

Institution: Middlesex University		
Unit of Assessment: 24 – Sport and Exercise Sciences, Leisure and Tourism		
Title of case study: The physical preparation of GBR Fencers for the 2016 Rio Olympics and beyond		
Period when the underpinning research was undertaken: Mar 2012 – Dec 2016		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): Anthony N. Turner	Role(s): Associate Professor	Period(s) employed by submitting HEI: Feb 2008 - present
Period when the claimed impact occurred: Aug 2013 – Dec 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact		
<p>Since 2012, our research on athletic development in fencing has been translated to improvements in Olympic, elite, and developing fencers' performance, and provided important new insights to coaching education and practice. Dr Turner's research, which has challenged traditional practices through a research and evidence-based ideology, was undertaken by working closely with coaches and athletes from GBR fencing.</p> <p>The key outputs and their impacts include:</p> <ul style="list-style-type: none"> • <i>Physical preparation guidelines and testing battery</i> – following the success of GBR fencing using these fitness benchmarks, several fencing teams have also adopted them (e.g., Denmark, Sweden, Qatar, and Canada). • <i>Total Score of Athleticism – a physical profiling system</i>, which informed the selection of fencers and their funding. It is now used more widely (e.g., in the NFL, British Army, professional football, NATO, and the English National Ballet). • <i>Curriculum changes to coach education</i> – courses changed from teaching the traditional understanding of physical preparation of fencers, to that based on Dr Turner's research. 		
2. Underpinning research		
<p>Research on the physical demands of competition and subsequent knowledge transfer by improving coaches' and athletes' understanding of performance, is one way to enhance the chances of success in competition. Dr Turner undertook research (Mar 2012 – Aug 2016) with British Fencing to bolster the medal-winning ambition of the GBR Team at the 2016 Rio Olympic Games. Equally, these insights resulted in changes to coach education programmes and manuals, from grass roots to elite, with the aim of improving success at future games. As a final outcome, Dr Turner sought to use this information to identify a scoring system from which an assessment of holistic physical capacity could be provided, and thus be used to support the selection of fencers as well as funding-based decisions made in conjunction with UK Sport.</p> <p>Research on elite athletes is inherently difficult, as athletes and their coaches are generally hesitant to participate in research due to reluctance in making changes to their normal training, which can often contradict the traditional approaches they have used. To overcome this, Dr Turner undertook a series of graduated studies, initially involving cross-sectional and observational analysis, progressing to athletes having to provide data during live international competitions, and finally, those requiring athletes to make deliberate changes to practice.</p> <p>Initially, Turner <i>et al.</i>, (3.1) investigated the physical characteristics underpinning the kinetics and kinematics of the lunge, as well as change of direction speed in fencing, which are considered fundamental skills; over 70 fencers were analysed, covering each stage of the high-performance pathway. This research helped establish an evidence-based training system, the validation of a new agility test, and provided athlete benchmarks across the sport.</p> <p>Following this, Turner and colleagues (3.2) further explored the lunge and how this motor skill could be developed such that athletes could stand further from their opponent (a key</p>		

performance indicator as identified by the coaching staff and senior athletes). The research looked at all senior Olympic and academy fencers to better differentiate performance variables and again ensure that results could feed directly back to strength and conditioning training and coaching resources aimed at physically preparing young fencers for future games.

Next, Turner *et al.*, **(3.3)** investigated the physiological demand of international competitions, using the GBR Olympic fencing team who were preparing for the Rio Olympic games. This would provide invaluable information, including around recovery between bouts and competitions. Given the study placed additional demands on the athletes, within an already highly-pressured environment, this was unsurprisingly the first study (and remains the only study) to undertake such an analysis. Between each bout, each fencer had saliva samples taken (for the analysis of testosterone, cortisol, immunoglobulin A, and alpha amylase), blood lactate recorded, and jumped on force plates. Furthermore, all fencers wore HR monitors throughout the competition, as well as providing RPE scores. The data was able to identify relevant fitness training programmes and the time-course for recovery within and between bouts, with its findings in stark contrast to traditional beliefs and methods, which centred on low intensity, endurance-based practices.

Building on the previous study, Turner and colleagues **(3.4)** validated a fitness test that measured the fundamental requirements of fencing athletes to repetitively lunge. This test was a unique format of testing within the sport, designed around competition-based data. In contrast to other commonly used tests, this was able to ensure HR, RPE, blood lactate, and changes in direction met the worst-case scenario conditions of fencers, as measured during actual competition. Furthermore, 36 elite fencers were monitored for 16 weeks, split into an intervention and control group. The intervention group included strength and conditioning sessions that targeted the physical characteristics hypothesised to improve repetitive lunging ability as determined by multiple regression analysis, with it indeed highlighting a cause-and-effect relationship.

