

# A systematic review of collective tactical behaviour in futsal using positional data

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**ABSTRACT:** Although many studies on collective tactical behaviour have been published in the last decade, no study has revised and summarized the findings provided for futsal. The main aim of this systematic review was to identify and discuss the geometrical centre (*GC*), *distance* and *area* tactical variables used to assess team behaviour in futsal. In addition, it summarizes the findings on the tactical response during futsal competition and training. A systematic review of the relevant articles provided on futsal was carried out using seven electronic databases (SPORTDiscus, ProQuest, Cochrane Plus, Scopus, Google Scholar, PubMed and Web of Science) until September 25, 2019. From a total of 1,209 studies initially found, 12 were included in the qualitative synthesis. There were some trends in the analysis of positional data in futsal with the most relevant situations analysed being 1 vs 1 and 5 vs 4+Goalkeeper. The *distances* and angles between two points were the most assessed tactical variables. Five types of *distance* variables were used to assess collective tactical behaviour in futsal: GC-GC, GC-player, player-player, player-ball and player-space. Pressure (GC-GC) was greater in shots on goal than in tackles during professional futsal matches. *Area* variables were reduced to *occupied space*, *exploration space* and *dominant area*. *Occupied space* was measured only during competition while the *dominant area* was measured only during training sessions. The surface area and dominant regions were greater when players were attacking in comparison to when they were defending. In addition, two non-linear techniques (i.e. relative phase and entropy) were applied to analyse synchronisation and complexity and regularity or predictability. Defenders were highly synchronous, while attackers tried to break this coordination to achieve possibilities for action. Task constraints are suitable to induce different regularity patterns. This review is an opportunity to develop studies aimed at bridging the gap in collective tactical behaviour in futsal.

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## INTRODUCTION

Team sports are social systems [1, 2] in which teammates collaborate (i.e., positive interaction) to overcome the opposing team (i.e., negative interaction), in response to social uncertainty [1–3]. The social interaction and the emerging collective tactical behaviour [4] are determined according to the nature of the constraints (i.e. structural traits) of each team sport [1–3]. Specifically, futsal is a team sport involving Gk+4 vs 4+Gk with unlimited substitution allowance [5]. Also it is possible to substitute the goalkeeper for an extra outfield player during the game (i.e. 5 vs 4+GK) [6]. The game takes

place in a rectangular playing space of 40 x 20 m, with the relative space (i.e. [length\*width]/10 players) being 80 m<sup>2</sup>. The duration of the playing time is divided into 2 halves of 20 min with clock stops in every dead ball, so that total match time can be as much as 75–90 min [7]. Together with others, these constraints (i.e. structural traits) [2, 3] determine both physical match performance [5, 8, 9] and collective tactical behaviour [10–12].

Collective tactical behaviour can be assessed thanks to several electronic performance and tracking systems [13, 14]. Based on the

position of the players in the playing space ( $x$ ,  $y$  coordinates), these technologies allow us to measure three types of collective team behaviour variables: a) point or *geometrical centre* (GC), b) distance or *dyad*, c) *area* variables [15, 16]. The GC was suggested to assess coordination between whole team movements and between two team movements [17], and has been one of the most assessed variables in team sports such as soccer [15]. The *distance* variables represent the distance between two points inside the court (i.e. player-player; player-goal, player-space, player ball, player-GC, GC-GC, GC-ball, GC-space) and have been used to assess the relationship between players or groups of players and the distance of the players to specific zones within the playing space [16]. The *area* variables consider the space used by a player or several players at each point in time, or take into account the training task or the entire match [10, 17–19]. The three types of variables allow for a quantitative understanding of overall team organization and can be used to analyse and compare the response of the players and the teams during matches [10, 15]. This information can then be used as a reference to design training tasks that replicate the tactical response of the match [20].

Despite the fact that the constraints (i.e. structural traits) of a futsal match guide individual and collective tactical behaviour and imply a certain regularity, the uncertainty (i.e. lack of information) due to teammates (positive interaction) and opponents (negative interaction) always means unpredictability and non-linearity of behaviour [21]. Thus, the aforementioned variables are sometimes complemented with non-linear processing techniques (e.g. *relative phase* and *entropy*) [22, 23]. The *relative phase* was suggested as a collective variable data processing technique to capture the modes of movement that two oscillators demonstrate during games, showing two patterns of relative motion: in-phase ( $0^\circ$ ) where the oscillators move in the same direction, and anti-phase (i.e.  $\pm 180^\circ$ ) where the oscillators move in opposite directions [22]. These signals could be used to assess the synchronisation between different types of oscillators. *Entropy* [23] was applied to team sports due to its appropriateness for analysing the results of nonlinear dynamic systems such as sports teams [24]. This data processing technique has been widely used to assess the complexity and regularity or predictability of the team's GC, *distance* and *area* variable time series in team sports [15].

Since the assessment of the collective tactical behaviour is carried out based on the selected tactical variables, their identification, computational examination and critical assessment are crucial in team sports such as futsal. This type of analysis would allow selection, or creation, of a suitable tactical variable according to the aim of the research and the technical staff. The assessment of the collective tactical behaviour during a match can be used as a reference to optimize the design of training strategies in order to improve performance during competition. Therefore, the main aim of this systematic review was to identify and discuss the GC, *distance* and *area* tactical variables used to assess team behaviour in futsal. In addition, it summarizes the findings on the tactical response during futsal competition and training.

