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Characteristics of the efficiency of actions of top-level goalkeepers in soccer

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Abstract

The aim of this study was to present the characteristics of the actions efficiency in elite goalkeepers. 54 observations of 25 goalkeepers participating in 27 matches of the World and the European Championships and the Africa Cup of Nations and Copa America held in the years 2014–2019 were included. The study applied a method of observation. Game data were registered on a self-developed observation sheet. Goalkeepers' activity, effectiveness, and reliability with a view to implementing the objectives of the game were analyzed in offensive and in defense. It was found that in the elite goalkeepers' game, offensive actions constitute 62% and defensive 38% of all actions taken in matches. Actions aimed at positioning the game and at preventing a loss of a goal (60% and 22% respectively) dominated. In offensive goalkeepers showed the highest reliability in positioning the game by passing the ball with the foot, while in defense in preventing the loss of a goal by catching the ball. The created models mapping the top-skilled goalkeepers' actions allow improving the process of coaching by referring their game to objective patterns.

Keywords

football, goalkeepers, performance, observation sheet

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Article

Characteristics of the efficiency of actions of top-level goalkeepers in soccer

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Abstract: Introduction: The aim of this study was to present the characteristics of the action efficiency in elite goalkeepers. Material and Methods: 54 observations of 25 goalkeepers participating in 27 matches of the World and European Championships, Africa Cup of Nations and Copa America held in years 2014–2019 were included. The study applied a method of observation. Game data were registered on a self-developed observation sheet. Goalkeepers' activity, effectiveness, and reliability with a view to implementing the objectives of the game were analyzed in offense and in defense. Results: The current study results demonstrated that offensive actions constitute 62% and defensive 38% of all actions taken in matches. Actions aimed at positioning the game and preventing a loss of a goal (60% and 22% respectively) dominated. In offensive game, goalkeepers showed the highest reliability in positioning the game by passing the ball with the foot, while in defense in preventing the loss of a goal by catching the ball. Conclusion: The created models mapping the top-skilled goalkeepers' actions allow improving the process of coaching by referring their game to objective patterns.

Keywords: football, goalkeepers, performance, observation sheet.

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1. Introduction

Players' competencies are the basic condition for effective competition in soccer. At the highest level, these abilities are very balanced; therefore, the final success in the game is determined by minor differences related to the individual players' physical, technical-tactical and mental preparation [1–3]. Hence, rational training in these areas is the key to success. Emphasizing training elements in technical-tactical terms should directly result from the observation of players made with the use of objective research tools in the real game conditions [4–6]. Such practical knowledge about actions during the competition allows for the creation of so-called game models that are used to improve the activity of both individual players and entire teams. The efficiency of actions is understood as a total of practical qualities of play, which includes: activity (the number of actions performed by players of one team during a match), effectiveness (the number of positive/successful actions) and reliability (the ratio between the number of effective actions and the number of all actions). Other indices of game efficiency encompass rationality (actions

cognitively justified), valuableness (the value of assessment of action efficiency), and economy (loss–gain ratio). The player with the most positive evaluations in relation to the objectives of the game (scored goals, gained playfield, reception of the ball) performs more efficiently than others, or, in the case of the same number of positive assessments, the one whose scores have the highest value.

For many years, researchers have focused on finding success factors in soccer [7, 8]. Unfortunately, goalkeepers were ignored in these analyses, although it is widely recognized that they play a key role in achieving team successes. In this sense, the study by West [9] should be considered as exceptional. The author analyzed the available literature on goalkeepers in terms of the requirements and expectations related to this position [10], and on this basis, she formulated recommendations for goalkeepers' training. Most recently, Jamil et al. [11] used machine learning algorithms to identify key performance indicators that distinguish elite goalkeepers. It was found that in modern soccer the ability to play the ball with feet is one of the important factors differentiating elite and sub-elite goalkeepers.

