**Institution:** Liverpool John Moores University (LJMU)

**Unit of Assessment:** UOA24

**Title of case study:** Driving transformation in player tracking technology and elite player preparation across the global football industry

**Period when the underpinning research was undertaken:** 2009-2019

**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: |
|---|---|---|
| Martin Littlewood | Reader & FEx Lead | 2005 to date |
| Warren Gregson | Professor | 2004 to date |
| James Morton | Professor | 2008 to date |
| Graeme Close | Professor | 2009 to date |
| Alistair McRobert | Reader | 2007 to date |
| Barry Drust | Professor | 2002 to 2019 |

**Period when the claimed impact occurred:** 2014-2020

**Is this case study continued from a case study submitted in 2014?** N

## 1. Summary of the impact

Football has immense sporting, cultural and economic impact with reach around the globe. Research undertaken by the Football Exchange (FEx) includes match and training analysis and key aspects of player preparation and recovery. This research has been translated into evidenced-based practice to produce impact within multiple layers of the global football industry. FEx research has significantly changed player tracking procedures underpinning the global uptake of this technology within elite football. Our research has also changed practice associated with player preparation and recovery in elite clubs, national associations and international governing bodies. The successful translation of FEx research has provided football practitioners from around the world with evidence-based models for their professional practice that have enhanced player and team development from an economic, health and performance perspective.

## 2. Underpinning research

The FEx is a leading unit for football related research and applied consultancy activity in the UK, first established through the pioneering research of Professor Tom Reilly in the mid 1970's. It has produced >170 peer-reviewed articles (4857 citations) between 2000-2020 and generated in excess of £1million of external grant and industrial income from a range of important stakeholders (i.e., National football associations, elite clubs, international governing bodies and technology companies) across the global industry. Specific FEx research has led to demonstrable changes in player tracking technology and the way in which football clubs use technology to track and monitor the physical capabilities of their players. Physical preparation and recovery strategies have also been changed within clubs as a direct consequence of research into energy intake, expenditure and body composition and the development of methods to evaluate training status of elite players. The information below describes the two research themes and the unique insights and outcomes that the studies have generated.

The FEx has a long history of providing empirical data that has informed the development of leading player tracking technologies used across the global game. The data generated from **REF 1** established the validity and reliability of Stats Perform's (formerly Prozone) automated match-analysis tool, which remains the world's leading computerised match performance analysis system. Crucially, data demonstrated that the system was highly accurate (within 0.4%) and reliable (~1.5-6 %) at quantifying match-related displacement velocities. **REF 1** also provided the foundation for subsequent research undertaken through a Knowledge Transfer Partnership (KTP)**.** The KTP focused on the unique application of advance machine learning analytical techniques to create a multi-variate playing style methodology which provides a more comprehensive understanding of the complex inter-relationships between variables at the level of the individual player and the team (player interaction, style of play) and the extent to which they influence the outcome of games. **REF 2** assessed the validity of the world's leading wearable global positioning

system (GPS) technology to evaluate important metrics for examining the physical demands of training in football. We demonstrated the system presented a valid measure of maximal sprint speed versus the criterion measurement tool (laser gun), however, the system failed to provide valid measures of important metrics including acceleration and deceleration capacity. Collectively, this body of work has led to changes in the software provided to elite team sports by the world's leading player tracking technology companies as described in the detailed resulting impact in Section 4.

