Institution: St Mary's University, Twickenham

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

Title of case study: Informing and enhancing female health, participation, and performance in sport and exercise

Period when the underpinning research was undertaken: 2012-2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
1. Dr Nicola Brown	1. Associate Professor in Female Health	1. 01/09/2009-Present
2. Dr Richard Burden	2. Senior Lecturer in Exercise Physiology	2. 21/09/2009-Present
3. Dr Charles Pedlar	3. Associate Professor in Sport Physiology	3. 01/09/2009-Present
4. Dr Ross Wadey	4. Associate Professor in Sport Psychology	4. 01/10/2014-Present
5. Dr Atefeh Omrani	5. PhD Researcher	5. 01/10/2016-2020

Period when the claimed impact occurred: 2017-2020

Is this case study continued from a case study submitted in 2014? Y

1. Summary of the impact (indicative maximum 100 words)

Research from St Mary's has enhanced understanding of how factors specific to females affect participation and performance in exercise and sport, with this knowledge successfully applied to educate and empower female exercisers. We have increased knowledge, altered attitudes and perceptions, and increased physical activity participation levels in female exercisers. Our research has been used by a sport apparel company to inform the design and development of a new product line of sports bras. Impact has been realised in elite performance environments, with the English Institute of Sport using our research on the menstrual cycle and breast health to inform strategic policy through its national SmartHER programme that has changed the practice of sport scientists and benefitted athletes. Our research on the menstrual cycle has also led to the development of the FitrWoman mobile Application that has contributed to the US Women's National Team World Cup success and also benefitted recreational female exercisers. Our research is also benefitting sport medicine practitioners working with patients who present with menstrual cycle challenges.

2. Underpinning research (indicative maximum 500 words)

1.9 million fewer women and girls participate in sport each week than males (*Women in Sport*). However, due to under-representation of women in sport and exercise science research there has been a lack of understanding of female-specific issues, and difficulty in the extrapolation of findings generated from predominantly male participants. The overarching aim of the research presented here was to increase understanding of female-specific health issues, and develop and disseminate effective, evidence-based strategies to enhance participation and performance of female athletes and exercisers.

Influence of the Breast and Breast Support on Female Health, Participation, and Performance in Sport and Exercise.

The influence of the breast is rarely considered when discussing female participation in sport and physical activity. To address this gap and to explore factors affecting adolescent females' participation in sport and exercise, Brown undertook a survey study with > 2000 schoolgirls aged 11-18 years. This revealed that 46% reported that their breasts negatively affected their participation in sport and exercise. Over half (51%) said they never wore a sports bra for exercise, and the more breast concerns reported by girls the less they participated in exercise. However, 87% expressed a desire to know and understand more about breasts (**3.1**). This showed the effect that breasts can have on female participation in sport and exercise and highlighted the need for educational content on breasts for schoolgirls. Subsequently, an evidence-based breast education package was delivered to

375 adolescent girls and, using validated evaluation tools, identified improvements in breast knowledge, attitudes to breasts, and engagement with positive breast habits (including wearing a sports bra for exercise). Improvements were sustained when re-tested six months later and were significantly greater compared to 412 control participants who did not receive the breast education package (**3.2**).

Research conducted by Brown on adult female marathoners (n=1285) has identified that the influence of the breast on sport and exercise participation is not restricted to adolescent females. Brown found a third of marathoners experienced breast pain (mastalgia), with exercise the most prevalent factor in its occurrence. Of those reporting mastalgia, 17% said it negatively affected their exercise behaviour. Despite being so discomforting, almost half (44%) reported taking no measures to relieve or manage the symptoms (**3.3**). Although high numbers of female marathoners recognised the importance of sports bra use, 75% reported issues in relation to poor bra fit. Their use of professional bra fitting was low, as was participants' perceived knowledge of breast health (**3.4**). It was suggested that sports bra design could be improved to manage consequences arising from poor fit, while females would benefit from educational materials on the importance of breast support and properly fitted sports bras.

Influence of the Menstrual Cycle on Female Health, Participation, and Performance in Sport and Exercise.

The menstrual cycle has received scant attention from sport and exercise science researchers; however, this is something our staff have addressed. Amenorrhea (absence of the menstrual cycle) has typically been the focus of research in this area, however Pedlar, Burden, and Brown demonstrated that heavy menstrual bleeding (also known as menorrhagia) is prevalent among recreational and elite athletes and is a risk factor for iron deficiency. Large cohorts of recreational (n=1073) and elite (n=90) runners were surveyed, and menorrhagia was identified in 36% and 37% of the respective cohorts and linked with a history of iron deficiency or anaemia (**3.5**). These were the first research studies to investigate and report menorrhagia in healthy women participating in sport. A meta-analysis undertaken by Burden and Pedlar provided evidence that iron treatments are effective in improving iron status and aerobic capacity of iron deficient athletes, where menorrhagia may be an underlying cause of the iron deficiency with associated impacts on performance and training schedules (**3.6**).

