Institution: St Mary's University College

Unit of Assessment: 26: Sport and Exercise, Leisure and Tourism

Title of case study: Improving the health and performance of distance runners

Summary of the impact (indicative maximum 100 words)

The research outlined below concerning medico-physiological issues in distance runners has directly informed medical policy, investigations and therapy strategies applied to elite distance runners, and raised the profile of issues relating to the Female Athlete Triad for coaches such as those within British Athletics and England Athletics.

The research findings have been disseminated via several avenues, such as the education of Sport and Exercise Medicine (SEM) doctors (through content for lectures delivered on SEM programmes at bachelors and masters level), and via CPD workshops for coaches and SEM practitioners, thus with the capacity to directly affect medical practice.

2.Underpinning research (indicative maximum 500 words)

The elite athlete endeavours to optimise performance through effective training and competition preparation; however, negative consequences for health and well-being can ensue. The work of Pedlar and co-authors has furthered understanding of aspects of elite endurance athlete health (female athlete triad[1]; iron-deficiency non-anaemia[2]), as well as other elite athlete issues such as hypoxic training[3] and performance at altitude, performance determinants, sleep[4,5], and recovery[6]. Pedlar combines research with practice at St Mary's University College (SMUC), resulting in research outputs with high ecological validity, and direct application. Two themes are highlighted:

i) The Female Athlete Triad (the Triad), characterised by low bone-mineral density, loss of the menstrual cycle, and disordered eating. The long-term prognosis is poorly understood; but associated with an increased risk of stress fracture, failure to achieve peak bone strength, and poor performance. Summer and winter sports athletes as well as in recreational exercisers are at risk. The American College of Sports Medicine, the International Olympic Committee Medical Commission and others have published position stands on the Triad.

ii) Iron deficiency in distance runners may be caused by a number of mechanisms including inflammation / hepcidin interaction, footstrike haemolysis, reduced visceral blood flow during exercise, and gastro-intestinal bleeding. Iron is involved in mitochondrial energy production and the production and maintenance of haemoglobin; thus, a healthy iron balance is crucial for performance. Iron injections have been effective in some, but not in all, studies. Longitudinal data, particularly in elite athletes, are rare and much needed in order to further understand the clinical significance of iron deficiency.

The Pollock et al. (2010) paper [1] details the prevalence of aspects of the female athlete triad in 44 elite British female distance runners. Low bone mineral density was present in 34.2% of athletes, with 33% displaying osteoporosis of the radius. Pedlar commenced pilot data collection for the project in 2002, concerned that the health of distance runners could be compromised by their training and recovery practices. Female distance runners based at SMUC were encouraged to visit Middlesex University for an annual Duel-energy X-ray Absorptiometry (DXA) scan, funded by the English Institute of Sport. Interest grew and a number of collaborations developed with sports medicine practitioners including Dr Roger Wolman and Dr Noel Pollock, prompting the systematic

data collection for the purpose of a research study commencing in 2003. Pedlar presented preliminary data at a British Olympic Association professional development session for doctors in 2007, organised by Dr Roger Wolman and after sufficient longitudinal data was collected, the paper was published in 2010 by clinician Dr Noel Pollock.

The Pedlar et al. (2013) case study[2] relating to iron deficiency contains unique data derived from the combined sports science and medical support of a world-class professional female athlete over 4 years, demonstrating that continued aerobic development occurred despite chronic iron deficiency. A PhD student supervised by Pedlar is currently studying the efficacy of iron repletion in iron deficient, non-anaemic elite distance runners and has completed a collaborative study with the Mr Toby Richards at University College London (vascular surgeon).

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

The research relating to the *Details of the impact* section below:

1. Pollock N, Grogan C, Perry M, **Pedlar C**, Cooke K, Morrissey D, Dimitriou L. Bone-mineral density and other features of the female athlete triad in elite endurance runners: a longitudinal and cross-sectional observational study. *Int J Sport Nutr Exerc Metab*. 2010 Oct;20(5):418-26

2. **Pedlar CR**, Whyte GP, Burden R, Moore B, Horgan G, Pollock N. A Case Study of an Iron Deficient Female Olympic 1500m Runner. *Int J Sports Physiol Perform*. 2013 8(6):695-698

Other research examples cited in *Underpinning research* section above:

3. BA Holliss, J Fulford, A Vanhatalo, **CR Pedlar**, AM Jones. Influence of intermittent hypoxic training on muscle energetics and exercise tolerance. *J Appl Physiol.,* 2013 114(5):611-619