Research from the FEx has also examined multiple facets of player preparation and recovery. More specifically, potential measurements of player training status during an in-season competitive phase were examined in elite players (**REF 3**). Morning-measured perceived ratings of fatigue, sleep quality and muscle soreness were more sensitive than heart rate-derived indices to the daily fluctuations in training load, suggesting that they could be used as non-invasive assessments of player training status in elite soccer players. This research has been integral to the development and implementation of a novel framework to evaluate player training status which has led to a significant reduction in injury-related unavailability at a leading Premier League club. Our research has also informed evidence based nutritional guidelines for adolescent and adult male professional soccer players. Although the physical and physiological demands of soccer match play and training have been reasonably well documented, the energy requirements of elite soccer players throughout the player pathway (i.e. adolescent through to adulthood) were not yet characterised. To this end, we conducted a 5-year programme of research that quantified body composition, resting energy requirements and total daily energy requirements (TDEE) of adolescent and adult male soccer players. In utilising the gold standard technique of doubly labelled water, we quantified for the first time the TDEE of adult male football players from the English Premier League (**REF 4**). During the common two-game per week schedule, data demonstrated that professional players expend approximately 3500 kcal/day, equating to a relative TDEE of 45-55 kcal/kg fat free mass (FFM). In relation to adolescent soccer players, absolute TDEE progressively increased as players transition through the academy pathway (**REF 5**) where relative TDEE equates to 60-80 kcal/kg FFM. For example, U18 players presented with a TEE (3500 kcal/day) that was approximately 600 and 700 kcal/day higher than both the U15 (3000 kcal/day) and U12/13 players (2900 kcal/day), respectively. Moreover, it is noteworthy that some individual players (as evident in all age groups) presented with a TDEE that was comparable to (or exceeded) that previously reported in adult players. We also provided the first report to simultaneously quantify body composition in both adolescent and adult players (using dual- energy X-ray absorptiometry). Importantly, these data demonstrate that both adolescent and adult players present with similar absolute levels of fat mass but distinct differences in FFM (**REF 6**). Collectively, this body of work now informs nutrition policy and practice that aims to promote growth, maturation and performance across the player development pathway as described in the detailed resulting impact in Section 4.

**3. References to the research**

The research programmes and the six key outputs described in Section 2 that underpinned the impact are shown below. All outputs have been through a rigorous peer review process and are published in some of the leading international journals in this field. Substantial elements of this work were funded by external funders.

1. Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P. and Drust, B. (2009). Analysis of High Intensity Activity in Premier League soccer. *Int J Sports Med*. 30, 205-212. doi:10.1055/s-0028-1105950.
2. Kyprianou E, Lolli L, Al Haddad H, Di Salvo V, Varley MV, Mendez Villanueva A, Gregson W, Weston M. (2019). A novel approach to assessing validity in sports performance research:

integrating expert practitioner opinion into the statistical analysis. *Sci Med Football*. 3, 333-338. doi:10.1080/24733938.2019.1617433.
3. Thorpe, R. T., Strudwick, A. J., Buchheit, M., Atkinson, G., Drust, B., & Gregson, W. (2016). Tracking morning fatigue status across in-season training weeks in elite soccer players. *Int J Sports Physiol and Perform*. 11, 947-952. doi: 10.1123/ijspp.2015-0490.
4. Anderson, L., Orme. P., Naughton, R.J., Close, G.L., Milsom, J., Rydings, D., O'Boyle, A., Di Michelle, R., Louis, J., Hambley, C., Speakman, J.R., Morgans, R., Drust, B and Morton, J.P. (2017). Energy intake and expenditure of professional soccer players of the English Premier League: evidence of carbohydrate periodization. *International Journal of Sport Nutrition and Exercise Metabolism*, 27, 228-238. doi:10.1123/ijsnem.2016-0259.
5. Hannon, M., Parker, L.J.F., Carney, D.J., McKeown, J., Drust, B., Unnithan, V.B., Close, G.L. and Morton, J.P. (2020). Energy requirements of male academy soccer players from the English Premier League. *Medicine and Science in Sports and Exercise*, 53, 200-210. doi:10.1249/MSS.0000000000002443.
6. Hannon, M, Unithan, V., Drust, B., Carney, D., Close, G.L. and Morton, J.P. (2020). Cross-sectional comparison of body composition and resting metabolic rate in Premier League academy soccer players. *Journal of Sports Sciences*, 38, 1326-1341. doi:10.1080/02640414.2020.1717286.

**Details of Funding** (funding information relates specifically to relevant projects outlined above):
1. Gregson (2013-2015), Stats Perform (Formerly Prozone Sports) and Economic & Social Research Council (ESRC), KTP funding, £144,000.
2. Gregson (2010-2014), Manchester United FC, PhD funding, £60,000.
3. Morton and Close, (2016-2020), Everton FC, PhD funding, £105,000.
4. Morton and Close (2010-2015), Liverpool FC, PhD funding, £60,000.
5. Morton and Close, (2018-2020), UEFA, £15,000, PhD Project.