In the available literature concerning the match analysis of goalkeepers, the conceptual eclecticism and a variety of methodological approaches dominate, which makes reliable comparative analyses impossible [12]. It is easier when research focuses on time-motion analysis [13–15], while where the research concerns the match performance analysis [16, 17] and selected skills performance analysis [18–20], it is practically impossible. White et al. [12] noted that out of nearly 60 variables describing goalkeepers' game, only a few can be compared due to divergent definitions. Thus, the preparation of rational training for players in the goalkeeper position should be made on the basis of notational analysis, taking into account a consistent methodological interpretation [7, 8, 21]. This demand is in line with the praxeological approach to a sports game.

Therefore, the aim of this study was to characterize the efficiency of elite soccer goalkeepers in consistence with the praxeological interpretation. The following research questions were posed: (i) what actions do elite goalkeepers of sport-effective teams execute the most often in the offensive and defensive phase of the game? (ii) what is the activity, effectiveness, and reliability of individual and team actions in elite soccer goalkeepers? It was hypothesized that more collective actions will be performed by goalkeepers in the offensive phase of the game, while individual actions will dominate in defending the goal and in creating goal-scoring prevention situations.

2. Materials and Methods

2.1. Participants

The research material consisted of video recordings of 27 matches of the cup finals (semi-final, final, and 3rd-place matches) played during the largest world and continental tournaments, such as Africa Cup of Nations (2015, 2019), World Cup (2014, 2018), European Championship (2016), Copa America (2015, 2019). Together, 54 analyses were conducted of the game of goalkeepers from 25 teams (nine from Europe, eight from Africa, eight from South America) of the top sports level (age: 29.52 ± 4.80 yrs, height: 188.94 ± 5.18 cm).

2.2. Study Design

The data was recorded on the authors' observation forms developed by Szwarc & Chamera [22]. Such variables as activity, effectiveness, and reliability of actions were analyzed. In offense (jointly 16 actions), control of the playfield, keeping possession of the ball, creating goal-scoring opportunities, and scoring a goal were assessed. In defense (jointly 16 actions), actions against both scorings a goal and goal-scoring situations were analyzed. The goalkeepers' actions were assessed within the regular 90-minute game time. Actions taken in additional time were not taken into account. The zones where the actions were performed were also recorded in the forms. With this in mind, the pitch was

divided into zones and sectors, assuming that its dimensions comply with international requirements (length – 105 m, width – 68 m). In zone A, three sectors were distinguished: sector A1 – the goal area, sector A2 – the penalty area excluding the goal area, sector A3 – the area from the end line of the pitch, excluding the penalty area, to the imaginary line of the beginning of zone B (length 33 m). Zone B comprised the area from 33 m from the team's own goal to 33 m in front of the opponent's goal. Zone C was 72 m from own goal's net to the end line of opponents' side.

This study was conducted in accordance with the Declaration of Helsinki and meets the ethical standards. The presented analysis did not consist of any testing on human subjects. All the data used in the study were obtained in a secondary way from video recordings. Therefore, no ethical approval was required for this research.

2.3. Statistical Analysis

Basic descriptive statistics were used. The results are presented in the form of a tabular description. The total number of individual types of actions was indicated. The arithmetic mean of action in a match and percentage of action's types were calculated. All calculations were accomplished using Statistica 13.0 software (TIBCO Software Inc, 2017).

3. Results

3.1. The Model of the Efficiency of Offensive Actions

The data presented in Figure 1 show that in the top-level goalkeepers' game, actions aimed to gain the playfield (78% of all actions) and actions aimed to keep possession of the ball (18%) dominated in the offense. Actions creating goal-scoring situations accounted for only 4% of all offensive actions performed by the analyzed players, and actions aimed at scoring goals were not found at all.

