakfast News, BBC World TV, The One Show, Midlands Today, BBC Radio Scotland, BBC Radio WM, BBC Radio 4, Saga Radio, CBC News, and the BBC World Service.

**c. Strategy and plans**

The University of Leeds has prioritised the delivery of impact from research for more than a decade (Institutional Strategy, 2004 <http://strategy.leeds.ac.uk/>). Local support (IIC), and subsequently cross-campus (sector Hubs, £6M investment, section b) support vehicles have been deployed by SES throughout the REF period to translate new research advances to benefits for external user groups. This experience has defined our current and future strategy for impact, as follows:

1. Organisation of research in translational themes capable of the rapid delivery of impact in the areas of exercise, health and rehabilitation, e.g. Birch - NIHR clinical collaborative topics; Burke, Rossiter - NIHR Research for Patient Benefit grant (*exercise training benefits in rectal cancer patients*, PB-PG-060918262); Rossiter - BBSRC-funded collaboration with British Cycling (*optimizing exercise tolerance*, BB/I00162X/1).
2. A recruitment strategy for new academic staff that prioritises impact alongside research excellence. Recruitment of research leaders engaged in the impact agenda and conducting leading translational research in areas of significant external need (exercise in health and rehabilitation), e.g. diabetes (Birch), heart failure (Rossiter), cancer (Burke), vascular remodelling (Egginton), motor control rehabilitation (Chakrabarty).
3. Engagement with institutional impact support mechanisms (IIC, sector Hubs - Health Services, Medical Technologies, Pharmaceuticals & Biopharmaceuticals) to enhance the delivery of impact from translational research. Research projects in sports nutrition (Ferguson), exercise benefits to cancer rehabilitation (Burke), mechanisms of drug delivery (Calaghan, Steele), open days, and the establishment of advisory boards for industry and clinical user groups.
4. Support to commit staff time to drive industrial (and other user groups) engagement: 30 days consultancy time for each staff member (Utley, Yorkshire Water & RedLedge; Steele, Gilead), internships to evaluate impact routes (Pro-motion: Messenger, Utley).
5. Utilise funds for the pump priming of collaborative research with industry: reinvestment of gains from previous spin-out company in MSc by Research projects (Burke/Utley, Cyclists Fighting Cancer; Ferguson, High5 sports nutrition).

**d. Relationship to case studies**

The first case study “Helping patients with severe spinal injuries to stand and step: from animals to humans” (Ichiyama) provides evidence of impact of exercise and movement research on **health and welfare**. The high profile nature of the original underpinning research (*Nature Neuroscience* and *J Neuroscience*) and subsequent translation to man underpinned further strategic investment in motor control rehabilitation, including the appointment of Chakrabarty. The second case study “The Leeds Consensus Statement: A universal standard to diagnose and assess Developmental Coordination Disorder” (Utley) also provides evidence of impact of research of motor control on **health and welfare**. In this case, the underpinning research benefited from outreach activities involving local schools and clinics. Furthermore, the development and elaboration of the definition of DCD and effective therapeutic strategies produced a step change in the diagnosis and treatment of the condition, together with clear principles to guide intervention (**impact on practitioners and professional services**). Both of these case studies demonstrate how SES research at Leeds engages with the wider community and special interest groups (**public engagement**). In addition the case studies are successful examples of how effective our strategy to organise research in translational themes has been and demonstrate our commitment to the rapid delivery of impact in the areas of exercise, health and rehabilitation.