## MATERIALS AND METHODS

### *Protocol and registration*

This systematic review protocol was registered in the International Prospective Register of systematic Reviews (PROSPERO) under number 156739.

### *Search strategy*

A systematic review of the available literature was conducted according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines. Seven electronic databases were searched (SPORTDiscus, ProQuest, Cochrane Plus, Scopus, Google Scholar, PubMed and Web of Science) to identify articles published before September 25, 2019. We were aware of the names of the journals and the manuscript authors. The search strategy combined terms covering the topics of population (futsal AND indoor football), and tactical variables (“coordination patterns”, “organization, behavior”, “GC”, “geometrical center”, “centroid”, “weighted centroid”, “interpersonal coordination”, “attacker-defender”, “dyad”, “distance”, “team separateness”, “length”, “width”, “area”, “space occupied”, “surface area”, “team shape”, “total space covered”, “convex hull”, “expansion speed”, “spread”, “effective playing space”, “EPS”, “major ranges”, “spatial exploration index”, “SEI”, “concentration of players”, “density”, “team numerical advantage”, “dominant region”, “Voronoi”, “weighted dominant region”). The search was carried out using combinations of the following terms linked with Boolean operators “AND” (inter-group Boolean operator) and “OR” (intra-group Boolean operator). Studies were excluded if they: (1) were conference abstracts or systematic reviews; (2) did not assess collective tactical behaviour through positional data, and, (3) did not consider futsal in their research. Due to the limitations of the search in the ProQuest database, the search was limited to scientific documents in this database.

### *Selection of studies*

One of our researchers (MRG) downloaded the main data from the articles (title, authors, date, and database) to an Excel spreadsheet (Microsoft Excel, Microsoft, Redmond, USA) and removed the duplicate records. Then, the researchers MRG, JPO and ALA screened the search results independently against inclusion/exclusion criteria. The references that could not be eliminated by title or abstract were set aside and independently evaluated for inclusion. Any disagreements on the final inclusion-exclusion status were resolved through discussion in both the screening and excluding phases and a final decision was agreed upon. Abstract and conference papers from annual meetings or conference papers were not included. If we had any questions about the application of the inclusion-exclusion criteria, we requested further information from the authors. The additional information provided by the authors was considered during the screening process. Lack of additional forthcoming information led to the article being excluded.

