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| Institution: University of Chester |
| Unit of Assessment: 26 Sport and Exercise Sciences, Leisure and Tourism |
| Title of case study: The assessment of game, training and playing demands in relation to preparation and performance in elite rugby (league and union) |
| <p>1. Summary of the impact</p> <p>The main applied outcomes of this body of research have been: (i) the objective quantification of individual player demands during competitive match play to better understand the typical internal and external loads imposed on rugby players; (ii) identification of fatigue characteristics and pacing strategies of interchange and whole-game players to inform training practices and tactical strategies; (iii) the design of appropriate training practices to ensure players are conditioned to tolerate the most demanding passages of play during competitive matches; and, (iv) the development of match simulation protocols for the objective evaluation of player performance.</p> |
| <p>2. Underpinning research</p> <p>The research underpinning this impact case study was carried out between 2006 and 2012 and continues to the present day in the research of on-going PhD projects. The research quantified the external and internal match demands of elite rugby league and rugby union players. Global Positioning System (GPS) technology and video analysis were used to measure the total and relative distances, number of collisions, heart rate and perceived exertion (session RPE) for different positional groups during matches. Depending on playing position, elite players cover mean distances of 4,200 – 6,900 m (89-95 m·min⁻¹) and 5,100 – 7,100 m (62-78 m·min⁻¹) in rugby league and rugby union, respectively. Rugby league players demonstrate reductions in high intensity (31%) and very high intensity running (47%) between the first and last quarter of a match. More importantly, replacement players adopt a high initial intensity in their first match quartile before a severe decline thereafter. However, in a second bout, lower exercise intensity at the outset enables a higher physiological exertion for later periods. Rugby league forwards are involved in a collision approximately every minute, whereas this occurs less frequently for backs (0.3 per minute) and adjustables (0.6 per minute) during a match. Mean heart rates ~82-84% of maximum heart rate were measured, with summated heart rate values of ~200, ~270 and ~300 AU, and session RPE values of ~240, ~435 and ~380 AU for forwards, adjustables and outside backs, respectively.</p> <p>The case study emanated from the research of a group consisting of five members of academic staff, supplemented by a core of PhD students: Dr Craig Twist (Leader/Senior Lecturer/Reader, 2004-present); Dr Paul Worsfold (Leader/Senior Lecturer, 2006-present); Dr Jamie Highton (PhD student, 2007-2011/Lecturer, 2012-present); Dr Kevin Lamb (Reader, 1992-present); Dr Ceri Nicholas (Senior Lecturer, 2006-present); Dr Mark Waldron (PhD student, 2009-2012. Left to join University of New England, Australia, 2012); Dr Dave Sykes (PhD student, 2006-2010. Left to join Herriot-Watt University, 2011); Christine Foster (MPhil Student, 2006-2010), Nicola Cahill (PhD student, 2010-present);and Elisavet Velentza (PhD student, 2012-present).</p> <p>Through collaboration with the International Rugby Board (IRB), Premiership Rugby and the Rugby Football Union (RFU), a new law dispensation was implemented by the IRB (Dispensation from Law 4 and Regulation 12, 12th May 2010) allowing players to wear GPS devices for the purpose of the research study. At the same time, the Rugby Football League (RFL) gave approval for players to wear GPS devices during competitive Super League matches in order to facilitate this research. Accordingly, the Applied Sports Sciences Research Group was the first to utilize GPS technology and heart rate telemetry during professional rugby competition in the UK and this practice has now become commonplace across both rugby codes. The Group has, therefore, led the way for both research and practice in professional rugby in relation to the assessment and applied understanding of external and internal training loads imposed on players during competition.</p> |

Impact case study (REF3b)**3. References to the research**

The basic research underpinning the impact was manifest in the following papers:

