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Relating external load variables with individual tactical actions with reference to playing position: an integrated analysis for elite futsal

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ABSTRACT

The purpose of this study was to contextualise players' high-intensity activities (HIA) with individual tactical actions during match play with reference to playing positions. Tracking data was obtained using local positioning system devices from 19 male elite futsal players (28.8 ± 2.4 years). The HIA measures included high-intensity acceleration (ACC; $\geq 3 \text{ m} \cdot \text{s}^{-2}$), deceleration (DEC; $\leq -3 \text{ m} \cdot \text{s}^{-2}$), and high-speed running (HSR; $\geq 18 \text{ km} \cdot \text{h}^{-1}$). Tracking data and match footage were synchronised using the SPRO™ to code players' physical performance and technical-tactical actions. A small statistically significant association was observed between HIA and players' actions with or without the ball ($\chi^2 = 183.27$ (2, $N = 4234$), $p < .001$; *Cramer's V* = 0.21). When players have the ball, the number of DEC efforts tends to increase with a corresponding decrease in ACC and HSR. When the players do not have the ball, ACC and HSR running tend to increase with a corresponding decrease in DEC. A comparison between HIA revealed that futsal performance requires greater mechanical efforts (ACC + DEC) than kinematic efforts (HSR). This underscores the importance of mechanical efforts within short space for futsal performance. Moreover, the diverse tactical actions associated with different player positions contribute to distinct activity profiles and physical requirements.

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1. Introduction

Futsal is characterised by the relationship of cooperation and opposition between players, in which each team engages in a competitive pursuit to achieve goal-scoring while concurrently implementing defensive strategies to prevent the opposing team from scoring, to win the match (Travassos et al., 2012). It is a team sport distinguished by its fast pace and a myriad of physical, psychological and tactical – technical parameters that sustain team performance (Spyrou et al., 2020).

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Due to restrictions on space and time to make a decision, and the constant variations in the contexts of play (Méndez et al., 2019), futsal can be characterised as a high-intensity intermittent sport, in which players frequently perform high-intensity actions (HIA) to change their speed or direction, and perform high braking events (Spyrou et al., 2020). HIA are composed of the sum of external load variables consisting of both mechanical (ACC and DEC) and kinematic (speed and distance covered) dimensions, which are measured at specific velocity thresholds. Concretely, elite futsal players perform 8 ACC ($>3 \text{ m} \cdot \text{s}^{-1}$) and 8 DEC ($> -3 \text{ m} \cdot \text{s}^{-1}$) during player interchange rotations (averaging 4 effective minutes on-play) and cover an average distance of 3–4 km per game, with the highest percentage of distances covered occurring between 0 and 6 km/h (Ribeiro et al., 2020; Ribeiro et al., 2022a). Analysis of HIA, which considers both mechanical and kinematic variables, allows for a more holistic approach towards better understanding the physical requirements of the game (Ribeiro et al., 2022a).

Over the years, most of the research has characterised futsal efforts by neglecting the relationship between physical outcomes and individual tactical actions (contextual information) of the game (Arjol-Serrano et al., 2021; Bradley & Ade, 2018; Pino-Ortega & Rico-González, 2021). Understanding the frequency of HIA is just as important as understanding context during which HIA occur (Ju et al., 2023). More than a reductive quantification of efforts, HIA should be contextualised and associated with specific match events (Nosek et al., 2021). In fact, there is a need to understand the relationship between high-intensity efforts, such as changes of direction, as well as increasing and decreasing velocity (Ribeiro et al., 2022b; Spyrou et al., 2020), with offensive and defensive individual tactical actions (Bradley & Ade, 2018). Thus, the contextualisation of HIA is critical for the analysis and development of individual athletic performance and team-based training (Santos et al., 2020).

For example, passes, dribbles, defensive-marking actions or defensive returns, correspond to the specific tactical actions that players perform individually to contribute to the collective success of the team (Agras et al., 2016). From an ecological dynamics perspective, these individual tactical actions emerge from the relationship between the players' capabilities to play (perceptive, physical, coordinative, technical, etc.) and variations in the game environments, during two specific phases of the game: (a) with ball possession and (b) without ball possession (Corrêa et al., 2012). Moreover, it is currently acknowledged that variations in individual tactical actions and also in the physical efforts of players may be associated with variations in playing positions or individual specificities of each players' actions during match play (Serrano et al., 2020). Additionally, the average total distance covered while in ball possession was notably lesser for Pivot players compared to Wingers. Furthermore, the proportion of high-intensity exercises without ball possession was lower for Defenders in contrast to Wingers (Ohmuro et al., 2020). In this regard, recent research has demonstrated that a team is characterised by players with different activity profiles, described by high inter- and intra-player variability (Ribeiro et al., 2020; Ribeiro et al., 2022b). Such findings provide further evidence that “one size does not fit all” and emphasises the need to contextualise players' activities to optimise training and monitoring processes.