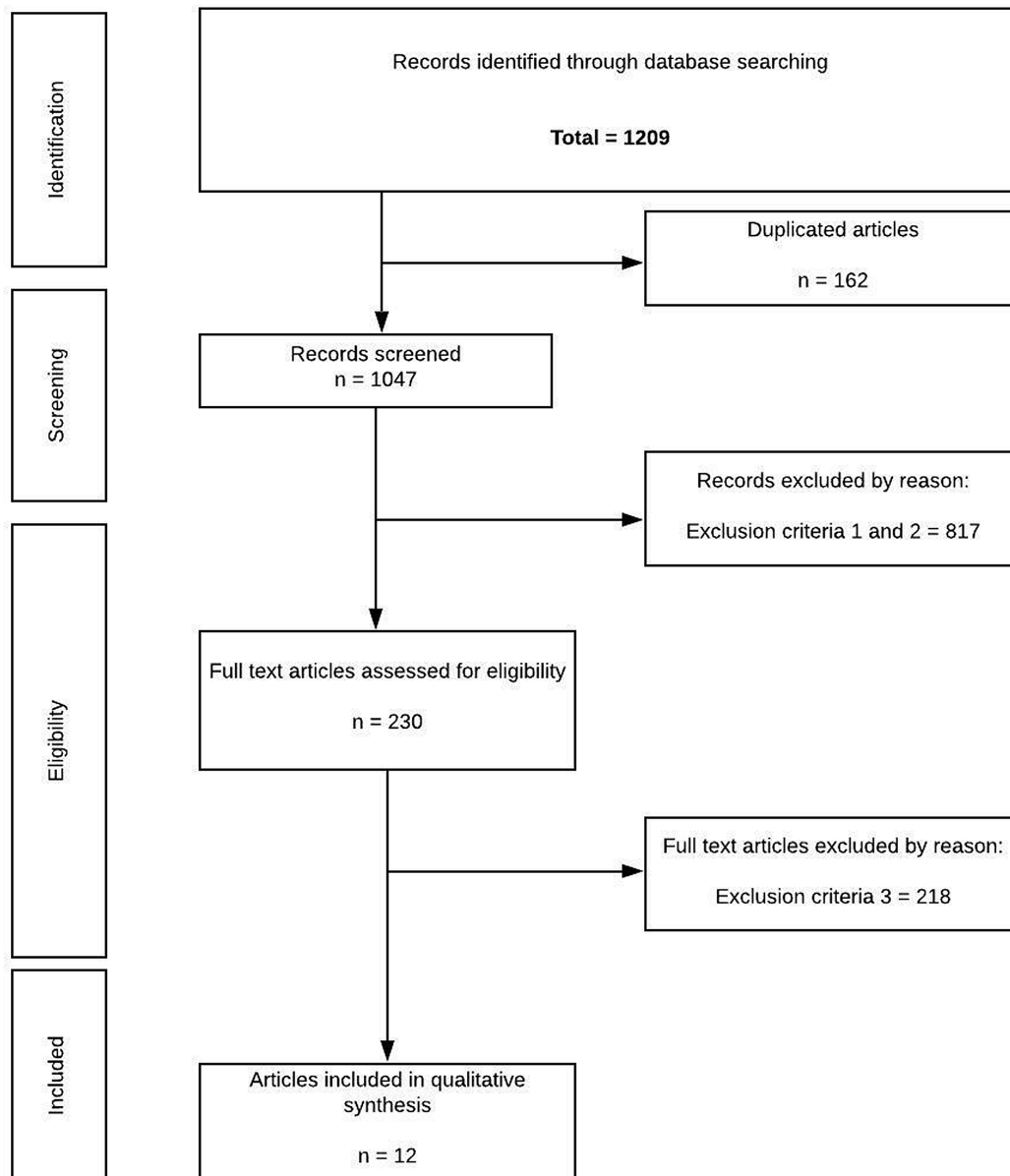


FIG. 1. Flow diagram of the study selection

#### *Assessment of methodological quality*

The quality of included studies was individually assessed using a modified assessment scale of Downs and Black by Sarmento et al. [25]. As in other systematic reviews [15], the quality scores were classified as follows: (1) low methodological quality for scores  $\leq 50\%$ ; (2) good methodological quality for scores between 51% and 75%; and (3) excellent methodological quality for scores  $> 75\%$ . Two reviewers (MRG and ALA) applied the quality index to each included study independently and any scoring discrepancies were resolved by consensus of the two researchers. An independent inter-rater reliability analysis was carried out using Cohen's kappa value [26].

#### *Data extraction*

Team sports tactical variables were classified into three principal groups: *GC*, *distance* and *area* [13]. The tactical variables measured in futsal studies were extracted by two researchers (MRG, ALA). The values of the futsal collective behaviour are reported in Tables 2 and 3: distance variables in futsal (Table 2), and area variables in futsal (Table 3). With the aim of highlighting what tactical variable was used, and what was the aim, the following data were extracted: contextualization (aim, sample and task), considered tactical variables, the finding, and the practical applications for coaches and technical staff using these collective tactical variables in the assessment of collective behaviour.

## RESULTS

### *Identification and selection of studies*

A total of 1,209 works were initially retrieved from SPORTdiscus (132 studies), ProQuest (721 studies), Cochrane Plus (8 studies), Scopus (96 studies), Google Scholar (27 studies), PubMed (29 studies) and Web of Science (196 studies), of which 162 were duplicated. Thus, a total of 1047 articles were screened. Next, the titles and the abstracts were checked and those documents which were only abstracts, conference papers, systematic reviews (exclusion criteria 1) or were not developed in futsal (exclusion criteria 2) were excluded where possible ( $n = 817$ ). The full texts of the remaining 230 articles were screened and 218 articles were excluded because the assessment of tactical variables using positional data was not carried out (exclusion criteria 3). Thus, 12 studies were included in the qualitative synthesis.

### *Assessment of methodological quality*

The inter-rater reliability analysis achieved a kappa value of 0.93, indicating very good agreement between observers. In the evaluation of methodological quality, the mean score for the Downs and Black modified scale was 82%. All studies had excellent methodological quality (quality score  $> 75\%$ ). Concretely, the articles included in this systematic review ( $n = 12$ ), 2 qualified with 75% of the required criteria, 6 qualified with 81% and another 4 qualified with 88%.

### *Study characteristics*

The tactical variables were classified into three main groups: a) *GC*, b) *distance*, and c) *area* [13, 15]. Six studies assessed the tactical variables during 1 vs 1 situations such as: shot on goal or tackle opportunities during futsal matches [10, 27, 29, 31, 33, 34], one during ball pass situations [28], three studies during the 5 vs 4 + Gk situation in futsal matches [6, 11, 32], and one during small-sided games (SSGs) [12].

### *Geometrical centre (GC) related variables*

The GC has been assessed in futsal to measure the *distance* between two points, with one of these being the GG: GC-GC, GC-player, GC-ball. These *distances* are shown in Table 2 (i.e. *Distance related variables*).

### *Distance related variables*

*Distance* was assessed in the eleven included studies. Specifically, these studies measured *player-player distance* [6, 28, 29, 32–34], *player-ball distance* [12, 34], *player-space distance* (i.e. ball trajectory) [28, 31], *GC-player distance* [12], *GC-GC distance* [10–12, 27], and *GC-ball distance* twice [11, 12]. In addition, *player-player with angle* as a measurement association was suggested twice [29, 33].

### *Area related variables*

*Area* related tactical variables were suggested and measured in three

**TABLE 1.** Quality assessment of the studies using a modified Downs and Black checklist.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	%
Moura et al. [27]	1	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	81.25
Travassos et al. [6]	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	0	75.00
Travassos et al. [11]	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	87.5
Travassos et al. [28]	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1	0	75.00
Vilar et al. [29]	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	0	81.25
Fonseca et al. [30]	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	0	81.25
Vilar et al. [31]	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	0	81.25
Fonseca et al. [32]	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	0	81.25
Vilar et al. [33]	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	87.5
Vilar et al. [34]	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	0	81.25
Bueno et al. [10]	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	87.5
Travassos et al. [12]	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	87.5

C = Criteria; C1 = Was the study purpose stated clearly?; C2 = Was relevant background literature reviewed?; C3 = Was the design appropriate for the research question?; C4 = Was the sample described in detail?; C5 = Was sample size justified?; C6 = Was informed consent obtained?; C7 = Were the outcome measures reliable?; C8 = Were the outcome measures valid?; C9 = Was the method described in detail?; C9 = Were the results reported in terms of statistical significance?; C10 = Were the analysis methods appropriate?; C11 = Was importance for the practice reported?; C12 = Were any drop-outs reported?; C13 = Were the conclusions appropriate given the study methods?; C14 = Are there any implications for practice given the results of the study?; C15 = Were limitations of the study acknowledged and described by the authors?

articles, specifically, the surface area twice [10, 27, 35] and dominant region area once [32].