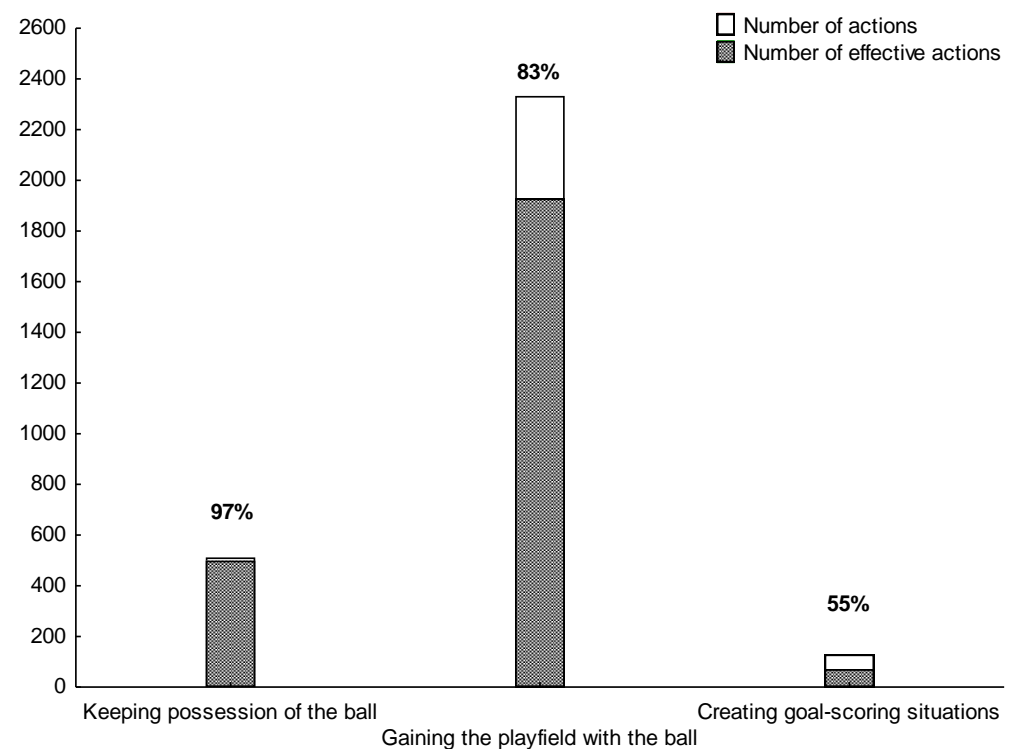


Fig. 1. The model of the efficiency of offensive actions of top-level goalkeepers.

On, average, goalkeepers kept possession of the ball nine times in one match (97% reliability), gained the playfield with the ball 43 times (83% reliability) and created goal-scoring opportunities for the partners twice (129 actions in total, with 55% reliability). From the detailed data showing the number of actions performed during the attack in terms of the objectives of the game (Tab. 1–3), it follows that when keeping possession of the ball, cooperation with partners was almost three times greater than individual actions (68% and 32%, respectively). On the other hand, gaining the playfield with the ball and creating goal-scoring situations were only the result of collective actions. In the analyzed matches, none of the examined goalkeepers attempted to position the game on their own.

3.1.1. Actions Aimed to Keep Possession of the Ball

The data presented in Table 1 show that the examined goalkeepers most often took the action of receiving the ball passed by their partner; they caught the ball played by a teammate almost three times less often, and more than three times less often they kept possession of the ball by a sliding tackle (4.8, 1.7 and 1.5 times per match, respectively). In turn, they applied to faking and/or dribbling the ball much less frequently or catching the ball after previous faking and/or dribbling it (1.1 and 0.4 times, respectively). The greatest number of joint actions to keep possession of the ball was undertaken in zone A2, and individual actions were evenly distributed in all sectors of zone A. In total, the examined players achieved very high 97% reliability in actions keeping possession of the ball, higher in cooperation (99%) than when performing individual actions (93%). They faked and/or dribbled the ball perfectly, while the lowest reliability index was achieved when keeping possession of the ball by a sliding tackle.

Table 1. Characteristics of actions taken by top-level goalkeepers to keep possession of the ball.