In order to now integrate the training programme and monitor its effectiveness, including the training-load imposed on the athletes (determining also the association between what was prescribed by the coaches and what was experienced by the athletes), Turner *et al.*, **(3.5)** next assessed the association between various measures of internal and external training load (again via salivary markers, blood lactate, neuromuscular fatigue, HR, and RPE) to determine the most valid, reliable, and feasible methods. Furthermore, the association was assessed during all forms of training, from light footwork, to conditioning sessions, to five and 15-point sparring matches. The analysis revealed the efficacy of sRPE in programming and recording training load data and was thus implemented within GBR fencing.

A final analysis was undertaken by Turner and colleagues **(3.6)** to determine if any differences existed across swords (i.e., foil vs. epee vs. sabre). This data would provide the final challenge to the traditional physical training practices adopted by fencers, demonstrating it did not need to be modified based on sword. While some rules and styles were different across swords, they were not so different as to assert different physiological and biomechanical demands. This information would serve all fencers, including those on pathways and in training for the Tokyo and Paris Olympics.

The above research enabled two additional developments. Firstly, with a greater understanding of the physical demands of the sport, Dr Turner was able to identify fundamental physical characteristics of elite fencing athletes, from which he developed a physical profiling system – the Total Score of Athleticism – to assist with selection and funding decisions made in collaboration with coaches and UK Sport. Secondly, given his understanding of movement kinetics and kinematics in fencing, Dr Turner and colleague published a technical report challenging current technical teachings of fencing footwork, and proposing a new paradigm of

“bouncing”, which led to enhanced movement economy and propulsion. This style of footwork was subsequently used by the finalists of the 2016 Olympics and several competitions since.

3. References to the research

- 3.1 Turner, A.N., Chavda, S., Edwards, M., Brazier, J., Bishop, C., & Kilduff, L. (2016). Physical Characteristics underpinning lunging and change of direction speed in fencing. *The Journal of Strength and Conditioning Research*, 30 (8), pp. 2235-2241. <https://doi.org/10.1519/JSC.0000000000001320>.
- 3.2 Turner, A.N., Marshall, G., Noto, A., Chavda, S., Atlay, N., & Kirby, D. (2017). Staying out of range: Increasing attacking distance in fencing. *International Journal of Sports Physiology and Performance*, 12(10), pp.1319-1323. <https://doi.org/10.1123/ijsp.2016-0680>.
- 3.3 Turner, A.N., Kilduff, L.P., Marshall, G.J., Phillips, J., Noto, A., Buttigieg, C., Gondek, M., Hills, F.A. and Dimitriou, L., (2017). Competition intensity and fatigue in elite fencing. *The Journal of Strength & Conditioning Research*, 31(11), pp.3128-3136. <https://doi.org/10.1519/JSC.0000000000001758>.
- 3.4 Turner, A.N., Marshall, G., Phillips, J., Noto, A., Buttigieg, C., Chavda, S., Downing, W., Atlay, N., Dimitriou, L. and Kilduff, L., (2016). Physical characteristics underpinning repetitive lunging in fencing. *The Journal of Strength and Conditioning Research*, 30(11), pp.3134-3139. <https://doi.org/10.1519/JSC.0000000000001402>
- 3.5 Turner, A., Bishop, C., Cree, J, Edwards, M., Chavda, M., & Kirby, D. (2017). Do fencers require a weapon specific approach to strength and conditioning? *The Journal of Strength and Conditioning Research*, 31(6), pp.1662-1668. <https://doi.org/10.1519/JSC.0000000000001637>
- 3.6 Turner, A., Buttigieg, C., Noto, N., Marshall, G., Phillips, J., & Kilduff, L. (2017). Ecological validity of Session RPE method for quantifying internal training load in Fencing. *International Journal of Sports Physiology and Performance*, 12(1), pp.124-128. <https://doi.org/10.1260/1747-9541.10.4.729>

4. Details of the impact

Physical preparation guidelines and testing battery

The research of Dr Turner contributed to Great Britain winning its first ever fencing European title, winning gold at the inaugural European Games in Baku in 2015, and achieving 6th place in the team and 4th in the individual event at the Rio Olympic Games. In fact, this was the first time that GBR had qualified a fencing team for the Olympics, as well as seeing a GBR fencer become world no.1 and another world no.2. The Performance Director for GBR fencing said that “*The application of this research meant we had fencers who were fit and able to cope with the intensity and frequency of training and competitions, certainly something that gave us a competitive edge over our opponents. This focus, as a result of the research, had a significant positive effect on the physical preparation of our fencers and it can be credited with enabling us to achieve our performance milestones.*” (5.1). Subsequent to the success of GBR, several fencing teams and nations (including Denmark, Sweden, Qatar, and Canada) have adopted the physical preparation guidelines and testing battery as described by Turner. Notably, Denmark Fencing have used Turner to work with their squad to embed his physical training philosophy within their performance pathways and continue conducting his research. The Performance Director for the Danish Fencing Federation, said that “*I knew that there was an advantage to be gained by bringing Anthony in to advise and work with our national teams. His presence and the testing and training programs he introduced have been hugely appreciated by athletes and coaches, ensuring our athletes are in the best physical condition possible to aid us in achieving our vision for Olympic success; I’m pleased to say that our performances are steadily improving*” (5.2).