### DISCUSSION

The main aim of this systematic review was to identify and discuss the *GC*, *distance* and *area* tactical variables used to assess team behaviour in futsal. In addition, it summarizes the findings on the tactical response during futsal competition and training. The main findings were: a) while most studies analysed shot on goal situations during matches, simulated situations of 5 vs 4+Gk phases were assessed during the training process; b) the *distance* variables (i.e. GC-GC, GC-player player-player, player-space, and player-ball) have been the most measured in futsal; c) professional players showed greater GC-GC distances than U15 and U18, and average distance between the GCs was greater in shots on goal than in tackles during professional soccer matches, d) an increase in the number of goal targets promoted a higher team dispersion and the regularity was higher with two targets in comparison to one goal during SSGs; e) whilst *occupied space* and *dominant area* have been analysed in futsal, *exploration space* has not; e) *occupied space* was measured only during competition while the *dominant area* was measured only during training sessions; f) the *surface area* and *dominant regions* were greater when the players were attacking in comparison with when the players were defending during match 1 vs 1 shot on goal and tackle situations, and during the simulated 5 vs 4+Gk phase situation, respectively.

The assessment of collective tactical behaviour during competition should be used to identify possible mistakes during matches and to enhance tactical performance during futsal training [27]. However, we did not find a link between the studies that analysed collective team behaviour during futsal matches and training. While most studies that assessed collective tactical behaviour during matches analysed shot on goal situations [10, 27, 29, 31, 33, 34], the studies that assessed collective team behaviour during training sessions analysed simulated situations of the 5 vs 4+Gk phase [6, 11, 30, 32] (Tables 2 and 3). In future, both these specific situations (i.e. shots on goal and 5 vs 4+Gk phase) should be analysed during competition and training to compare tactical responses and to improve performance during matches. In addition, since the situation 4+Gk vs 4+Gk is the most frequent during matches [11], this should also be assessed in the future. Among the three types of tactical variables [13, 15] it is the *distance* variables (i.e. GC-GC, GC-player, player-player, player-space, and player-ball) [13] that have been measured most in futsal [6, 10, 11, 27, 33]. This would suggest that the relationship between a pair of players and the distance between the player and a specific point in the court or the ball are of paramount importance to researchers and futsal technical staff. The attacking phase and defending phase of play have been differentiated to assess collective tactical behaviour during 5 vs 4+Gk bouts [6, 11, 30] or shot on goal situations [27–29, 31, 33, 34]. However, this differentiation was not applied during continuous situ-

ations such as SSGs, where both phases were taken as a whole [12]. Since game patterns differ considerably between attacking and defending phases [36, 37] and playing phases have become fundamental as basic principles of team coordination in team sport [36], the differentiation of attacking and defending organization should be considered when assessing collective tactical behaviour in future studies of futsal.

#### *Geometrical centre (GC) related variables*

In futsal, the GC has always been measured as part of several types of *distances/dyads* such as GC-GC [10, 12, 27], GC-ball [11, 12] and GC-player [12]. Despite the relative space per player and the dispersion degree of the players being lower than in soccer, the GC has not been measured as such in futsal. Maybe it would be interesting to measure the change in GC position according to the playing phase (i.e., attacking, defending, and transitions) and the use or not of outfield goalkeepers instead of only the position of the GC.

#### *Distance related variables*

In futsal, GC-GC *distance*, GC-player *distance*, player-player *distance*, player-ball *distance*, and player-space *distance* have been used to assess collective tactical behaviour (Table 2). Since Schmidt, O'Brien and Sysko [38] proposed the distance between player and basket in basketball, and Palut and Zanone [22] assessed the interaction of two players in racket games, the *distances* between the GCs (i.e. GC-GC), the GC and players (i.e. GC-player), players (i.e. player-player), the players and the ball (i.e. player-ball), and the players and a point on the playing space (i.e. player-space) [13] have been widely used to assess collective tactical behaviour in team sports [15, 24, 39–43].

The GC-GC dyad was measured in shot on goal and tackle situations during official matches in professional [10, 27] and U15 and U18 futsal teams [10]. These studies found that the distances between the teams' GC varied according to the competition level of the players and the game phase [10, 27]. Specifically, the professional (PRO) category showed greater GC-GC distances than U15 and U18, especially during interceptions. [10]. On the other hand, Moura et al. [27] showed that the average distance between the GCs was greater in shots on goal than in tackles during professional soccer matches. These findings provide interesting information to optimize the design of training strategies (e.g. relative space per player) according to the competition category to enhance tactical performance in competition [10]. Since different team dispersion could show the same distance between GC and subsequently the same degree of "pressure", a previous study suggested a new collective computation (i.e. *team separateness* [TS]) instead of the GC-GC dyad to assess "pressure" in soccer [44]. Based on the defender-attacker dyad, Silva, Duarte, et al. [44] proposed the sum of distances between each team player and the closest opponent. The TS provided a measure of the degree of free movement that each team has available considering the defender-attacker *distance* [44] and could be used in futsal in the future. Travassos et al. [12] first introduced a non-