- Cahill, N., Lamb, K., Worsfold, P., Headey, R., & Murray, S. (2012). The movement characteristics of English Premiership rugby union players. *Journal of Sports Sciences*, 31(3), 229-237. DOI:10.1080/02640414.2012.727456. Medline indexed, impact factor: 2.082.
- Foster, C., Twist, C., Nicholas, C., & Lamb, K.L. (2010). Heart rate responses to small-sided games among elite junior rugby league players. *Journal of Strength and Conditioning Research*. 24(4), 906-911. DOI: 10.1519/JSC.0b013e3181aeb11a. Medline indexed, impact factor: 1.795.
- Sykes, D., Nicholas, C., & Lamb, K., & Twist, C. (2013). An evaluation of the external validity and reliability of a rugby league match simulation protocol. *Journal of Sports Sciences*, 31(1), 48-57. DOI: 10.1080/02640414.2012.720702. Medline indexed, impact factor: 2.082.
- Waldron, M., Twist, C., Highton, J., Worsfold, P., & Daniels, M. (2011). Movement and physiological match demands of elite rugby league using portable Global Positioning Systems. *Journal of Sports Sciences*, 29(11), 1223-1230. DOI:10.1080/02640414.2011.587445. Medline indexed, impact factor: 2.082.
- Waldron, M., Highton, J., & Twist, C. (2013). The reliability of a rugby league movement simulation protocol (RLMSP-i) designed to replicate the performance of interchanged players. *International Journal of Sports Physiology and Performance*, 8(5), 483-489. Available on request. Medline indexed, impact factor: 2.247.
- Waldron, M., Highton, J., Daniels, M., & Twist, C. (2013). Preliminary evidence of transient fatigue and pacing during interchanges in rugby league. *International Journal of Sports Physiology and Performance*, 8(2), 157-164. Output listed in REF2. Medline indexed, impact factor: 2.247.

4. Details of the impact

The beneficiaries of this applied research were primarily the management, coaching staff and players (senior and academy) of St Helens RFC (Date of impacts: November 2010-September 2012), Warrington Wolves RFC (Date of impact: September 2008-September 2010), and Premiership rugby union clubs (Date of impact: September 2011-July 2013) as well as the governing bodies of rugby league (RFL. Date of impact: January 2011-July 2013) and rugby union (RFU. Date of impact: September 2011-July 2013). Contracts with all organizations have existed during the assessment period for employment of research students to conduct knowledge transfer activities (RFL, 2006-2010; Warrington Wolves RFC, 2006-2010; St Helens RFC, 2009-present) or funded studentships (RFU, 2010-present). Some of these contracts remain to ensure on-going impact from the original research or development of new research.

Until this research was performed, the movement demands of elite rugby players (league and union) were based on out-dated evidence or inappropriate populations. Accordingly, professional clubs were unable to deliver training programmes informed by the internal and external loads currently imposed on players in Super League (rugby league) and English Premiership (rugby union) competitions. Therefore, the primary impact of this Group's research has been to influence coaching practice via the objective quantification of individual player, and positional specific demands during competitive match play. Data from competitive matches (Waldron et al., 2011; Sykes et al., 2011; Cahill et al., 2012; Waldron et al., 2013) were reported to the management and coaching staff of St Helens RFC, Warrington Wolves RFC and via one-to-one meetings with staff of several Premiership rugby union clubs. Findings were also fed into the national governing body via national coaching conferences (RFU), seminars (RFL) and invited symposia (BASES Annual Conferences 2009 and 2013), which enabled dissemination of the work to a wider audience of academics and practitioners.

The extent of the impact is evidenced in coaches' use of the data to construct and deliver sport-specific, field-based practices that prepare players for the demands of the competitive environment. For example, our work has had direct impact on coaches' practices at St Helens RFC where we helped to inform position- and individual-specific conditioning strategies. More specifically, we have helped design and implement training practices (i.e. drills) that are based on

worst-case game scenarios that have been employed by coaches and *'ensure players are conditioned to meet the demands of competitive matches'* (St Helens RFC, see 5.1). Governing bodies (i.e. RFL) have also incorporated our data into *'The re-structure of the RFL competition framework for Super League Academies'* (RFL, 5.1), and coach education resources which *'have helped to change the delivery approach taken by many coaches across all levels and have provided a more evidence-based approach to the use of small-sided games in coaching young rugby league players'* (RFL, 5.1). These data have enabled rigorous evolution of individual clubs' training practices and have been used to benchmark player performance in relation to recovery and subsequent training. Accordingly, our research has been used by the RFL and *'has been central to recent changes that we [RFL] have implemented to the RFL Player Development Pathway and the England programme in particular'* (RFL, 5.1). Assessing the movement demands during matches has also allowed a better understanding of fatigue (defined as reductions in high intensity activity during a match) and the degree to which players *'pace'* their involvement within a game (e.g. Sykes et al., 2011; Waldron et al., 2013). More specifically, the studies have been invaluable for informing coaches on the preparation and use of interchange players (i.e. substitutions) who, it appears, have different movement characteristics to those of whole-game players (Waldron et al., 2013). Accordingly, clear evidence to support the impact of our work has been St Helens RFC's implementation of their interchange strategies during the 2011 and 2012 seasons based on the research we had conducted with them, i.e. *'we refined our preparation of individual players and implementation strategy for interchange players during games based on the data collected as part of the initial GPS project in 2009'* (St Helens RFC, 5.1).