3. References to the research (indicative maximum of six references)

3.1. Scurr, J., **Brown, N.,** Smith, J., Brasher, A., Risius, D., & Marczyk, A. (2016). The influence of the breast on sport and exercise participation in schoolgirls in the UK. *Journal of Adolescent Health, 58*, 167-173. https://doi.org/10.1016/j.jadohealth.2015.10.005

3.2. **Omrani, A.**, Wakefield-Scurr, J., Smith, J., **Wadey, R.,** & **Brown, N.** (2020). Breast education improves adolescent girls' breast knowledge, attitudes to breasts and engagement with positive breast habits. *Frontiers in Public Health - Children and Health.* https://doi.org/10.3389/fpubh.2020.591927

3.3. **Brown, N.,** White, J., Brasher, A., & Scurr, J. (2014). The experience of breast pain (mastalgia) in female runners of the 2012 London Marathon and its effect on exercise behaviour. *British Journal of Sports Medicine, 48*, 320-325. http://dx.doi.org/10.1136/bjsports-2013-092175

3.4. **Brown, N.,** White, J., Brasher, A., & Scurr, J. (2014). An investigation into breast support and sports bra use in female runners of the 2012 London Marathon. *Journal of Sports Sciences, 32*, 801-809. https://doi.org/10.1080/02640414.2013.844348

3.5. Bruinvels, G., **Burden, R., Brown, N.,** Richards, T., & **Pedlar, C.** (2016). The prevalence and impact of heavy menstrual bleeding (menorrhagia) in elite and non-elite athletes. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0149881

3.6. **Burden, R. J.,** Morton, K., Richards, T., Whyte, G. P., & **Pedlar, C. R.** (2015). Is iron treatment beneficial in, iron-deficient but non-anaemic (IDNA) endurance athletes? A systematic review and meta-analysis. *British Journal of Sports Medicine*, *49*, 1389-1397. http://dx.doi.org/10.1136/bjsports-2014-093624

4. Details of the impact (indicative maximum 750 words)

Improving knowledge and changing attitudes on factors affecting participation in sport and exercise among teenage girls

Based on her research showing how factors associated with, and concerns about, breasts negatively affected participation in sport and exercise (3.1), Brown and colleagues developed '*Treasure Your Chest*', an educational workshop that has been freely downloadable since May 2018. The '*Treasure Your Chest*' website and new resources were relaunched in 2020 and have been downloaded by 137 schools and organisations across England, Wales, and Scotland. The workshop comprises videos, activities and interactive tasks to empower girls to increase their breast knowledge, feel more confident talking about breasts, and make positive changes to their breast habits. During 2020 the '*Treasure Your Chest*' workshop was delivered to 408 schoolgirls aged 11-15 years. The workshop was scheduled to be delivered to over 1,000 schoolgirls, however school closures because of the COVID-19 pandemic meant this full schedule could not be delivered.

Following the workshop, 98% reported an increase in breast knowledge, 78% were more confident talking about their breasts, 90% reported more positive attitudes towards their breasts, and 97% wanted to make a positive change to their breast habits (e.g., check their bra fit, wear a sports bra when taking part in sports and exercise, and check for healthy breasts) (**5.1**). Those attending the workshop highlighted that it also made them feel more confident with their bodies when exercising (**5.1**). Teachers, assistant head teachers, wellbeing coordinators, and directors at schools that received the workshop have recognised benefits in their pupils following attendance at the workshop. Specifically, they have seen improvements in self-confidence and knowledge, with this increased knowledge having secondary benefits as the pupils have commented that they have shared their knowledge about the importance of a well-fitting bra and how to check for healthy breasts with family and friends (**5.1**). These school representatives confirmed they will recommend the workshop to colleagues at other schools and will be incorporating the materials within their school curriculum (**5.1**).

Development of a new sports bra and education concerning bra-fit

Recognising that teenage years are a critical time for females, when many drop out from sport (3.1), along with the impact of breast pain and bra-fit issues upon exercising females (3.3, 3.4), Brown's research has been used by **[text removed for publication]**, a sports apparel company, to inform design of a new sports bra. This company aims to encourage girls to participate in sport and reduce drop-out through the development of bespoke products and has used Brown's research to inform the design and development of a new product line of sports bras that are specifically designed and engineered for teenage girls to help the company achieve its commercial aim (**5.2**).

The Women's Sports Network is a not-for-profit organisation that works with the educational, commercial, and charity sectors, as well as national governing bodies. It combines a desire to educate, inform, and empower, along with the aim of increasing sport participation levels amongst women and girls. To help achieve this, they invited Brown to contribute her research (3.1) on breast health and bra-fit to inform their range of 'MoJoManuals'.

MoJoManuals are an educational resource to help girls overcome issues and barriers they face in sport and have been translated into multiple languages. More recently, MoJoManuals have been tailored to specific sports with the rowing version (ROWMoJo) containing breast specific advice and education, which has been distributed by Rowing Australia to every girls' school in Australia that rows and adopted by World Rowing/FISA as part of their global initiative to get more girls rowing (**5.3**).