TABLE 2. Distance variables in futsal

Study	Aim	Sample	Task	Tactical variables	Results	Practical applications
<b>Studies developed during matches</b>						
Moura et al. [27]	To quantify and analyze organization on the court in shot on goal and tackle situations	1 International Challenge match (Brazil-Paraguay)	1 vs 1 shot on goal (i.e. 58) and tackle situations (i.e. 120) during the match	GC-GC	The average distance between centroids was greater in shots on goal than in tackles.	The identification of possible mistakes during the match to enhance tactical performance during training and, consequently, during competition.
Travasso et al. [28]	To explain how defenders intercept the trajectory of a passing ball by understanding how they coupled their actions to critical information sources in a competitive performance setting in team sports.	15 senior players of the National Futsal University team in Portugal	Pass situation during a match	Each defender-attacker (ball carrier) Each defender-ball trajectory Attacker with the ball-ball receiver	When defenders were located further away from the ball at the moment of pass initiation, they were more likely to intercept the trajectory of a passing ball. The distance of second closest defender to the ball trajectory was higher in non-intercepted passes than in intercepted passes.	Linking tactical variables with time and ball speed can provide information about defender behavior in order to intercept the ball.
Vilar et al. [29]	To investigate how the locations of the goal and ball constrain the pattern-forming dynamics of attacker-defender dyadic systems	5 national teams in the 2009 Lusophony Games (Portugal)	Goal sequences	All defenders-all attackers The closest defender to each attacker Players-ball (RP) Players-goal (RP) Players-ball (angles as a measure association) (RP) Players-goal (angles as a measure association) (RP)	While the attacker was in possession of the ball, and the defender was between the goal and attacker, symmetry between the players was maintained. In order to break system symmetry and score a goal, the attacker with the ball used lateral displacement to increase the angle to the goal relative to the defender's position, while decreasing the distance to the goal. In contrast, the defender tried to maintain a stable relationship between the distance and angle to the goal relative to those of the attacker, in order to intercept the ball and block shots Although attackers and defenders exhibited similar angular orientations to the goal, the latter always remained closer to the goal than the attackers. In-phase patterns of coordination emerged from changes to both the distances and angles of attackers and defenders to the goal. Attackers always remained closer to the ball than defenders, while the latter exhibited a lower angle to the ball than the attackers. A pattern of in-phase coordination modes emerged between the attackers' and defenders' distances and angles to the ball.	The manipulation of task constraints facilitates the appropriate detection and use of information by the players and increases opportunities for transfer of functional behaviors to the competition.

TABLE 2. continued

Study	Aim	Sample	Task	Tactical variables	Results	Practical applications
Vilar et al. [31]	To examine the influence of opposing players constraining the decision-making of an attacker during shooting performance	71 players from 5 national teams played 10 futsal games in Lusophony Games (Portugal)	During a match, the moment a shot was taken until the ball was intercepted or entered the goal according to three different performance outcomes: ending in a goal, a goalkeeper's save and an interception by the nearest defender	Defender-goals to the interception point	Distance values from a defender and goalkeeper to the interception points were significantly lower when they intercepted the ball.	Information regarding the location of the defender and the goalkeeper should be carefully manipulated in training games, allowing attacking players to perceive spatial relationships with immediate defenders and goalkeepers during practice.
Vilar et al. [33]	To examine the coordination patterns of attackers and defenders with respect to key task constraints on performance (e.g. locations of the goal and the ball), that enable the creation/prevention of opportunities to score goals during team sports.	71 players from 5 national teams played 10 futsal games in Lusophony Games (Portugal)	Sequences of play in which a pass from a teammate preceded an attacker's shot at goal, according to three different performance outcomes: ending in a goal, a goalkeeper's save and an interception by the nearest defender during competitive game	Defender's angle to the goal and the attacker Relative distance to the goal Player-opponent	When a goal was scored, the defender's angle to the goal and to the attacker tended to decrease, the attacker was able to move to the same distance from the goal alongside the defender, and the attacker was closer to the defender.	The distinctive patterns of movement coordination between a shooter, a closest defender and the location of the ball can be taken into account to design training strategies.
Vilar et al. [34]	To examine how the location of the goal and ball constrained the interpersonal coordination tendencies emerging from attacker-defender dyadic systems	71 players from 5 national teams played 10 futsal games in Lusophony Games (Portugal)	52 outfield attacker-defender interactions involving thirteen goal-scoring sequences during matches	Player (ball carrier)-1 <sup>st</sup> opponent (RP) Player (ball carrier)-2 <sup>nd</sup> opponent (RP) Player (ball carrier)-3 <sup>rd</sup> opponent (RP) Player (ball carrier)-4 <sup>th</sup> opponent (RP) Attacker-goal (RP) Attacker-ball (RP)	Stable in-phase patterns of coordination emerged between specific values of an attacker's distances to defenders and the goal and between specific values of distances of ball carriers to defenders and teammates. A stable pattern of coordination of 60° emerged between the values of an attacker's distances to defenders and the ball.	Defenders coordinated their movements to decrease their opponents' possibilities for action with information on distances between the attackers and the goal and ball. Attackers without the ball seemed to coordinate their movements (i.e., their distance to the ball carrier) with information on distances of the ball carrier to defenders, providing the ball carrier with a high number of collective possibilities for action.