As a result, one of the major challenges of team sports analysis is to integrate and contextualise physical data with individual tactical actions (Torres-Ronda et al., 2022). The best training results are achieved when the training stimulus replicates the

physiological demands and movement patterns of the sport (Gabbett, 2010). Based on this premise, coaches and strength and conditioning professionals should be aware of specific match contexts and activities when designing training drills as a means of improving the behaviours and physical performance levels of team sports athletes (Gabbett et al., 2009). To the best of the author's knowledge, no previous research has focused on investigating the relationship between physical and individual tactical data in futsal to provide coaches with concise information to better prepare training sessions.

Therefore, this study aims to (i) contextualise individual players' HIA with tactical actions during match play and (ii) investigate the associations between different playing position, individual tactical actions, and HIA characteristics. Furthermore, this study presents a novel concept towards understanding the relative contribution of specific HIA variables, measured by acceleration, deceleration and high-speed running, to specific tactical actions. From a practical standpoint, this study suggests how each physical variable should be integrated with individual tactical actions to provide a holistic understanding of elite futsal players' performance according to playing position (Ju et al., 2023). The underlying hypothesis formulated for this study posits that varied tactical actions impose different physical requirements, thereby manifesting in the specific roles of players on the field.

2. Material and methods

A retrospective observational study was conducted to quantify and analyse a total of 4234 HIA efforts and tactical actions according to positional differences in elite futsal players across seven official matches from one team that competes in the Liga Nacional de Fútbol Sala (LNFS) 1st Spanish Division (2018–2021) as well as the Union of European Football Associations (UEFA) Futsal Champions League.

2.1. Subjects

Tracking and match video data were collected from 19 professional futsal players (age: 28.8 ± 2.4 years, weight: 73.7 ± 6.2 kg, height: 175.9 ± 5.9 cm) that participated in seven competitive matches. Players were classified according to their playing position into defenders (DF; $n = 6$), wingers (WG; $n = 10$), and pivots (PV; $n = 3$). Inclusion criteria were the following: (1) outfield player, and (2) no report of physical limitation or skeletal muscle injury that could affect performance, and (3) only data from participants who played ≥ 2 min were analyzed, as previous studies applied (Ribeiro et al., 2022b). Goalkeepers were not included in this study because their tactical position is very specific and their positioning dynamics are different from outfield players (Serrano et al., 2021). All players were informed of the purpose of the study and gave written informed consent before the study was conducted. The experimental procedures used in this study were based on the ethical principles of the Declaration of Helsinki and were approved by the local Ethics and Scientific Committee.

2.2. Procedures

Matches were randomly selected while simultaneously controlling various situational factors (phases of the season, all official matches were played on the same indoor court

under similar environmental conditions, and team or opponent standards) by previously outlined approaches (Ju et al., 2023). Matches were included only if they were close games (goal differential ≤ 2) and were excluded if a player was dismissed, as this can affect overall work-rates (Ju et al., 2022). A Local Positioning System performance tracking system (WIMU PRO™, Realtrack Systems, Almeria, Spain) was used to monitor and collect external load data when players were on the court. The devices were placed in the upper part of the back in tight-fitting harnesses. The WIMU PRO system showed a high intraclass correlation coefficient (ICC) for the x-coordinate (0.65), a very high ICC for the y-coordinate (0.85), and a good technical measurement error of 2% (Bastida-Castillo et al., 2019). The external load data was analysed using the SPRO™ (Realtrack Systems, Almeria, Spain) software, which uses timeline monitors to determine when each external load variable (specifically HIA) occurred. To identify the HIA and associate the respective individual tactical actions, the game video footage was synchronised with this timeline. This synchronisation is only possible because the player tracks his movements with positional data. Each player's analysis had to be done separately in order to facilitate and eliminate errors in order to identify the HIA. The following individual tactical actions were analysed by the researcher and more two observers, who belong to professional futsal staffs (UEFA qualified coaches), who all have more than 10 years of experience in futsal research and video analysis, and demonstrated almost perfect inter-rater reliability (Kappa statistic, $k = 0.85$) and perfect intra-rater reliability ($k = 0.96$) (Ju et al., 2022; McHugh, 2012; Oliva-Lozano et al., 2022). If there were a disagreement, the decision would be made by another professional observer from the research group.

2.3. Measurements

The following physical demand variables were measured and reported as the number of high-speed running activities (HSR; $>18 \text{ km} \cdot \text{h}^{-1}$), high-intensity accelerations (ACC; $\geq 3 \text{ m} \cdot \text{s}^{-2}$), and high-intensity decelerations (DEC; $\leq -3 \text{ m} \cdot \text{s}^{-2}$). Table 1 provides descriptions of all individual tactical actions with a ball or without the ball analysed by the research and the observers in each HIA based on previous proposals (Ju et al., 2022; Lupescu, 2017).

2.4. Statistical analysis

The association between the overall HIA efforts and tactical actions (with and without the ball) variables was determined using a chi-square test and the associated effect size was estimated using Cramer's V based on the following criteria: ≤ 0.2 , small; 0.2–0.6, moderate; and >0.6 , large association. The adjusted residual values greater than 1.96 or less -1.96 , for each category analysed, were considered significant (Ho, 2014). A Pearson one sample chi-square test was used to investigate the relationship between HIA within each individual tactical action, with and without the ball. A follow-up binomial test was used to identify statistically significant differences between HIA within each individual tactical action and in instances where only two HIA actions were associated with a specific tactical action. To account for the type I error rate, the p -value was adjusted to an α -level of $p \leq 0.02$ based on the number of contrasts performed. The magnitude of statistically significant observations were assessed using Cohen's W , for Pearson chi-

Table 1. Descriptions of the variables utilised within the integrated approach.

