Focus Collection on Modern Approaches to Sports Medicine and Performance

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Introduction

In the 21st Century there are more people than ever before participating in sports, with sport becoming a universal language to bring people together no matter what their background or origin. Sports medicine and performance provision in amateur and elite level sport have been growing over the past decade (Stuart et al., 2018), due to the recognition of such provision in preventing and minimizing sports-related injuries, as well as enhancing techniques or performance. In order to maintain a winning edge, modern athletes, clinicians (i.e. doctors, physiotherapists, sports therapists/athletic trainers etc.) and performance enhancement specialists (i.e. strength and conditioning coaches etc.) are keen to develop analytical parameters that can reduce injury risk, speed-up recovery times and improve all aspects of player performance (Baca and Schwartz, 2016). Traditionally, clinicians and background support staff are required to deal with complex injuries and performance issues using only subjective rating scales or professional experience, which only provide limited understanding of the problem and may not be sensitive to subtle underlying impairments or issues. For example, the development of simple subjective paper-based concussion assessments (e.g. Sport Concussion Assessment Tool) allowed clinicians to standardize assessment for potential deficits (Stuart et al., 2017). The simplicity and subjectivity of paper-based assessments may lead to subtle deficits or issues being missed, which may lead to athletes returning to play before they are ready, as well as increased risk of further serious injuries or declines in performance. For example, 60% of rugby players returning to play within the same season as having a concussion either have symptom reoccurrence or a secondary injury (Cross et al., 2016). This problem has led to a growth in the sports technology industry (Thompson, 2014), with a plethora of novel technologies and wearable devices marketed towards assisting sports medicine and performance professionals in managing athlete health and fitness by providing highly sensitive, quantitative and objective outcomes (Mooney et al., 2015, O'Reilly et al., 2018).

Development and application of sports technology has been enabled with novel designs, advanced materials and increasingly smaller micro-technologies (Thompson, 2018). Such devices provide a deeper understanding of the particular needs of athletes and their health/performance, which are beginning to be used by multidisciplinary teams of support staff to provide innovative healthcare and training enhancement. With the application of modern technologies within sports medicine and performance settings, people are now able to visualize objective information regarding an array of physical activity, health, daily movement, mood, and behaviors, in order to monitor their routines, improve sport performance or change techniques/behavior (Düking et al., 2016, Mertz, 2013). However, the application of sports technology is currently done in an *ad hoc* manner, which is largely based upon the limited understanding of best practice in this area. There is therefore a vital need to develop and understand modern techniques or technologies that can provide quantifiable evidence to identify risk factors for injury prevention, as well as assist in injury diagnosis, management and performance progression.

Therefore, Physiological Measurement is pleased to present the Focus Collection entitled "Modern Approaches for Sports Medicine and Performance" (https://iopscience.iop.org/journal/0967-3334/page/Focus_on_modern_approaches_for_sports_medicine_and_performance). This focus collection aims to provide an awareness of the modern sports-related technologies available to sports medicine and performance professionals, with a particular focus on their usefulness within practice and robustness to provide deeper understanding of the athlete population. This collection of articles presents some recent advances in novel technological applications to sports medicine and performance, specifically addressing areas such as theoretical, methodological and practical approaches to be considered when applying modern technologies within sports settings or populations.

Modern Approaches

Objective technological applications within sport can be derived from "snapshots" of motor function through highly sensitive, but expensive and large-scale devices, such as the use of 3D motion capture or force plates by Stoneham et al. (2019) and Murray et al. (2019), or magnetic resonance imaging by Rothwell et al. (2019). However, progression has been made to inexpensive mobile technologies, such as inertial sensors (Johnston et al., 2016, Johnston et al., 2018), that are capable of capturing an array of immediate or longitudinal data related to athlete health and performance (Fantozzi et al., 2016, Rawashdeh et al., 2016, MacDonald et al., 2017, Fino et al., 2019). For example, Gregory et al. (2019) have used wearable heel-mounted foot sensors to measure running biomechanics in athletes, and Demarie et al. (2019) used inertial sensors to measure anaerobic capacity in elite swimmers. Furthermore, research-grade wearable devices are being examined for application within sporting or athlete populations to inform clinical and performance decisions. For example, Stuart et al. (2019) used mobile eye-trackers to study concussion injuries and

Snegireva et al. (2018) reviewed the use of such devices for sports-related concussion injuries. Additionally, smartphones/tablets (Johnston et al., 2017), functional near infra-red spectroscopy (Urban et al., 2015, Hocke et al., 2018) and other research devices have been used to provide objective measurement outcomes. For example, Howell et al. (2019) used a smartphone to capture gait measures to differentiate adolescents with concussion from healthy controls, and Toshiyo (2019) reviewed the use of wearables for monitoring oxygen uptake and energy consumption. These devices could allow for comprehensive objective monitoring of physiological and behavioral data within amateur and elite sport, in the near future.

The sports technology and wearables industry has provided opportunity to collect an almost endless stream of data regarding athlete health and performance; however, with the huge amount of data that can be accessed and used, there are also issues that must be dealt with. For example, despite the popularity of novel technologies and wearables, very few of these devices have been rigorously and independently examined to determine their accuracy, reliability, validity (Johnston et al., 2019), and overall usefulness within sports medicine and performance settings or populations (Wallen et al., 2016, MacDonald et al., 2017).

Many of these modern technologies still need to be tested for issues such as;

(1) Placement of wearable devices (i.e. anatomical locations or external to body)

(2) Reduction of movement artefacts

(3) Optimal sampling frequencies or algorithms to detect specific movements or activities

(4) Outcome variable reduction (i.e. a few sport-specific variables rather than a suite of meaningless variables)

(5) Data security and transmission within a variety of environments (e.g. indoor/outdoor/underwater/built-up etc.)

(6) Lack of external factor measurement (i.e. not measuring external influences on performance, such as humidity, temperature, altitude etc.)

(7) Interference from other physiological contributors (e.g. sweat or hair influencing wearable device placement, vasoconstriction etc.)

If athlete health and development is to be protected, there cannot be a reliance on clinical or training tools that do not provide robust, useful or meaningful data. Therefore, it is important that we consider where, how and what these modern approaches derive from our athletes. As such, appropriate, evidence-based scientific approaches must be applied to the wealth of technological and wearable devices that are available to sports medicine and performance professionals to improve athlete health and fitness.

Final Thoughts

We hope that papers within this focus collection will contribute a meaningful body of knowledge in the field of sports medicine and performance, and that they will motivate the development of future research within this area. Both sports medicine clinicians or other background staff, as well as researchers will find the articles within this focus collection useful for their clinical/professional decision making for the achievement of optimal athlete health and performance.

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