**Total £384,000**

## 4. Details of the impact

The FEx has strategically engaged in a number of dissemination events with external stakeholders to communicate and translate the group's research to change practice. This has included a number of industrial advisory and consultancy roles for members of the FEx with clubs in the English Premier League [i.e., Everton FC (Close 2016-2019), Liverpool FC (Morton, 2010-2015; Drust 2006-2019), Manchester United FC (Gregson, 2008-present), Aston Villa FC (Close 2020-present)], national associations [i.e., The Football Association (Close, 2017-present), Qatar FA (Gregson, 2012-present)] and governing bodies [i.e., UEFA (Morton, 2018-2020]. The international reach is further evidenced in a number of keynote addresses and committee roles for staff, and the appointment of the FEx as the strategic partner of Isokinetic Medical Group at their annual international conference (**Evidence 1**). In addition, FEx staff have supported development of the global industry's first digital knowledge exchange platform (https://fellows.aspire.qa/index.aspx). Launched in 2014, Aspire in the World enables elite clubs and national associations from over 30 countries to share practice on elite player development (~190k hits to date). The FEx has also been integral in the School's Professional Doctorate in Applied Sport and Exercise Sciences (DSPORTEXSci). Validated in 2015, the programme has supported the development of a significant number of practitioners (i.e., 19) working as researching professionals nationally and internationally in applied football environments (e.g., English Premier League, Scottish Premier League, Football League, The Football Association, Major League Soccer and the Professional Referees Organisation. Evidence of change, including its significance and reach are outlined below, and the process, beneficiaries and nature of the impact are explained in detail.

**1. Development of contemporary player tracking technologies which have revolutionised performance analysis capability across the global football industry**

*a. Stats Perform computerised performance analysis system*

Data derived through advanced computerised technology in relation to the performance of players during match-play is now universally adopted across the global football industry. Our research (**REF 1**) was crucial in initially allowing Stats Perform (formerly Prozone) to demonstrate the accuracy and reliability of its computerised performance analysis system. Consequently, these data were instrumental in allowing Stats Perform to gain acceptance across the global football industry as the leading provider of automated tracking solutions. Over the period 2014-2020, Stats Perform global market share has continued to grow with its client base and revenues increasing by more than 400% (**Evidence 2**). Validation of the system also provided the foundation for our subsequent research undertaken as part of an award-winning KTP (**Evidence 3** https://educatenorth.co.uk/2016-winners/). The KTP, completed in 2015 (jointly funded by Stats Perform and the ESRC), led to the development and implementation of the global football industry's first commercially available software for tactical profiling and playing styles analysis of elite teams (https://www.statsperform.com/team-performance/football-performance/match-analysis/) (**Evidence 2**). Released in 2019, the software has changed the interpretation of game-related statistics by coaching and performance staff in elite football clubs. This change in interpretation has proved valuable for practitioners who utilise such data to develop performance plan(s) of players, teams and organisations. This can be demonstrated by the use of these data and processes by the Head of Performance and Research at English Premier League team Wolverhampton Wanders (**Evidence 4**). Since its release, the software has attracted a global client base spanning 10 countries (**Evidence 2**).

*b. Catapult Sports wearable global positioning system (GPS) technology for evaluating the physical demands of football*

Wearable global positioning system (GPS) technology has revolutionised the ability to evaluate the physical demands of training in football and therefore enhanced the capability of practitioners to optimise performance, mitigate injury risk and facilitate safe return to play following injury. At the elite level, the precision of GPS data is of critical importance. The detailed information in **REF 2** has directly led to changes in the algorithms which underpin the software utilised by Catapult Sports (**Evidence 5**). As the world's leading provider of wearable GPS tracking technology in sport with a global client base of over 1200 users, our research has therefore directly impacted the quality of data now available to elite sports team on a global level (**Evidence 5**). **REF 2** directly influenced the development and implementation of a unique national player tracking programme in Qatar as part of the countries preparations for hosting the 2022 FIFA World Cup (**Evidence 6**). The research findings underpinned a successful grant application to FIFA (£1.5 m) which financed the provision of GPS technology to all elite clubs in Qatar together with QFA youth and senior national teams. Implementation of this technology together with a contemporary data management system and ongoing coach education has significantly changed the capability of Qatar's coaches to develop training programmes which optimise player development (**Evidence 6**). For example, the ability to measure precise running speeds using GPS, as shown by our research (**REF 2**), has provided staff with data to help guide, control and optimise the training stimulus, thereby enhancing both the quality of team training and the process of rehabilitation for injured players (**Evidence 6**).