Forms of efficiency of action		Activity				Effectiveness				Reliability [%]				Total number of actions in matches		Average number of actions per match		Reliability [%]
Mode of action		Pitch zone												A	E	A	E	
		A1	A2	A3	B	A1	A2	A3	B	A1	A2	A3	B					
Individual	Sliding tackle to keep possession of the ball in play	21	22	23	16	20	21	20	11	95	95	87	69	82	72	1.51	1.33	88
	Faking and/or dribbling the ball	27	16	14	1	27	16	14	1	100	100	100	100	58	58	1.07	1.07	100
	Catching the ball after faking and/or dribbling	7	15	0	0	7	14	0	0	100	93	0	0	22	21	0.41	0.39	95
Total individually		55	55	37	17	54	51	34	12	–	–	–	–	162	151	3.00	2.78	2.78
Cooperation	Catching the ball played by a team-mate	16	76	0	0	16	74	0	0	100	97	0	0	92	90	1.70	1.66	98
	Receiving the ball from a partner	77	91	90	3	77	90	90	3	100	99	100	100	258	258	4.77	4.77	100
Total in cooperation		93	93	90	3	93	164	90	3	–	–	–	–	350	348	6.48	6.44	6.44
Total number of actions		148	148	127	20	147	215	124	15	–	–	–	–	512	499	9.48	9.24	9.24

NOTE: A – activity, E – effectiveness; A1 – the goal area, A2 – the penalty area excluding the goal area, A3 – the area from the end line of from the pitch, excluding the penalty area, to the imaginary line of the beginning of zone B (length 33 m), B – the area from 33 m from team's own goal to 33 m in front of the opponent's goal.

3.1.2. Gaining the Playfield with the Ball

The data in Table 2 demonstrate that the tested goalkeepers gained the playfield most often by passing the ball with their foot from the ground from zone A2, with a similar frequency at closer and longer distances (449 and 438 actions, respectively), but with significantly different reliability (98% and 56%, respectively). They passed the ball with their foot from zones A3 and A1 much less frequently and occasionally from zone B (respectively: 537, 430, and 39 actions in all matches). In turn, “playing with hands,” for example throwing the ball by hand and the so-called hitting the ball dropped from the hand, was also a common means of gaining the playfield with the ball (a total of 420 actions with 93% and 82% reliability, respectively), performed mainly from zone A2.

The most common types of actions to gain the playfield performed by each goalkeeper in a single match included: passing the ball with the leg after receiving it (14 times on average), passing the ball from a set-piece (over 12 times), passing the ball with the leg without receiving it (almost eight times). Throwing the ball by hand (almost 6 times) and kicking it out of hand (almost 3 times) were applied less commonly. Long passes of the ball with a foot were characterized by the lowest reliability, in particular passes without receiving, passes from a set-piece, and passes after receiving (51%, 56%, and 57%, respectively). In turn, the highest reliability index was achieved by the surveyed players in short passes of the ball with a foot and in throwing the ball with a hand (98% and 93%, respectively). The analysis of the effectiveness of particular actions, depending on where they were executed, showed that the tested goalkeepers perfectly used a short pass of the ball with a foot from zones A1 and B and in performing a short pass without receiving from zones A2 and B. In contrast, they showed the lowest reliability in long passes of the ball with a foot after receiving it from zones B and A3 (31% and 46%, respectively) and in long passes from set-pieces of the game in zones B and A3 (40% and 54%, respectively).

3.1.3. Creating a Goal-Scoring Situation

The data in Table 3 show that goalkeepers most often created goal-scoring situations for their partners by passing the ball dropped from a hand (58 actions, half of which were effective), passing the ball with a foot (57 actions, half of which were effective) and throwing the ball with a hand (14 actions, with 86% reliability). The analysis of efficiency in individual types of actions depending on where they were executed showed that the surveyed goalkeepers mostly passed the ball dropped from a hand from sector A2 (58 times), passed the ball with a foot after receiving it from sector A3 (16 times), threw the ball with a hand from sector A2 (14 times) and passed the ball with a foot from set-pieces from sectors B, A3 and A2 (11, 10 and 8 times, respectively). They achieved the highest reliability in the following types of actions: throwing in the ball with a hand from sector A2 (88%), passing the ball with a foot from a set-piece from sector A3 (86%), passing the ball with a foot without receiving from sector A3 (83%).

Table 2. Characteristics of actions taken by top-level goalkeepers to gain the playfield with the ball.

