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A Review for the Development of a Comprehensive Framework of Performance Analysis in Team Sports - Trends and future directions

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Review question / Objective: **The aims of this scoping review were 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 of performance analysis in team sports 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 09 December 2022 (registration number INPLASY2022110080).

INTRODUCTION

Review question / Objective: **The aims of this scoping review were 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 of performance analysis in team sports 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: A systematic search was conducted on the electronic databases PubMed, Web of Knowledge (all

databases), and Scopus, according to the recommendations from the PRISMA Statement [17]. A searched by relevant publications prior to 31 October 2022 using the keys ((“Global Position System” OR GPS OR “Local Position System” OR LPS) AND (“Team Sports*”, “Indoor Team Sports**”) 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 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.

To increase research accuracy, two reviewers (AF and BT) independently screened tittles 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 (HS) 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.

Data management: The quality of the studies was assessed as recommended in Faber et al. [18] using the criteria for critical review forms in Law et al. [19] (16 items) with the purpose of identifying the studies in which the low-quality score could interfere in the results. The quality of each eligible article was independently analyzed by both researchers (AF, BT). Whenever a disagreement arose between the two researchers’ evaluations, a consensus was reached either by discussion or with the help of a third reviewer (HS). 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. [18] 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) [20] 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. Disagreements were resolved in discussions between these two authors (first and last authors). To organize the results, the studies were classified into categories established according to the major research topics.

Presentation of the results: Studies were categorized by sport in which the studies were carried out: (1) football (34.2%), (2) futsal (14.5%), (3) rugby (11.8%), (4) Australian football (9.2%), (5) field hockey (7.9%), (6) Gaelic football (6.6%), (7) ice hockey (3.9%), (8) American football (3.9%), (9) basketball (3.9%), (10) rink hockey (2.6%) and (11) netball (1.3%).

Based on the main outcome of the study, the variables used were grouped. The results revealed that most of the research with tracking technology in team sports: (1) combined kinematics and mechanical variables (36.8%); (2) only considered kinematics (21.1%), and (3) combined kinematics, mechanical, and metabolic variables (17.1%). On the other hand, the analysis of IL or the relationship between EL variables and IL variables are less explored as well as the ones related to technical variables and to athletes' perception of the technology (see figure 2).

Regarding to the approaches of the studies in analysis: (1) 64.5% of them were focused on the characterization and comparison of drills, training and matches sessions; (2) correlational analysis between metrics (22.4%), and (3) predictions of performance, fatigue, and injuries (7.9%). Finally, experimental studies using tracking technologies (2.6%), and qualitative studies to measure how do athletes perceive the use of such technology (2.6%) are sparse (figure 3).

Regarding the main research topics from the studies in analysis, it was observed: (1) performance analysis, training, and match demands, (2) Injuries (3) nutrition and, (4) tactical behavior (figure 4).

The analyzed studies bring up information regarding to the use of tracking systems in different domains of sport sciences such as the importance of technology to better understand the physical requirements for co-adaptations in which players establish spatial-temporal interactions with teammates and opponents [21,23]. Experimental approaches were employed to test if specific nutritional intake may improve players response to the exigence of an indoor team sport [24]. Also, during the recent years multiple sports have used varied methods in efforts to track injuries by understanding the external information which better characterized sporting activities [7,25], [26]. Regarding to the understanding of training and matches demands in performance and analysis of team sports, several researches have been developed by a number of team sports to compare positional [22], tactical and technical differences [27], intra-game information [28][29], comparisons of levels of competitions [30], to determine predictors of intensity, fatigue and match performance [31,33][34] and more recently, to understand the most high intensity activities (HIA) and periods (MIPs) [35],36].

Language restriction: No.

Country(ies) involved: Portugal.

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