The fencing training and testing methods established by the research of Dr Turner and colleagues, can be noted across the training manuals of several nations including Canada (5.3)

and Sweden (5.4), and British Fencing use the fitness benchmarks established by Turner's research as pre-requisites for international competition selection (5.5). Equally, given the scale with which the work of Dr Turner challenged the traditional practices used by coaches and athletes to prepare fencers for the physical demands of competition, his research also culminated in challenging the fencing style and footwork adopted by athletes. Most notably, the finalists of the 2016 Olympics and several competitions since, use the "bouncing" technique described by Turner and his colleague, who is a current international coach and former Olympic and world gold medallist (5.6). Testament to this collective impact, is that in an updated coaching manual, Dr Turner's work on fencing was described as "breakthrough research" (5.6).

Total Score of Athleticism – a physical profiling system

The research of Dr Turner and colleagues has impact which reaches beyond fencing, with Turner invited to share his work, which centres on research which challenges tradition, with England Rugby league, the British Army, and various professional football clubs including Arsenal, Leicester, and Chelsea FC. Furthermore, his impact beyond fencing can be noted through the athlete profiling system he established, to support athlete selection, assist with athlete funding, and ultimately report fitness testing data back to coaches and athletes, which would in turn direct physical training to improve performance and reduce the likelihood of injury (5.1). This scoring system, titled Total Score of Athleticism is now widely used across multiple sports, as well as by the British Military, and the North Atlantic Treaty Organisation. The Medical Director at the English National Ballet said that "Since adopting this system, we have been able to better present physical limitations that should be targeted by the dancer, and in such a way that is understandable to both the artistic team and the individual dancer. This system is relatively new in dance, but has aided us in increasing awareness of physical fitness testing and we have now started to look to reduce the incidence of injury" (5.7). Finally, its impact in soccer was highlighted in a keynote talk at an international conference by a representative from Arsenal FC, where it was noted that "this system directs our training to target physical windows of opportunities and track player progress relative to their team mates, as they transition through the academy" (5.8).

Curriculum changes to coach education

In conclusion, the mechanism for achieving impact from this research is primarily via Dr Turner's broad and significant involvement in applied work with practitioners. Dr Turner's close working relationship with British Fencing and more recently, Denmark Fencing, has allowed him to translate research directly to the very highest level of the sport. While research on elite athletes is inherently difficult and changes are in most cases practically impossible to quantify at the athlete level given so many extraneous variables, the widely-adopted strength and conditioning practices, fitness testing batteries, and scoring system developed by Dr Turner, are evidence that multiple fencing nations, and indeed sports in general, have changed their policies and practices. Coaches and athletes appreciate and value the insights drawn from his work. The enduring impact of his research was summarised by the Head of Coach Education at British Fencing, who said that following Dr Turner's research, the coach education programmes delivered by the National Academy and the Advanced Apprenticeship in Sporting Excellence course, were changed to ensure "coach development training included fitness training for fencers, raising the coaches' awareness and knowledge of the subject" (5.9).

5. Sources to corroborate the impact

- 5.1 *British Fencing Performance Director*. This testimony evidences the direct impact the research of Turner and colleagues had on the GBR team, in preparation for the Rio Olympics, including the use of data for athlete selection.
- 5.2 *Denmark Fencing Performance Director*. This testimony evidences the direct impact the research of Turner has had on the physical training and testing of Denmark's national team, and how this has positively impacted fitness and performance.

- 5.3 *Canada/Ontario Fencing training manual* (click [here](#)). This training manual cites the research of Turner in the preparation of its national fencers
- 5.4 *Minutes from Physical training advisory Committee of The Swedish National Fencing Association*. These minutes cite how the research of Turner is used in the physical preparation and testing of its national fencers
- 5.5 *Great Britain, Fitness benchmarks* (click [here](#)). This document highlights the fitness perquisites that must be obtained to attend training camps. These benchmarks were developed through the research of Dr Turner and colleagues.
- 5.6 *Updated coaching instruction resource. See foreword, page liii to liv. in Epee 2.5. SwordPlay Books (2017)*. This foreword highlights the significant changes made to the coaching and physical training of fencers as a consequence of Dr Turner's work.
- 5.7 *Medical Director at the English National Ballet*. This testimony evidences the direct impact the athlete profiling system is having on physical preparation in ballet dancers
- 5.8 *Training the youth athlete: Theory and application (2019). Australian Strength and Conditioning Association national conference*. In this keynote presentation, the impact the profiling system developed by Turner has had at Arsenal FC is discussed (link to presentation [here](#)).
- 5.9 *British Fencing Head of Education*. This testimony evidences the direct impact the research of Turner and colleagues had on the coach education programme delivered to aspiring GBR coaches, citing how the physical preparation of fencers was updated in line with this research.