In the case of rugby union, GPS data are collected and analyzed each week then entered onto a central database (Rugby Football Union 'Elite Hub') for clubs to review. Data are then used to review individual and team workloads, from which club training practices can be altered to optimize performance (RFU, 5.1). These data are also used by international coaches to monitor player match and training loads in advance of international matches and training camps (RFU, 5.1).

Evaluating the efficacy of training programmes or dietary manipulations in rugby players, monitoring player performance after injury or assessing a player's match capability is problematic due to a variety of issues involved in studying real matches. For example, individual between-match variability of approximately 15% in high intensity running has been reported in rugby league, meaning that match-to-match comparisons of performance are impractical. This measurement *'noise'* complicates the assessment of systematic changes in match-related performance variables, thereby hindering potential developments in the understanding of rugby performance. Experimental research in a team sport environment is also often considered to be invasive and difficult to control, thus preventing its use with elite rugby players. To avoid such problems, the research from the initial movement demands studies has been used in conjunction with Higher Education Innovation Funding to develop a match simulation protocol that simulates the movement patterns observed during rugby league matches (Sykes et al., 2012; Waldron et al., 2013). This provides a more stable research model with which to detect systematic changes in performance and has several applications, including; informing coaching practice and player selection (i.e. talent identification), player rehabilitation and research. These match simulation protocols (Sykes et al., 2012; Waldron et al., 2013) are now adopted by the broader rugby league community for the assessment, monitoring and conditioning of rugby league players. For example, our work has changed practice at two Super League clubs who have used the simulation protocol to condition players to specific match demands (St Helens RFC, 5.1) and determine players' suitability to return to play after injury and rehabilitation (Widnes Vikings RFC, 5.1). That is to say, rather than using running tests based on subjective opinion as was the practice before, practitioners now have players perform the simulation protocol (or part of) to ascertain their physical capacity and ability to tolerate the running and contact demands associated with match play. Coaches are now able to make informed decisions on the player's capacity and how they might be best managed on their return to play. The outcome is more objective judgement of player capacity and a lower incidence of re-injury on return to play. The protocols are also being used in current projects to answer coach-led research questions that will impact on improving performance via training, nutritional or tactical interventions.

Impact case study (REF3b)**5. Sources to corroborate the impact**

We provide below several sources to corroborate the impact. Non-electronic evidence can be accessed from the Group on request.

- 5.1 A folder of correspondence confirming the quotes attributed in section 4 and how the Group's work with GPS has informed rugby practice, including letters from:
 - Head of Strength and Conditioning, St Helens RFC;
 - Head of Sports Science Support, Rugby Football Union;
 - Head of Performance Analysis and Biomechanics, English Institute of Sport;
 - a former staff member at Warrington Wolves RLFC, now Heart of Midlothian FC;
 - Director of Performance and Coaching, RFL;
 - Head of Strength and Conditioning, Widnes Vikings RFC; and
 - a former Head of Coach Development RFL, now Coaching and Education Manager British Cycling).
- 5.2 Interview with Matthew Daniels corroborating applied work with St Helens RFC:
<http://www.superleaguefans.com/st-helens/2012/01/13/saints-preseason-training-ga-with-matt-daniels.html>
- 5.3 *Supporting a UK success story: The impact of university research and sport development.* Government Report. 'Using GPS Technology to reveal the secrets of performance' pp20-21. Presented at University Week (Houses of parliament, London) (ISBN 978-1-84036-271-8). Electronic copy available on request.
- 5.4 Presentation of data on the use of GPS in elite rugby to IRB medical conference:
<http://www.irbplayerwelfare.com/?documentid=82>
- 5.5 Dissemination of material corroborating the use of GPS in Rugby Football:
 - http://www.rfu.com/News/2011/April/News%20Articles/140411_GPS_Premiership
 - <http://www.plextek.com/about-us/industry-news/30-wireless-communications-news/148-rugby-organisation-uses-gps-to-monitor-players.html>
 - <http://www.telegraph.co.uk/sport/rugbyunion/news/8449218/RFU-hope-hi-tech-study-can-add-to-Martin-Johnsons-England-armoury-ahead-of-the-World-Cup.html>
 - <http://www.rugbynetwork.net/main/s245/st162531.htm>
 - <http://www.rugbyweek.com/news/globalrugbynews.asp?id=27003>
- 5.6 Higher Education Innovation Fund application and confirmation of funding.