TABLE 2. continued

Study	Aim	Sample	Task	Tactical variables	Results	Practical applications
Bueno et al. [10]	To analyze futsal players' organization on the court in different categories while attacking and defending, in interception and shot to goal situations.	U15: 89 players U18: 102 players Professional: 110 players	Shots to goal and interceptions (with or without participation of the outfield Gk) during official matches	GC-GC Spread	While the players were attacking, all categories presented a greater spread, compared to values when players were defending. GC-GC (with and without the outfield Gk): the PRO category showed greater distances when they performed interceptions than when they performed shots on goal. While the players were attacking, all categories presented greater spread, compared to values when players were defending. Among the categories, the results showed lower spread values for the younger players. In the specific analyses of shots on goal and interceptions, small and medium effects were found for almost all analyses, except for the U15 surface areas in defending situations and for the PRO centroid values with the outfield goalkeeper.	The development of tactical training should be performed according to the characteristics of each category. In younger categories, a defense may have greater success if players are trained to organize themselves in order to mark individual opponents. For the professional category, remaining distant from the opponent may be more effective. The coach must deal with the different tactical demands faced by players when they change from one category to another and thus aid the tactical evolution of players throughout their careers in futsal.
<b>Studies developed during training</b>						
Travassos et al. [6]	An investigation of the patterned movement behavior of players for a 5 vs 4+Gk sub-phase of the game of futsal	15 senior players of the National Futsal University team in Portugal	5 vs 4+Gk phase during training	Defender player-ball (RP) Each attacker-ball (RP) All defender-team-mate in lateral/longitudinal axes separately (RP) All attacker-team-mate in lateral/longitudinal axes separately (RP)	Different coordination dynamics for the defending and attacking dyads, from which the authors interpreted evidence for different playing sub-systems consistent with different team objectives linked together in an overarching game structure. In keeping with dynamical systems theory for complex systems, the authors view 5 vs 4+Gk of futsal as being characterized by coordinated behavior patterns that emerge as a result of self-organizing processes. These dynamic patterns are generated within functional constraints, with players and teams exerting mutual influence on each other. In-phase attractions between players were reported with stronger attractions between defenders than attackers, and furthermore in the lateral direction as opposed to the longitudinal one.	The results are opposite to those obtained from investigations of basketball due to the evident differences between basketball and futsal in general, as well as the different playing conditions investigated (5-vs-5 in basketball, 5-vs-4+Gk in futsal) and the different defending strategies used ("one-on-one" marking in basketball, zonal marking in futsal). Hence, the number of players and defending strategies could influence team behavior.



TABLE 2. continued

Study	Aim	Sample	Task	Tactical variables	Results	Practical applications
Travassos et al. [11]	To investigate the behavioral dynamics of teams in futsal game practice during 5 vs 4+Gk sub-phase	15 senior players of the National Futsal University team in Portugal	5 vs 4+Gk phase during training (2.1 game segments), without transition in ball possession were selected from the ongoing practice session game data.	Attacking GC-ball (RP) Defending GC-ball (RP) Attacking GC-ball (angles as a measure association (RP) GC-GC (RP)	Stronger phase relationships with the ball for the defending team than the attacking team for both coordinate systems Phase relationships between each team and ball, and, to a lesser extent, between teams themselves, produced greater stabilities in the lateral (side-to-side) direction than the longitudinal (forward-backward) direction. Phase attractions were most pronounced for the defending team and ball when using angles as a measure of association, indicating ball position and goal location as key informational constraints for futsal game behavior.	The general approach is to encourage individual and collective behavioral possibilities and decision-making by the players in specific game contexts regulated by certain informational constraints shaped by coaching design.
Fonseca et al. [30]	To investigate the spatial dynamics of players' behavior	15 senior players	19 simulated situations of 5 vs 4+Gk phase during training	Player-teammate	Different patterns of interaction between attackers and defenders, at both individual player and team level	
Travassos et al. [12]	To identify how the manipulation in the number of goal targets affects the tactical behavior of players from different age groups	40 youth players (U9, U11, U15 and U17)	Gk+4 vs 4+Gk with 1 goal targets or 2 goals during SSG	Player-GC (ApEn) Each player-ball (ApEn) GC-GC (ApEn) GC-ball (ApEn)	The ApEn values showed higher regularity in the condition with two targets. All age groups were sensitive to the manipulation of goal targets, however, the U9 were the most sensitive to the changes, as seen by the dispersion of players in the field. Independently of age and experience, the increase in the number of goal targets promote a higher team dispersion in relation to the ball position as well as to the team center	Coaches can use one target to promote movement irregularity of players and two targets to increase the team dispersion, mainly in younger age groups that tend to agglomerate around the ball.

GC: geometrical centre; Gk: goalkeeper; RP: relative phase was computed; SSG: Small-sided games; ApEn: Approximate entropy