4. **Pedlar CR**, Whyte G, Emegbo S, Stanley N, Hindmarch I and Godfrey R. Acute sleep responses in a normobaric hypoxic tent. *Med Sci Sports Exerc.,* 2005 37(6):1075–1079

5. Leeder J, Glaister M, Pizzoferro K, Dawson J and **Pedlar C**. Sleep duration and quality in elite athletes measured using wristwatch actigraphy. *J Sports Sci.,* 2012 30(6):541–545

6. Hill J, Howatson G, van Someren K, Leeder J, **Pedlar C**. Compression garments and recovery from exercise-induced muscle damage: A meta-analysis. *Br J Sports Med.,* 2013 doi:10.1136/bjsports-2013-092456

All references listed here are published in established peer reviewed journals and are available on request from the institution.

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

The published findings from the Pollock et al. (2010) paper[1], described in section 2, have highlighted the prevalence of the Triad in female athletes and triggered a new approach to the medical care of British female distance runners, prioritising prompt identification and treatment of the Triad. Dr Noel Pollock – a British Athletics Doctor (and first author of the paper) commented: 'This study has informed British Athletics medical policy, investigations, and therapy strategy and, amongst other things, raised the profile of the issue for coaches'. Dr Pollock has provided a British

Athletics medical policy document citing this work.

This work has received global attention, featuring in a number of text books and websites, and summarised by other agencies. The work is cited in a professional development article in the South African Journal of Family Practice (Schwellnus et al. 2011) and summarised on the Female Athlete Triad Coalition (an international consortium affiliated to the American College of Sports Medicine) website: **www.femaleathletetriad.org** - 'To this end, it is notably imperative that female endurance athletes complete a DXA amongst their pre-participation screening. Furthermore, future research should investigate this association between high training volume, potential menstrual dysfunction, and reductions in lumbar BMD in larger populations of female endurance athletes. Based on these findings, it is indirectly suggested that a negative energy balance is a contributing factor to bone loss in these athletes.' Together, these references highlight the strong likelihood that this work has influenced practice internationally.

At SMUC, a post-doctoral research fellow with expertise in the promotion of bone health has been recruited in order to further this research and to seek further research funding to expand research into optimising the bone health of elite athletes.

The iron deficiency case study[2] was reviewed in detail in the popular press in a Runner's World blog, and has had over 5000 views (currently 100 / week): http://www.runnersworld.com/nutrition-runners/iron-levels-olympic-miler. The Runners World Website attracts 3.8 million views per week. Furthermore, Gill Horgan (a co-author), presented the case study to the Sports Dietitians UK group, of which she is a member, potentially influencing practice amongst Sports Dietitians.

St Mary's is uniquely placed in British distance running circles to influence, via its research, current and developing athletes, owing to the quality and quantity of distance runners training locally. St Mary's has hosted a number of high profile distance runners in the London Marathon, England Athletics and British Athletics supported Endurance Performance and Coaching Centre (EPACC). The EPACC has grown from 2 elite runners in 2003 (including Mo Farah) to some 140 athletes in 2013, and is host to several training camps, workshops, conferences and seminars for the distance running community; for example, the annual London Marathon Young Athlete Camp, the Annual England Athletics seminar series and the British Milers Club Endurance Conference 2013. This profile provides considerable scope for research impact through local and national distance running networks.

Beyond St Mary's, both themes feature in education programmes delivered to Sport and Exercise Medicine doctors at Queen Mary University of London and University College London through guest lectures by Dr Pedlar and co-authors, annually since 2010. Furthermore, Dr Pedlar is a guest lecturer on the British Association of Sport and Exercise Medicine (BASEM) Foundation Course using both of the above research examples as a means of educating the trainee sports doctor delegates. Dr Pedlar has recently spoken to practitioners about his research at the BASEM Annual Conference 2012, Marathon Medicine 2012, The Beachy Head Marathon Symposium 2011, The European Athletics Endurance Conference 2013, and the Running 2012 professional conference.

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

http://www.femalepatient.com/PDF/037060016.pdf

www.femaleathletetriad.org

http://www.runnersworld.com/nutrition-runners/iron-levels-olympic-miler

http://www.professionalevents.co.uk/_images/_products2downloads/85_224.pdf

http://www.englandathletics.org/core/core_picker/download.asp?id=6981&filetitle=Female+Athlete+Triad

References from GB level high performance athletics coaches

Sport and Exercise Medicine Doctors from the British Olympic Association, English Institute of Sport, British Athletics, and the London Marathon Medical Committee.