Variables	Description
<i>With ball</i>	
Dribble	Player moves with the ball in order to progress in some direction.
Interception	Player intercepts a pass by the opposition.
Dynamic ball control	Player receives a pass and moves the ball with intention.
Ball protection	Player uses their body to protect the ball from opponents.
Pass	Player passing the ball towards a teammate.
Shot	Player intends to direct the ball towards the opposition goal.
Disarm	Player intervention and attempt to take the ball away from a direct rival.
Static ball control	Player receives a pass and retains control of the ball in the same place.
<i>Without ball</i>	
Defensive return/loss reaction	The player runs back towards his own goal, immediately following the loss of possession.
Support movements – Away	Player moves to receive a pass from a teammate or to create/explore space (usually at depth).
Support movements – Break	Player moves to receive a pass from a teammate or to create/explore space (usually arrives short to receive ball)
Support movements – Strategy	Players moves to receive a pass from a teammate on strategical situations (e.g. corner kick and free kick)
Marking – Ball trajectory	Player runs following the movement of the ball towards the opponent
Marking – Opponent trajectory	Player runs following the direction of his opponent's movement
Marking – Individual duel	Player in base defence posture preventing opponent's advance
Help Coverage	Player moves to provide defensive cover for teammate

square tests, and Cohen's h , for assessing the magnitude of differences in proportions from binomial tests, and were based on the following criteria: Cohen's W ES: 0.1–0.3, small; 0.3–0.5, medium; ≥ 0.5 , large; Cohen's h effect size: 0.2–0.5, small; 0.5–0.8, medium; and ≥ 0.8 , large (Cohen, 2013). The α -level of statistical significance was set as $p \leq 0.05$, unless otherwise stated. All statistical analyses were conducted using IBM SPSS, version 27.0 (Armonk, NY: IBM Corp).

3. Results

Individual tactical actions without the ball ($n = 3497$) have a higher frequency in terms of HIA than individual actions with the ball ($n = 737$). Statistically significant differences were observed between the number of HIA efforts (ACC, DEC, and HSR) distribution for general individual tactical actions with or without ball ($\chi^2 = 183.27$ (2, $N = 4234$), $p \leq 0.001$) with a small effect size ($V = 0.21$). Specifically, the frequency of DEC is greatest, followed by ACC and HSR in individual tactical actions with the ball. In individual tactical actions without ball, the contribution of ACC is greatest, followed by DEC, and HSR increases.

Table 2 presents the detailed characterisation each individual tactical action with and without the ball according to specific HIA efforts. Generally, the tactical actions performed with the ball, such as static ball control, disarm, shot and pass, revealed prominent frequencies of DEC efforts, compared to ACC and HSR. Thus, such individual tactical actions with the ball can be considered as *unidimensional* as a function of unique DEC efforts.

Tactical actions with the ball, such as dynamic ball control and interception, revealed both DEC and ACC efforts, with significantly higher frequencies of DEC compared to ACC efforts ($p \leq 0.001$; $h = \geq 0.8$). Thus, such individual tactical actions with the ball can

Table 2. Frequency of HIA effort (ACC, DEC, HSR) according to action with (+) and without (-) the ball.

	Action	ACC	DEC	HSR	Pearson Chi Square/Binomial Statistics
Actions: + Ball	Static Ball Control	-	64	-	-
	Disarm	-	60	-	-
	Shot	-	72	-	-
	Pass	-	111	-	-
	Ball Protection	13	10	-	$p = 0.68$; $h = 0.13$
	Dynamic Ball Control	5	75**†	-	$p \leq 0.001$; $h = 1.1$
	Interception	5	49**†	-	$p \leq 0.001$; $h = 0.95$
Actions: - Ball	Dribble	169	64**α	40**β #α	$\chi^2 = 103.45$, $df = 2$, $p \leq 0.001$; $W = 0.62$
	Help Coverage	142	91**α	5**† ##†	$\chi^2 = 120.87$, $df = 2$, $p \leq 0.001$; $W = 0.71$
	Marking – Individual Duel	19	74**β	5**β ##†	$\chi^2 = 81.45$, $df = 2$, $p \leq 0.001$; $W = 0.91$
	Marking – Opponent Trajectory	341	272**	55**† ##β	$\chi^2 = 200.07$, $df = 2$, $p \leq 0.001$; $W = 0.55$
	Marking – Ball Trajectory	417	504**	30**† ##†	$\chi^2 = 401.70$, $df = 2$, $p \leq 0.001$; $W = 0.65$
	Support Movements – Strategy	21	20	5**β ##β	$\chi^2 = 10.48$, $df = 2$, $p = 0.01$; $W = 0.48$
	Support Movements – Break	120	74**α	13**† ##β	$\chi^2 = 83.51$, $df = 2$, $p = 0.01$; $W = 0.64$
	Support Movements – Away	479	321**α	186**α	$\chi^2 = 130.87$, $df = 2$, $p \leq 0.001$; $W = 0.36$
				#α	
		Defensive Return	152	84**α	67**α