TABLE 3. Area variables in futsal

Study	Aim	Sample	Task	Tactical variables	Results	Practical applications
<b>Studies developed during matches</b>						
Moura et al. [27]	To analyze organization on the court in shot on goal and tackle situations	1 International Challenge match (Brazil-Paraguay)	1 vs 1 shot on goal (i.e. 58) and tackle situations (i.e. 120) during the match	Team's coverage area	Defending team coverage area was greater when tackles were performed ( $47.7 \pm 37.8 \text{ m}^2$ ) than when the team suffered shots to goal ( $30.7 \pm 28.0 \text{ m}^2$ ).	The identification of possible mistakes during the match to enhance tactical performance during training and, consequently, during competition.
Bueno et al. [10]	To analyze futsal players' organization on the court in different categories while attacking and defending, in interception and shot on goal situations.	U15: 89 players U18: 102 players Professional: 110 players	Shots on goal and interceptions (with or without participation of the outfield goalkeeper) during official matches	Surface area	While the players were attacking, all categories presented a greater surface area, compared to values when players were defending. Among the categories, the results showed lower area values for the younger players. The surface area results showed different forms of organization for each of the categories in specific situations of shots on goal and interceptions	The development of tactical training should be performed according to the characteristics of each category. In younger categories, a defense may have greater success if players are trained to organize themselves in order to mark the opponents individual. The coach must deal with the different tactical demands faced by players when they change from one category to another and thus aid the tactical evolution of players throughout their careers in futsal.
<b>Studies developed during training</b>						
Fonseca et al. [30]	To investigate the spatial dynamics of players' behavior	15 senior players ( $23.3 \pm 2.0$ years old)	19 simulated situations of 5 vs 4+Gk phase during training	Voronoi diagrams	Different patterns of interaction between attackers and defenders, at both individual player and team level. Compared to defenders, larger dominant regions were associated with attackers. Furthermore, these regions were more variable in size among players from the same team but, at player level, the attackers' dominant regions were more regular than those associated with each of the defenders.	Voronoi diagrams can be used to characterize players' spatial interaction behavior in Futsal. Individual dominant regions were defined using Voronoi diagrams and they appear to be greater for the attacking team and smaller for the defending team. Lower regularity in the defending team implying that their behavior was more unpredictable than the interaction behavior observed in the attacking team.

Table 3. continued

Study	Aim	Sample	Task	Tactical variables	Results	Practical applications
Fonseca et al. [32]	To suggest a novel spatial method for describing teams' spatial interaction behavior, which results from superimposing the Voronoi diagrams of two competing teams	-	4 from 19 randomly selected trials of 5 vs 4+Gk during training	Dominant region	The observed patterns of behavior, assessed by means of the % of free area, lean more towards low levels of exclusive dyadic interaction (% of free area values inside the interval (0.22, 0.50 %), which was expected as defense players were playing in a zone defense fashion due to their numerical disadvantage.	It is possible to identify different defensive methods adopted by players at different levels. A different variable extracted from the same superimposed graphical construction, maximum % of overlapped area, makes it possible to describe, throughout the duration of the game, the type of interaction established between each attacker and his opponents, in particular to distinguish between different types of numerical relationships As these variables are calculated based on the teams' overlapped area, they are more informative regarding the spatial interaction of the players in comparison with others (e.g. convex hull or stretch index)

ApEn: approximate entropy; Gk: goalkeeper; RP: relative phase was computed; SSG: Small-sided games

linear analysis (i.e. approximate entropy [ApEn]) to assess the predictability of the teams' GC-GC distance during SSGs with different target numbers in U9, U11, U15 and U17 categories. ApEn values showed higher regularity with two targets in comparison to one goal, with the impact of the number of goals being higher for younger players. Hence, coaches can use one target to promote movement irregularity among players, mainly in younger age groups, that tend to agglomerate around the ball.

The *player-player* dyad was applied in futsal to assess the relationship between the attacker and the defender, the attacker and the GK, and the distance between the attacker with the ball and ball receiver (i.e. teammate) (Table 2). Fewer players, a greater proximity to the goals and more frequent use of man-man marking in futsal in comparison to other sports suggest the relevance of these types of *distances*. Vilar et al. [29, 33] found that when the attacker was in possession of the ball and the defender was between the goal and the attacker, symmetry between the players was maintained. In addition, the attackers without the ball seemed to coordinate their

movements to allow the ball carrier the highest number of collective possibilities for action during futsal matches [29, 34]. Training task design should ensure that the task's constraints (e.g. relative space per players, number of players carrying out the task) are suitable for producing a similar tactical response during training. Originally, *player-player* with *angle* as a measurement association was suggested twice in futsal [29, 33]. It proposed the assessment of the defender's angle to the goal and the attacker, that is the inner product of the defender's vector to the centre of the goal, and the defender's vector to the attacker [33]. This tactical variable reduced the need to differentiate movements between both lateral and longitudinal directions [45] and was suggested instead of the distance between players because the angle measurement revealed the alignment/misalignment between players to the ball or the goal during performance [29]. In order to break system symmetry and achieve goal scoring opportunities, the attacker with possession used lateral displacement to increase the angle to the goal relative to the defender's position, while decreasing the distance to the goal. In con-

trast, the defender tried to maintain a stable relationship between the distance and angle to the goal relative to those of the attacker, in order to intercept the ball and avoid difficulties for the goalkeeper saving the shot [29]. Further studies could consider the influence of the goalkeeper in this type of analysis.

Together with the computation of the *player-player* dyad, Moura et al. [37] proposed the measurement of the team spread to assess players' organization. This *player-player* dyad is computed by the Euclidean distance between each player and his teammates at that moment [37]. In futsal, Bueno et al. [10] found that while the players were attacking, all categories presented a greater spread compared to values when players were defending. Regardless of age and experience, while the players were attacking, all categories presented greater spread, compared to values when players were defending, although, among the categories, the results showed lower spread values for the younger players. As was suggested by Travassos et al. [12], players with less experience were the most sensitive to the changes. Therefore, the development of tactical training should be performed according to the characteristics of each category [10].