The 'SmartHer' Programme

Brown's research on how breasts affect sport and exercise, as well as that by Pedlar and Burden investigating the influence of the menstrual cycle, have been used by the English Institute of Sport (EIS) to inform their nationwide SmartHER programme as part of their initiative to better support female athletes, enhance performance, and improve overall health and wellbeing. The EIS has used research from St Mary's to provide better breast support to athletes and to adapt training and sport science techniques through an enhanced understanding of how the menstrual cycle affects athletes (**5.4**). SmartHER roadshows have been delivered to 102 athletes across 15 sports within the UK High Performance system. The SmartHER roadshows have also been delivered to coaches and sport science and medicine practitioners who work with the athletes; in total 122 staff from 25 different sports, including 30 coaches and 17 multi-disciplinary teams, have attended. As a result, sport science and medicine practitioners working within the EIS and sport national governing bodies have an enhanced knowledge base and can provide better informed and more impactful support to athletes (**5.4**). The ultimate beneficiaries are the female athletes, who now receive bespoke and evidence-informed coaching and sport medicine support to improve their training and performance (**5.4**). Collectively, this has enabled the EIS to create environments where female athletes can thrive and pursue world class performance (**5.4**).

Development of 'FitrWoman' Mobile Application

Research by Pedlar and Burden on the menstrual cycle and iron deficiency (3.5, 3.6) has been instrumental in the development by Orreco, a company specialising in sport- and data-science, of the FitrWoman mobile application which helps to optimise athletic performance (**5.5**). The App allows users to track their menstrual cycle and, using research findings from St Mary's, to train smarter by providing personalised training and nutritional advice. The App has been downloaded in over 200 countries and has benefitted recreational users by facilitating improvements to diet and training through an enhanced understanding of their bodies (**5.6**). It has also been adopted by high performing teams and organisations, including the World Cup winning US Women's National Soccer Team. Their team manager, Dawn Scott, testifies how research from St Mary's on female physiology and menstrual bleeding greatly influenced her management and preparation of players in training and during tournaments, and was an important factor in their FIFA World Cup win. In her current role as the FA's Senior Women's Physical Performance Manager, the impact of St Mary's research continues to be realised in enhancing physical programming, preparation, and coaching in women's football (**5.7**).

Medical practitioners have benefitted from St Mary's research on the menstrual cycle (3.5, 3.6) as they report greater awareness of the potential for heavy menstrual bleeding in female athletes. Where athletes present with these issues, medical practitioners use research findings from St Mary's to ensure a more evidence-driven and individualised approach to address iron-deficiency (**5.8, 5.9**).

Collectively, the research from St Mary's on female health and the menstrual cycle has been important in highlighting the gender gap in biomedical research, which has been recognised by the Wellcome Trust's public engagement team. Based on this, the Wellcome Trust subsequently developed a new sports and health related project strategy focusing on the three Ms: Menstruation, Motherhood, and Menopause that is informed by the issues identified in research from St Mary's (3.5, 3.6) (**5.10**).

5. Sources to corroborate the impact (indicative maximum of 10 references)

5.1. a. Evaluation report of the 'Treasure Your Chest' intervention in schools and associated impact testimonials from school representatives: b. The Wellbeing Coordinator at International Community School, London; c. The Director of Pastoral Care and Assistant Head Teacher at St Angela's Ursuline School; d. The Assistant Head Teacher at Waldegrave School; e. The Head of Year 9, Hoe Valley School).

5.2. Impact testimonial from **[text removed for publication],** Founder and CEO of **[text removed for publication]**.

5.3. Impact testimonial from Paul Reynolds, Company Director at Women's Sports Network.

5.4. Collection of impact testimonials from: a. The English Institute of Sport (Dr Craig Ranson, Director of Athlete Health at the English Institute of Sport; b. Laura Needham, Senior Physiologist for GB Triathlon and English Institute of Sport; c. Jess Varley, female athlete in an Olympic national governing body.

5.5. Impact testimonial from Dr Brian Moore, Founder and CEO of Orreco.

5.6. Reviews of the FitrWoman App by recreational exercisers.

5.7. Impact testimonial from Dawn Scott, ex-manager of US Women's National Team and current Senior Women's Physical Performance Manager at the F.A.

5.8. Impact testimonial from Dr Rebecca Robinson (Consultant in Sport and Exercise Medicine, Chief Medical Officer for British Canoeing, and Team Doctor for GB Boxing)

5.9. a. Links to online blogs from medical practitioners covering the recognition, diagnosis, investigation and management of heavy menstrual bleeding that cite research from St Mary's; b. PDF of (https://blogs.bmj.com/bjsm/2018/12/31/heavy-menstrual-bleeding-hmb-in-female-athletes-part-1-recognition-and-diagnosis/ and c. PDF of https://blogs.bmj.com/bjsm/2019/01/14/heavy-menstrual-bleeding-hmb-in-female-athletes-part-2-investigation-and-management/).

5.10. Impact testimonial from Lucy McDowell, Strategic Design and Innovation Manager, Wellcome Trust.