Significantly different than ACC (** $p \leq 0.001$; * $p \leq 0.05$). Significantly different than DEC (## $p \leq 0.001$; # $p \leq 0.05$). Cohen's W effect size (ES): 0.1–0.3, small; 0.3–0.5, medium; ≥ 0.5 , large. Cohen's h ES: 0.2–0.5, small (ω); 0.5–0.8, medium (β); ≥ 0.8 : large (\dagger). ACC: high-intensity acceleration ($\geq 3 \text{ m}\cdot\text{s}^{-2}$); DEC: high-intensity deceleration ($\leq -3 \text{ m}\cdot\text{s}^{-2}$); HSR: high-speed running ($\geq 18 \text{ km}\cdot\text{h}^{-1}$). WG: winger; DF: defender; PV: pivot. Adjusted p -value for Pearson Chi Square test $p \leq 0.02$. Statistically significant observations are bolded for clarity.

be considered as *bidimensional* as a function of both DEC and ACC contributions. Conversely, dribble revealed a contribution of all three HIA effort measures (ACC, DEC and HSR), with a significant high frequency of ACC ($\chi^2 = 103.45$, (2, $N = 273$), $p \leq 0.001$; $W = 0.62$), and can be considered as *multidimensional*.

Individual tactical actions without the ball, in contrast to the individual actions with the ball, require a combination of HIA efforts to be performed, and can therefore be considered as *multidimensional* tactical actions. The frequency of ACC is significantly ($p \leq 0.001$) greater than DEC and HSR in specific tactical actions without the ball, including help coverage, marking – opponent trajectory, support movements – break and away and defensive return. However, the frequency of DEC is significantly greater than both ACC and HSR in marking – individual duel and marking – ball trajectory ($p \leq 0.001$).

The data characterising individual tactical actions with and without the ball regarding HIA efforts (ACC, DEC, and HSR) according to playing position is presented in [Tables 3 and 4](#). In general, individual tactical actions with the ball revealed quite similar efforts across playing positions. Individual tactical actions without the ball revealed quite similar efforts across playing positions in line with the previous results observed regarding tactical in the actions with the ball. Slight differences were observed in help coverage, marking – individual, and support movement break in WG that require a combination of HIA efforts to be performed in contrast to DF and PV, which require ACC and DEC efforts.

Finally, [Figures 1 and 2](#) illustrate the most representative individual tactical actions within each position. Thus, it is possible to verify that the three most representative and statistically significant ($p \leq 0.01$) tactical actions with the ball for wingers are dribble (43.19%), pass (15.96%), and dynamic ball control (11.28%). Similarly, the three most prominent and statistically significant ($p \leq 0.01$) actions for DF are dribble

Table 3. Frequency of HIA effort (ACC, DEC, HSR) related to actions with (+) the ball according to playing position (WG, DF, and PV).

	Position	Action	ACC	DEC	HSR	Pearson Chi Square/Binomial Statistics
Actions: + Ball	WG	Static Ball Control	-	38	-	-
		Disarm	-	24	-	-
		Shot	-	37	-	-
		Pass	-	75	-	-
		Ball Protection	11	5	-	$p = 0.21; h = 0.38$
		Dynamic Ball Control	-	53	-	-
		Interception	-	24	-	-
		Dribble	127	47**α	29**β	$\chi^2 = 80.43, df = 2, p \leq 0.001; W = 0.63$
Actions: + Ball	DF	Static Ball Control	-	9	-	-
		Disarm	-	30	-	-
		Shot	-	26	-	-
		Pass	-	25	-	-
		Ball Protection	5	5	-	$p = 1.00; h = 0.00$
		Dynamic Ball Control	-	12	-	-
		Interception	5	18β	-	$p = 0.01; h = 0.60$
		Dribble	23	9*α	7**β	$\chi^2 = 11.69, df = 2, p \leq 0.001; W = 0.55$
Actions: + Ball	PV	Static Ball Control	-	17	-	-
		Disarm	-	6	-	-
		Shot	-	9	-	-
		Pass	-	11	-	-
		Ball Protection	-	-	-	-
		Dynamic Ball Control	5	10	-	$p = 0.32; h = 0.34$
		Interception	-	7	-	-
		Dribble	18	7	6**β	$\chi^2 = 8.58, df = 2, p = 0.01; W = 0.53$

Significantly different than ACC (** $p \leq 0.001$; * $p \leq 0.05$). Significantly different than DEC (## $p \leq 0.001$; # $p \leq 0.05$). Cohen's W effect size (ES): 0.1–0.3, small; 0.3–0.5, medium; ≥ 0.5 , large. Cohen's h ES: 0.2–0.5, small (α); 0.5–0.8, medium (β); ≥ 0.8 : large (\dagger). ACC: high-intensity acceleration ($\geq 3 \text{ m} \cdot \text{s}^{-2}$); DEC: high-intensity deceleration ($\leq -3 \text{ m} \cdot \text{s}^{-2}$); HSR: high-speed running ($\geq 18 \text{ km} \cdot \text{h}^{-1}$). WG: winger; DF: defender; PV: pivot. Adjusted p-value for Pearson Chi Square test $p \leq 0.02$. Statistically significant observations are bolded for clarity.