The distance between the player and the ball has been measured during matches [29, 34] and SSGs [6] using non-linear techniques (i.e. relative phase and entropy). While Vilar et al. [29, 34] used relative phase in order to assess player-ball synchronization during shot on goal sequences, Travassos et al. [12] linked player-ball distance in order to assess the movement regularity (i.e. ApEn) during SSGs with a different number of targets and a varied degree of age experience. However, to the best of our knowledge, no studies have provided the distance (in absolute values) between these two oscillators during futsal competition or training. Therefore, sports scientists should obtain these data in order to provide a reference for training task design. Along the same lines, Travassos, Araújo, Davids, et al. [28] found that when defenders were located further away from the ball at the moment of pass initiation, they were more likely to intercept the trajectory of a passing ball. In addition, the authors found that the distance of the second closest defender to the ball trajectory was higher in non-intercepted passes than in intercepted passes [28]. Training task design should ensure that the task's constraints (e.g. relative space per players) are suitable for producing a similar tactical response during training.

#### *Area related variables*

While *occupied space* and *dominant area* have been analysed, *exploration space* has not been assessed in futsal (Table 3). Thus, the assessment of *exploration space* [46] in futsal could provide an interesting field of research in the future. *Occupied space* was measured during competition while the *dominant area* was measured during training sessions (Table 3). Specifically, *occupied space* was measured during match 1 vs 1 shots on goal and tackles by *coverage area* in professional futsal players [27] and shots on goal and interceptions by *surface area* in U15, U18 and professionals [10]. Both articles agreed that the *surface area* was greater when the players were

attacking compared to when the players were defending. Future research should assess *occupied space* during training sessions to compare it with the use of the space during competition in futsal, differentiating the attacking and defending phases. On the other hand, Moura et al. [27] computed the convex hull based on Preparata and Shamos [47], while Bueno et al. [10] based their computation using the quickhull technique [48]. Until an analysis of the influence of each computation technique on the measurement of the *occupied space* has been carried out, comparisons between studies should be made with caution.

*Dominant area* was assessed by *Voronoi diagrams* [30] and by *dominant regions* [32] to analyse the use of the space during the 5 vs 4+Gk phase [30, 32]. Similarly to *occupied space*, players showed larger *area* [30] and *dominant regions* [32] during attacking than defending. Fonseca [32] found that, although players of the same team showed more regularity in dominant region area values, greater regularity in dominant region size was shown by attackers. In addition, Fonseca [32] proposed a new variable to assess *dominant region*: the percentage of free area and maximum % of overlapped area. These variables are particularly useful when identifying a defensive method adopted throughout a competition. [32]. *Voronoi diagrams* or *dominant region*, as well as the variables derived from them (i.e. percentage of free area and maximum % of overlapped area), provide more information about the spatial interaction of players in comparison with *surface area* or the *stretch index* [32].

#### *Study limitations*

The present systematic review has some limitations. The low number of studies does not allow generalization of the findings, and more original research should be conducted to obtain consistent information about the main outcomes summarized. Thus, any recommendation or evidence should be carefully interpreted mainly because of the small number of studies and great variation in methodologies.

## CONCLUSIONS

Mainly both 1 vs 1 and 5 vs 4+Gk situations have been analysed in futsal, but they have not been assessed in both training and competition. Surprisingly, few studies have analysed the collective tactical behaviour during the most frequent match situation (i.e. Gk+4 vs 4+Gk).

The wide range of variables proposed in futsal (i.e. GC-GC *distance*, GC-player *distance*, player-player *distance*, player-ball *distance*, player-space *distance*) suggests that these variables are of special interest for researchers and technical staff to assess tactical behaviour in futsal. The low number of players, a greater proximity to the goals and a more frequent use of man-man marking in futsal in comparison to other sports suggest the relevance of these types of *distances*. Originally, *player-player* with *angle* as a measurement association was suggested twice in futsal. This tactical variable was suggested instead of *distance* because the angle measurement revealed the alignment/misalignment between the players and the ball or the goal.

The *occupied space* and *dominant area* have been analysed in futsal, but *exploration space* has not. The *occupied space* was measured only during competition while the *dominant area* was measured only during training sessions. Until now, studies have found that the *surface area* and *dominant regions* were greater when players were attacking in comparison to when they were defending during match 1 vs 1 shot on goal and tackle situations, and during the simulated 5 vs 4+Gk phase situation, respectively.

Two non-linear techniques (i.e. relative phase and entropy) were applied to analyse synchronization and complexity and regularity or predictability in futsal. Team regularity was higher using 2 goals instead of one during SSGs. Greater synchronization was shown by defenders with teammates and ball than attackers during 5 vs 4+Gk training tasks considering distance variables.

Collective tactical behaviour, specifically the management of the distances and the use of the space, differs among competitive levels during both competition and training.

### Practical applications

1 vs 1, 5 vs 4+Gk and Gk + 4 vs 4 + Gk situations should be analysed during training and competition to compare the tactical response, design optimal training strategies and improve tactical performance during matches. In addition, the attacking phase and defending phase of play have been differentiated to assess collective tactical behaviour during these situations.

Since different team dispersion could show the same distance between GCs and subsequently the same degree of “pressure”, new collective tactical variables, such as the *team separateness* (TS), should be suggested to assess “pressure” instead of the GC-GC dyad.

The assessment of the *exploration space* in futsal could be an interesting field of research in the future. In addition, future research should assess both *occupied space* and *dominant area* during training and competition, differentiating attacking and defending phases, to compare the use of the space and improve the efficacy of designed training strategies.

Since ApEn is strongly dependent on the record length and is uniformly lower than expected for short records and lacks relative consistency, in addition to ApEn, other techniques, such as sample entropy, could be used.

Since collective tactical behaviour differs according to the game experience of the players, the design of tactical training should be adapted to the characteristics of each category.

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