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A Review of the use of the Electronic Tracking Systems on the Performance of Elite Athletes in Team Sports – Trends and Future Directions

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Review question / Objective: **To understand the applicability of tracking systems in team sports on the last decade by emerging an understanding of how the use of different variables and research goals may be profitable to develop a comprehensive framework that might help to shed a light into team sports performance and athlete´s well-being.**
Rationale: **To implement a training monitoring system, there is a need to understand how the different metrics available in training and competition may be manipulated to enhance the understanding of the context of performance in team sports. Additionally, how the information from tracking technology devices have been applied and what are the main issues that have being studied, in order to improve further research and practice.**

INPLASY registration number: This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 17 November 2022 and was last updated on 17 November 2022 (registration number INPLASY2022110080).

INTRODUCTION

Review question / Objective: **To understand the applicability of tracking systems in team sports on the last decade by emerging an understanding of how the use of different variables and research goals may be profitable to develop a comprehensive framework that might help to shed a light into team sports performance and athlete´s well-being.**

Background: **It is known that in team sports it is required the development of several intensity actions. This means that the production of movement involves the combination of short and long duration efforts through the production of accelerations, decelerations, changes of directions, short-term movements and collisions [1] with implications in players' physiological impact and accumulation of fatigue. Thus, the evaluation of this actions to better understand the physical and**

physiological demands during training and competition requires an accurate assessment of both, internal (IL) and external load (EL)[2]. Recently, the tracking of team sports athletes through global (GPS) and local (LPS) positioning systems combined with hearth rate bands have become regular tools to characterize movement patterns and athlete´s EL and IL [3]. Despite some concerns over quality, reliability validity of GPS and LPS measurements [4] performance analysts, fitness coaches and sports scientists are gradually increasing the use of such tracking technology as regards to improve the training environment [5].

The analysis of EL refers the quantification of movements demands in team sports which can analyze the work performed by each athlete [6]. According to Rossi [7] EL may also be classified into three main categories: (1) Kinematics, which quantifies overall movement during exercise; (2) Mechanical, which describes player´s overall load during exercise; and (3) metabolic, which quantifies overall movement energy expenditure during exercise. Beyond the relevant information available from external training load (ETL), athletes may experience different physiological (IL) responses [8]. In this setting, the internal training load (ITL) is the individual athlete´s response induced by the ETL stimulus which is commonly determined by using heart rate (HR) parameters due to its strong association to oxygen consumption during exercise [9]. As a less direct measure of internal physiological load the subjective rate of perceived exertion (RPE) or the session RPE (sRPE, RPE x session duration) [10] has also been a tool commonly used with athletes in order to measure the intensity of training and matches sessions [11].

The literature shows that the combination of both information (internal and external load) is especially important to team sports because athletes may perceive differently the same workload or perform completely different workload with different physiological impacts in the same match / training session [3]. Dissociation between external and internal load units may disclose an athlete's level of fatigue. A maximal performance test that replicates the athlete's event or competition would appear to be the best test of exhaustion in terms of ecological validity, however there is little that can be understood about the potential mechanism(s) of fatigue if just maximal performance is measured [12], [13]. Additionally, fatigue may be greatly influenced by the athlete's physiological and training status, as well as by ambient factors. The above definitions and restrictions show the multifaceted nature of exhaustion as well as the inherent difficulties in trying to track or evaluate fatigue in an athlete.[12], [14]. Consequently, to improve athletes performance, modifications in training load are necessary, particularly increased in frequency, duration, and intensity [12]. Thus, data collected from training monitoring may also help coaches and support staff to understand if specific physiological parameters are being achieved by the manipulation of EL [13]. Therefore, training loads must be adjusted at various times during the training cycles to either increase or decrease fatigue levels corresponding to a specific phase of training, such as baseline or competition phase, matching this variable to adaptation to training as well for competition performance [12]. This information may help to manage the training load which also may reduce the risk of injury [15] and increase athletic performance[16].