(22.41%), disarm (17.24%), and shot (14.94%). Similarly, PV are distinguished by dribble (32,29%), static ball control (17,71%), and dynamic ball control (15,63%), which are statistically significantly greater when compared to all other tactical actions ($p \leq 0.01$).

Regarding individual tactical actions without the ball (Figure 2), the three most representative actions for WG include support movement – away (29.4%), marking – ball trajectory (27.28%), and marking – opponent trajectory (18.67%). The following tactical actions were observed for DF: marking – ball trajectory (27.63%), support movement – away (25.11%), and marking – opponent trajectory (20.29%). Finally, the three most prominent tactical actions for PV are as follows: support movement – away (28.61%), marking – ball trajectory (25.61%), and marking – opponent trajectory (18.80%).

4. Discussion

The analysis of physical demands in futsal has been investigated within the last years with some detail and following different approaches (Illa et al., 2020; Ribeiro et al., 2020; Serrano et al., 2020). However, despite the advances in knowledge, the relationship between physical demands and individual tactical actions with and without ball in futsal remains unclear. The main objectives of this research were to contextualise the HIA with



Table 4. Frequency of HIA effort (ACC, DEC, HSR) related to actions without (-) the ball according to playing position (WG, DF, and PV).

Position	Action	ACC	DEC	HSR	Pearson Chi-Square/Binomial Statistics
WG	Help Coverage	104	65** α	5 ^{††} ##†	$\chi^2 = 85.76$, $df = 2$, $p \leq 0.001$; $W = 0.70$
	Marking – Individual Duel	13	45 ^{††} β	5** α ##†	$\chi^2 = 42.67$, $df = 2$, $p \leq 0.001$; $W = 0.82$
	Marking – Opponent Trajectory	207	166	41 ^{††} β ## β	$\chi^2 = 108.36$, $df = 2$, $p \leq 0.001$; $W = 0.51$
	Marking – Ball Trajectory	252	334 **	19 ^{†††} ##†	$\chi^2 = 264.86$, $df = 2$, $p \leq 0.001$; $W = 0.66$
	Support Movements – Strategy	12	8	-	$p = 0.50$; $h = 0.20$
	Support Movements – Break	56	37** α	8 ^{††} ## β	$\chi^2 = 34.71$, $df = 2$, $p \leq 0.001$; $W = 0.59$
	Support Movements – Away	306	218**	128** α ## α	$\chi^2 = 72.90$, $df = 2$, $p \leq 0.001$; $W = 0.33$
	Defensive Return	99	50** α	40** α	$\chi^2 = 31.65$, $df = 2$, $p \leq 0.001$; $W = 0.41$
	Help Coverage	33	21	-	$p = 0.13$; $h = 0.22$
	Marking – Individual Duel	5	24 ^{††} β	-	$p \leq 0.001$; $h = 0.71$
	Marking – Opponent Trajectory	97	82	6 ^{†††} ##†	$\chi^2 = 77.20$, $df = 2$, $p \leq 0.001$; $W = 0.65$
	Marking – Ball Trajectory	126	120	6 ^{†††} ##†	$\chi^2 = 108.86$, $df = 2$, $p \leq 0.001$; $W = 0.66$
DF	Support Movements – Strategy	5	7	-	$p = 0.77$; $h = 0.17$
	Support Movements – Break	33	28	5 ^{††} ## β	$\chi^2 = 20.27$, $df = 2$, $p \leq 0.001$; $W = 0.55$
	Support Movements – Away	118	78** α	33 ^{††} β ## α	$\chi^2 = 47.38$, $df = 2$, $p \leq 0.001$; $W = 0.45$
	Defensive Return	43	22** α	20** α	$\chi^2 = 11.46$, $df = 2$, $p \leq 0.001$; $W = 0.37$
	Help Coverage	5	5	-	$p = 1.00$; $h = 0.00$
	Marking – Individual Duel	-	6	-	-
	Marking – Opponent Trajectory	37	24	8 ^{††} β ## β	$\chi^2 = 18.35$, $df = 2$, $p \leq 0.001$; $W = 0.52$
	Marking – Ball Trajectory	39	50	5 ^{†††} ##†	$\chi^2 = 35.13$, $df = 2$, $p \leq 0.001$; $W = 0.61$
	Support Movements – Strategy	7	7	-	$p = 1.00$; $h = 0.00$
	Support Movements – Break	31	9 ^{††} β	-	$p \leq 0.001$; $h = 0.58$
	Support Movements – Away	55	25** α	25** α	$\chi^2 = 17.14$, $df = 2$, $p \leq 0.001$; $W = 0.40$
	Defensive Return	10	12	7	$\chi^2 = 1.31$, $df = 2$, $p = 0.52$; $W = 0.21$
PV	Help Coverage	5	5	-	-
	Marking – Individual Duel	-	6	-	-
	Marking – Opponent Trajectory	37	24	8 ^{††} β ## β	$\chi^2 = 18.35$, $df = 2$, $p \leq 0.001$; $W = 0.52$
	Marking – Ball Trajectory	39	50	5 ^{†††} ##†	$\chi^2 = 35.13$, $df = 2$, $p \leq 0.001$; $W = 0.61$
	Support Movements – Strategy	7	7	-	$p = 1.00$; $h = 0.00$
	Support Movements – Break	31	9 ^{††} β	-	$p \leq 0.001$; $h = 0.58$
	Support Movements – Away	55	25** α	25** α	$\chi^2 = 17.14$, $df = 2$, $p \leq 0.001$; $W = 0.40$
	Defensive Return	10	12	7	$\chi^2 = 1.31$, $df = 2$, $p = 0.52$; $W = 0.21$