**2. Enhancing elite player development and performance**

*a. Development and implementation of a framework to evaluate player training status which has contributed to a significant reduction in player injury at an elite football club*

The demands of training and match-play can induce a high degree of physical stress on elite football players which leads to injury. Prior to our research virtually no evidence was available concerning the validity and utility of practical assessment techniques for evaluating the training

status of elite soccer players in the field. Our research directly resulted in the development and implementation of a series of assessments which formed the basis of an assessment framework to evaluate player training status (**REF 3**). The framework was used by the club's first team coaches, medical and performance staff in their daily practice. This change in practice was significant in contributing to increases in match availability of approximately 14% per season in the first team playing squad through a reduction in injury-related unavailability over three competitive seasons (2014-2015 to 2016-2017) (**Evidence 7**). In light of the significant financial costs associated with injury related (team underachievement and player salaries) decrements in performance, the change in practice driven by our research had a significant positive impact on "return on investment" to the club (**Evidence 7**).

b. *Development of evidence-based nutrition policy and practice guidelines to influence player development during the pathway from adolescent to adult professional player*

Our data (**REF 4-6**) now informs both policy and practice of world leading governing bodies and professional soccer teams. As recognised research-informed practitioners, members of the Football Exchange were appointed to an Expert Advisory Group to co-author the 2020 UEFA Expert Group Statement on nutrition in elite football (**Evidence 8**). This work was published in the British Journal of Sports Medicine in an Expert statement that has already been downloaded over 18,000 times. The papers cited in section 2 were referenced accordingly as evidence-based research papers that inform the daily energy requirements for both adolescent and adult players. Our research is also directly informing practice within professional football environments in relation to both body composition strategies and the wider nutritional philosophy underpinning the club's performance nutrition programme. In relation to the former, our data now informs coaching and sport science practice in that adolescent players should not be aiming to reduce absolute fat mass. Rather our research supports the rationale for players to engage in well evidence-based nutritional and training practices that promote the growth of fat free mass (**Evidence 9**). Moreover, English Premier league teams are now using the cited research (alongside a wider body of nutritional related research from the Football Exchange) to underpin the evidence based nutritional philosophy of the club's performance nutrition programme (**Evidence 10**).

**5. Sources to corroborate the impact**

1. **Isokinetic Medical Group Ltd.** testimonial letter supporting the role of the FEx in enhancing the reach and impact of the leading international football medicine and performance conference.
2. **Stats Perform** testimonial letter describing; 1. impact of the validation data in developing tools for the global football industry and driving sales, 2. development of KTP in relation to playing style software.
3. **Educate North Award** https://educatenorth.co.uk/2016-winners/
4. **Head of Performance and Research**, **Wolverhampton Wanders** testimonial letter supporting the impact of the commercially available software on performance analysis capability across their first team coaching staff.
5. **Catapult Sports** testimonial letter outlining evidence for the impact of the research in changing the algorithms used in their software to detect important physical metrics.
6. **Director of Performance**, **Aspire Academy** & **Qatar FA** testimonial letter supporting the impact of the research on developing and implementing a national player tracking programme.
7. **Head of Performance**, **Manchester United FC**, testimonial letter including player availability statistics supporting the impact of the research informing decisions around methods to assess player training status.
8. **UEFA 2020 Expert Statement** for nutrition in elite football.
9. **Everton FC**, testimonial letter supporting the impact of the research in informing evidence-based nutrition policy and practice guidelines at the club.
10. **Aston Villa FC** nutrition philosophy document.