Rationale: To implement a training monitoring system, there is a need to understand how the different metrics available in training and competition may be manipulated to enhance the understanding of the context of performance in team sports. Additionally, how the information from tracking technology devices have been applied and what are the main issues that have being studied, in order to improve further research and practice.

METHODS

Strategy of data synthesis: Search Strategy; Database and inclusion Criteria A Systematic search was conducted on the

electronic databases PubMed, Web of Knowledge (all databases), and Scopus, according to the recommendations from the preferred reporting items for systematic and integrative reviews and meta-analysis statement (PRISMA) [17] A searched by relevant publications between the 1 January 2011 and 31 August 2022 using the keys "Global Position System" OR GPS OR "Local Position System" OR LPS AND ("Team Sports* OR "Handball" OR Futsal OR Basketball* OR "Rink Hokey", OR "Ice Hockey" OR "American Football", OR "Australian Football" OR "Rugby", OR "Football", OR "Net ball", OR "Gaelic Football", OR "Football") AND (performance* OR "External load" OR "internal load") were performed. The publications that were retrieved had to following the specific criteria: (1) contained relevant data regarding elite athlete´s performance; (2) athletes' external and internal load; (3) were written in the English language; (4) were only related to team sports. Exclusion criteria applied: If they (1) were specifically regarding the reliability, validity, or precision of global positions system equipment's; (2) were regarding to systematic reviews, (3) were published before 2011.

Eligibility criteria: The quality of the studies was assessed as recommended in Faber et al. [19] using the criteria for critical review forms in Law et al. [20] (16 items) with the purpose of identifying the studies in which the low-quality score could interfere in the results. The possible criteria for each item were 1 (meets criteria), 0 (does not meet the criteria), or NA (not applicable). Articles were assessed with regards to their purpose (item 1), relevance of background literature (item 2), appropriateness of the study design (item 3), sample included (items 4 and 5), informed consent procedure (item 6), outcome measures (item 7), validity of measures (item 8), significance of results (item 9), details of intervention (item 10), analysis (item 11), clinical importance (item 12), description of drop-outs (item 13), conclusion (item 14), practical implications (item 15), and limitation (item 16). Based on the guidelines of Faber et al. [19] a final score was calculated allowing to classify the articles as: (1) low methodological quality (≤50%); (2) good methodology quality (50%-75%); and (3) excellent methodology quality (>75%). A data extraction sheet (from Cochrane Consumers and Communication Review Group´s data extraction template [21] was adapted to this review´s study inclusion requirements and then tested on 10 randomly selected studies (pilot test). One author extracted the data, and another verified it.

Source of evidence screening and selection: The initial search identified 454 titles. These data were then exported to reference manager software Mendeley (Elsevier, San Francisco, CA, USA). Duplicates (n=134) were eliminated automatically or manually. The remaining 320 were then screened for relevance based on their title and abstract information, with 164 being excluded. The remaining 156 were analyzed in more detail, and 94 papers were excluded according to the following criteria: (1) articles published in languages other than English (n=5); (2) articles unrelated to team sports (n=3); (3) articles unrelated to elite athletes (n=9); (4) systematic reviews (n=14); (5) articles unrelated to the analysis of athletes performance by technology (n=20); (6) articles regarding to the reliability and validation of tracking technology (n=43). A total of 62 studies were included in the review.

Data management: To increase research accuracy, two reviewers (AF and BT) independently screened citations and abstracts to identify the articles which would potentially combine the inclusions criteria, having registered the characteristics of each study, including the name of the authors, sample, procedure and results or main outcomes. In case of disagreement regarding the eligibility of the article, a third reviewer (Hugo Sarmento) was included in order to reach a final decision. After all the articles were screened, the categories of the studies were organized into specific sports according to their main research topic.

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Language restriction: No.

Country(ies) involved: Portugal.

Keywords: load monitoring, global position systems, local position systems, elite sports, performance analysis.

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