Significantly different than ACC (** $p \leq 0.001$; * $p \leq 0.05$). Significantly different than DEC (## $p \leq 0.001$; # $p \leq 0.05$). Cohen's W effect size (ES): 0.1–0.3, small; 0.3–0.5, medium; ≥ 0.5 , large. Cohen's h ES: 0.2–0.5, small (α); 0.5–0.8, medium (β); ≥ 0.8 , large (\dagger). ACC: high-intensity acceleration ($\geq 3 \text{ m} \cdot \text{s}^{-2}$); DEC: high-intensity deceleration ($\leq -3 \text{ m} \cdot \text{s}^{-2}$); HSR high-speed running ($\geq 18 \text{ km} \cdot \text{h}^{-1}$). WG: winger; DF: defender; PV: pivot. Adjusted p -value for Pearson Chi-Square test $p \leq 0.02$. Statistically significant observations are bolded for clarity.

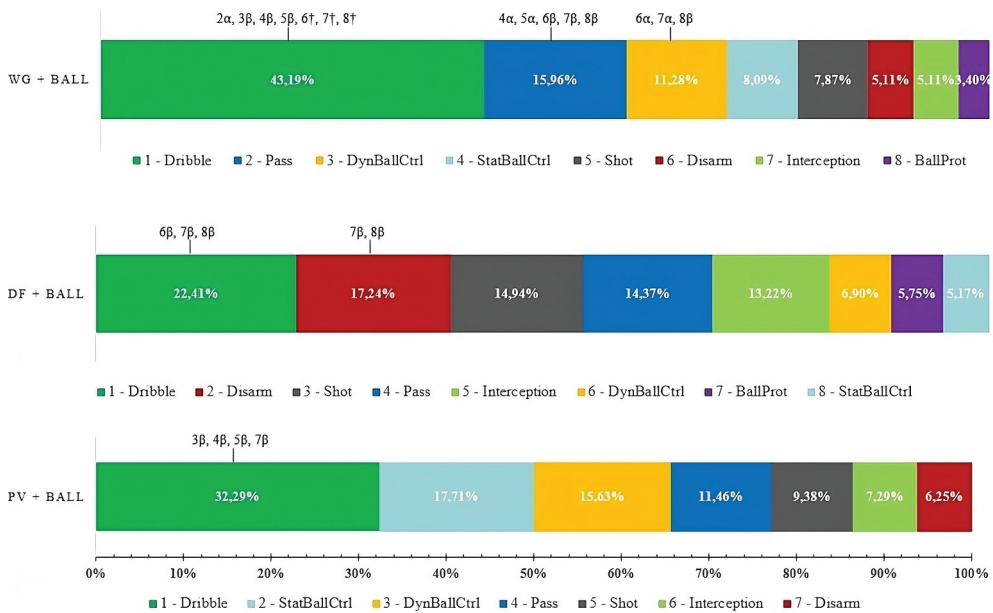


Figure 1. Frequency proportion of actions with the ball for each position. Significance and effect size are indicated for the top three greatest proportion actions for clarity. Significant differences are indicated by the corresponding action number within positions: Static Ball Control (StatBallCtrl), Disarm, Shot, Pass, Ball Protection (BallProt), Dynamic Ball Control (DynBallCtrl), Interception, and Dribble. WG and DF adjusted significance p-value: $p \leq 0.002$. PV adjusted significance p-value: $p \leq 0.0024$. Cohen's h effect size (h): 0.2-0.5; small (α); 0.5-0.8, medium (β); >0.8, large (t).

the individual tactical actions of players during official match play and investigate the associations between different playing positions, individual tactical actions, and HIA characteristics.

In general, a large percentage of HIA in futsal occurred without the ball. This trend can be attributed to the purposeful off-ball manoeuvres executed by players to strategically create passing opportunities, while simultaneously observing defenders exerting pressure on the ball. However, such actions require cooperation from the other three teammates based on where the player with the ball is positioned and their distance from the opponent (Vilar et al., 2012), which may potentially increase the number of HIA performed. In turn, when the team loses ball possession, the four players of the team without possession must make efforts to recover the ball and as a result may be required to perform greater HIA efforts.

Furthermore, the results of this study demonstrate that individual tactical actions in futsal, both with and without ball, are predominantly mechanical (ACC+DEC). However, while individual tactical actions with the ball tend to require DEC efforts (*unidimensional*), tactical actions without the ball require a combination of ACC and DEC efforts and a lesser contribution of HSR efforts (*multidimensional*).

The fact that most actions with the ball occur with a high frequency and magnitude of deceleration promotes a higher mechanical load (Dalen et al., 2016) caused by high-eccentric force impact peaks and loading rates, which promotes damage in soft-tissue

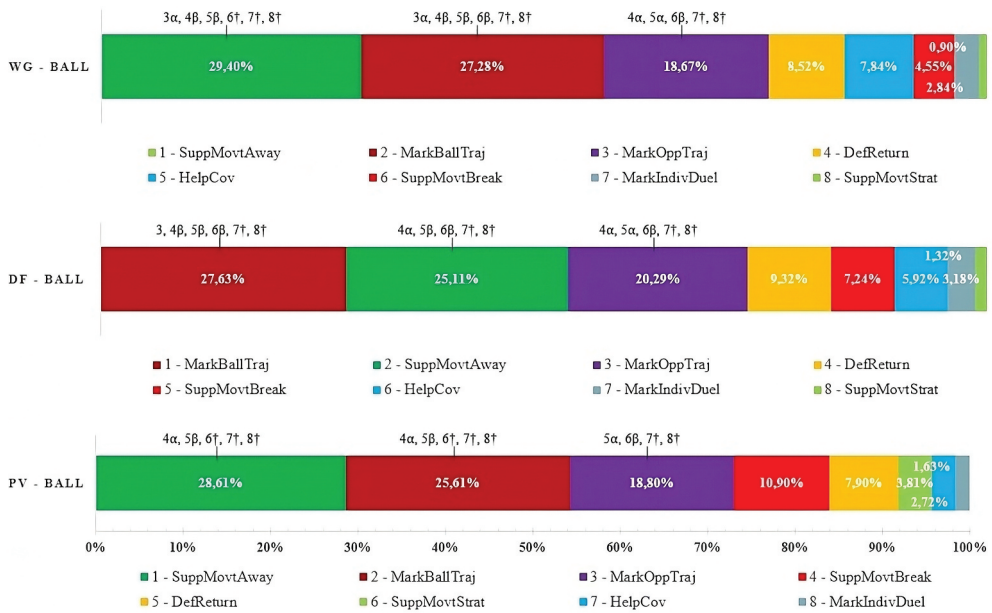


Figure 2. Frequency proportion of actions without the ball for each position. Significance and effect size are indicated for the top three greatest proportion actions for clarity. Significant differences are indicated by the corresponding action number within positions: Help Coverage (HelpCov), Marking – Individual duel (MarkIndivDuel), Marking - Opponent Trajectory (MarkOppTraj), Marking - Ball Trajectory (MarkBallTraj), Support Movements – Strategy (SuppMovtStrat), Support Movements – Break, (SuppMovtBreak), Support Movements - Away (SuppMovtAway), and Defensive Return (DefReturn). Adjusted significance p-value: $p \leq 0.002$. Cohen’s *h* effect size (*h*): 0.2-0.5; small (α); 0.5-0.8, medium (β); ≥ 0.8 , large (\dagger).

structures (Verheul et al., 2021). In this regard, it was noted that tactical actions with the ball have the highest proportion of *unidimensional* characterisation. That is, in such instances the actions of a pass, shot, disarming, and static reception of the ball all exclusively involve high DEC efforts.

It is interesting to note that this variable has already been mentioned in the literature as one of the most relevant and reliable for monitoring external load fatigue (Ribeiro et al., 2020) and is considered critical for the match outcome (Rhodes et al., 2021). According to previous research, individual tactical actions of shooting and disarming have the greatest impact on the outcome of the game and, as a result, the team’s success (Santos et al., 2020). Thus, coaches must ensure that players develop sufficient eccentric strength to be prepared to perform these actions frequently in game, as well as to improve the context of these actions during training exercises and the match.

Tactical actions without the ball have a higher HSR contribution than ball actions, which may suggest that high-intensity kinematic efforts are more pronounced in these moments of the game. This evidence supports the notion that sprint actions occur more frequently when there is no ball possession (Oliva-Lozano et al., 2022), which is consistent with previous futsal research findings (Ohmuro et al., 2020). Furthermore, these findings underscore the significance of the counterattack phase, where non-ball-related

actions such as disruptive or supportive movements are most prevalent. From a defensive standpoint, these results emphasise the substantial role played by defensive transition in the game.

Previous studies in association football have also found that increasing the number of actions with the ball reduces the distances covered and the speeds at which these distances are covered (Bradley et al., 2013; García-Calvo et al., 2022). However, it is crucial to recognise that the futsal field dimension (40 × 20) inhibits players from reaching maximum speeds, which may explain the reasons for less frequent observations of HSR when compared to ACC and DEC. Such a notion allows for the evaluation of physical requirements and their impact on players regardless of whether they have the ball or not. Following this line of thought, future research should further investigate which types of individual tactical actions are more physically demanding. Our findings suggest that when multidimensional efforts (ACC+DEC+HSR) occur in the same individual tactical action, they may be associated with more physically demanding activities. Furthermore, clarifying these physical efforts may contribute towards understanding when the most intense periods in a futsal match occur.

Therefore, it may be more relevant to investigate the context during which players accelerate, decelerate, or run at high speeds rather than the discrete frequency or magnitude of ACC, DEC, HSR efforts, to explain the modulators of physical efforts during match play. Our findings may allow coaches to design the physical intentions for each exercise by manipulating the individual tactical actions with or without the ball and combining them. For instance, to promote more strength exercises with a higher frequency of ACC and DEC actions or more resistance or velocity exercises with a higher frequency of HSR actions. Furthermore, our findings suggest that ACC and HSR are related to moments on the field when a team explores more open spaces to progress or recover, such as dribbling or support movements – away, defensive return and marking – opponent trajectory actions. Conversely, the combination of ACC and DEC efforts may be associated with match moments when players or teams want to close the space to prevent the opponent from progressing on the field through actions such as marking – ball trajectory, individual duel, and interception. Additionally, from an individual standpoint, this evidence will allow a better understanding of the physical impact that individual actions with or without the ball have on players, and according to a recent review, it could also help in injury prevention by identifying the actions that most commonly cause injury in football (Aiello et al., 2022).

The results also revealed that individual tactical actions, with or without the ball, tend to present similar physical characterisation of external load (HIA) regardless of playing position. Such observations support the notion that, regardless of different tactical constraints on playing positions, individual tactical actions are strongly associated with specific physical requirements. This observation could be linked to the ongoing trend in tactical development, which is reducing the prevalence of specialised positions and opening up opportunities for more versatile players. However, previous research has found that futsal players in different positions have different physical performances (Illa et al., 2021; Ohmuro et al., 2020; Ribeiro et al., 2022b; Serrano et al., 2020; Spyrou et al., 2020) with the authors tending to justify this over time (without proving sufficient evidence) as a result of the different roles and functions required for each playing

position. Thus, the frequency and type of individual tactical actions required in different playing positions may be what distinguishes the physical demands that players experience during a match or training session.

Our findings are consistent with the literature, suggesting that wingers and pivots are the most dissimilar positions. Wingers have a higher frequency of HIA (Ribeiro et al., 2022a), which renders them as the most physically demanding position. When wingers have the ball, they increase the number of 1v1 situations by increasing dribbling actions, dynamic receptions, and, as a result, ball protections. Tactical actions without the ball are usually represented by many offensive depth movements to create space or capitalise on goal-scoring opportunities (Ohmuro et al., 2020), which is represented in this study by the support movements – away tactical action. Also, the winger position demonstrates a higher frequency of defensive coverage actions, probably due to the player's lateral positioning on the field (Serrano et al., 2021), as well as many individual duels, which are represented by marking – ball and opponent trajectory tactical actions. Interestingly, wingers and defenders have the most similar profiles, which is likely due to the game's common rules and functions (Serrano et al., 2020). However, due to the role of playing position, defenders have a higher incidence of disarming and interception actions with the ball, marking in individual duels, and support movements away without the ball. In turn, pivots have the lowest frequency of HIA (Ohmuro et al., 2020; Ribeiro et al., 2022a), and usually maintain a tactical position on the field that is near to the goal (Serrano et al., 2020). Therefore, pivots usually play with their back turned to the opposing goal, in order to assist or shoot on goal (Sarmento et al., 2016), which is consistent with the representative ball actions found in current study for the pivot position, which are represented by dynamic and static receptions.

These findings provide novel information for using an integrated approach that contextualises match physical performance, which would progress the field towards a better understanding of the global match demands. Furthermore, a recent descriptive study of training load monitoring and player performance and fatigue assessment practices in Portuguese and Spanish professional futsal teams (Spyrou et al., 2022) found that the performance or fatigue assessments used by strength and conditioning coaches were all analytics, implying that physical tests were performed without context. The challenge for the future is to develop physical tests that contextualises the most relevant individual tactical actions of each playing position based on the current findings. To improve players' match performance, training tasks must be designed to expose players to game contexts which reflect technical, tactical and physical demands and represents the competitive environment of an official match.

4.1. Limitations

The present investigation has some limitations that should be considered. First, despite the sample size being constituted by elite players, the sample size is limited, and the number of players per position is not equal. The analysis also neglected the team formation used by the team in each match. Thus, the generalisation of results should be interpreted with caution (Hecksteden et al., 2021). Future studies should address these limitations to confirm drawn conclusions. Finally, while individual tactical actions were

analysed, other match-related contextual variables such as team level, style of play, players' age, or match status were not considered and might be considered in future studies.

5. Conclusions

The individual tactical actions with and without the ball have different physical requirements due to their respective HIA requirements and characteristics. It was found that in tactical actions with the ball there is a higher frequency and contribution of DEC and ACC when compared to HSR. Conversely, in tactical actions without the ball, there is a tendency for greater ACC and HSR frequency and performance when compared to DEC.

The high-intensity physical demands in elite futsal have an essential mechanical dimension (ACC+DEC), with high-intensity movements in a short space being a critical component of performance in the sport. It was discovered that regardless of the position of the player on the field, individual tactical actions tend to have the same physical characterisation (HIA), suggesting that such tactical actions are strongly associated with physical requirements despite the different tactical role of playing positions.

The frequency and type of individual tactical actions that each player most frequently performs, according to the rules and specificities of playing positions, will distinguish the different activity profiles and their physical demands. These findings have important implications for practice as coaches are better informed and have a greater understanding of the load that their players are exposed to during match play, which therefore allows them to organise and manage training sessions from both perspectives: performance enhancement and injury prevention.

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