Forms of efficiency of action		Activity				Effectiveness				Reliability [%]				Total number of actions in matches		Average number of actions per match		Reliability [%]		
Mode of action		Pitch zone																		
		A1	A2	A3	B	A1	A2	A3	B	A1	A2	A3	B	A	E	A	E			
Cooperation	Throwing the ball with a hand	25	266	0	0	24	248	0	0	96	93	0	0	291	272	5.58	5.04	93		
	Passing the ball dropped from a hand with a foot	0	154	0	0	0	127	0	0	0	82	0	0	154	127	2.85	2.35	82		
	Pass the ball with a foot from the ground*	after receiving	s	28	240	97	6	28	236	96	6	100	98	99	100	371	366	6.87	6.77	98
			l	20	219	162	16	11	146	75	5	55	66	46	31	417	237	7.72	4.38	57
		without receiving	s	23	132	79	3	21	132	76	3	91	100	96	100	237	232	4.38	4.27	98
			l	27	102	42	3	14	49	23	2	52	48	54	66	174	88	3.22	1.63	51
		from a set piece	s	164	77	80	6	162	75	79	5	99	97	98	83	327	321	6.05	5.94	98
			l	168	112	77	5	95	63	42	2	56	56	54	40	362	202	6.70	3.74	56
Total in cooperation		455	1302	537	39	344	1025	528	31	–	–	–	–	2333	1928	43.20	35.70	83		

NOTE: A – activity, E – effectiveness; A1 – the goal area, A2 – the penalty area excluding the goal area, A3 – the area from the end line of from the pitch, excluding the penalty area, to the imaginary line of the beginning of zone B, B – the area from 33 m from team's own goal to 33 m in front of the opponent's goal; s – short pass of the ball up to 30 m; l – long pass of the ball over 30 m;

Table 3. Characteristics of actions taken by top-level goalkeepers to create goal-scoring situations.

Forms of efficiency of action		Activity				Effectiveness				Reliability [%]				Total number of actions in matches		Average number of actions per match		Reliability [%]	
Mode of action		Pitch zone														A	E		A
		A1	A2	A3	B	A1	A2	A3	B	A1	A2	A3	B	A	E	A	E		
Cooperation	Throwing in the ball with a hand	0	14	0	0	0	12	0	0	0	86	0	0	14	12	0.28	0.22	86	
	Passing the ball dropped from a hand	0	58	0	0	0	31	0	0	0	53	0	0	58	31	1.07	0.57	53	
	Passing the ball with a foot from the ground	after receiving	0	0	16	3	0	0	5	1	0	0	33	33	19	6	0.35	0.11	31
		without receiving	0	3	6	0	0	2	5	0	0	67	83	0	9	7	0.16	0.13	78
		from a set piece	0	8	10	11	0	5	7	3	0	72	88	27	29	15	0.54	0.27	51
Total in cooperation		0	83	32	14	0	50	17	4	–	–	–	–	129	71	2.38	1.31	55	

NOTE: A – activity, E – effectiveness; A1 – the goal area, A2 – the penalty area excluding the goal area, A3 – the area from the end line of from the pitch, excluding the penalty area, to the imaginary line of the beginning of zone B, B – the area from 33 m from team's own goal to 33 m in front of the opponent's goal.

In total, all actions performed by goalkeepers which were aimed at creating goal-scoring situations for the partners accounted for a small percentage (4%) of all offensive actions. On average, in one match, each goalkeeper created such situations for the partners twice. They were a result of cooperation performed with 55% reliability.

3.2. The Model of the Efficiency of Defensive Actions

The data presented on Figure 2 show that the examined goalkeepers executed 1798 defensive actions. They prevented losing a goal more often (1042 actions with 94% reliability) than prevented the creation of goal-scoring situations (756 actions with 84% reliability). These actions accounted for 58% and 42% of all defensive actions, respectively. On average, in one match, each goalkeeper prevented the loss of a goal 19 times and prevented the opponents from creating goal-scoring situations 14 times.

In total, defensive actions accounted 38% and offensive 62% of all actions performed by the examined goalkeepers in the analyzed matches (Tab.1 and Fig. 1). Moreover, the defensive actions were much more often a result of individual interventions (93%) than of cooperation (7%).

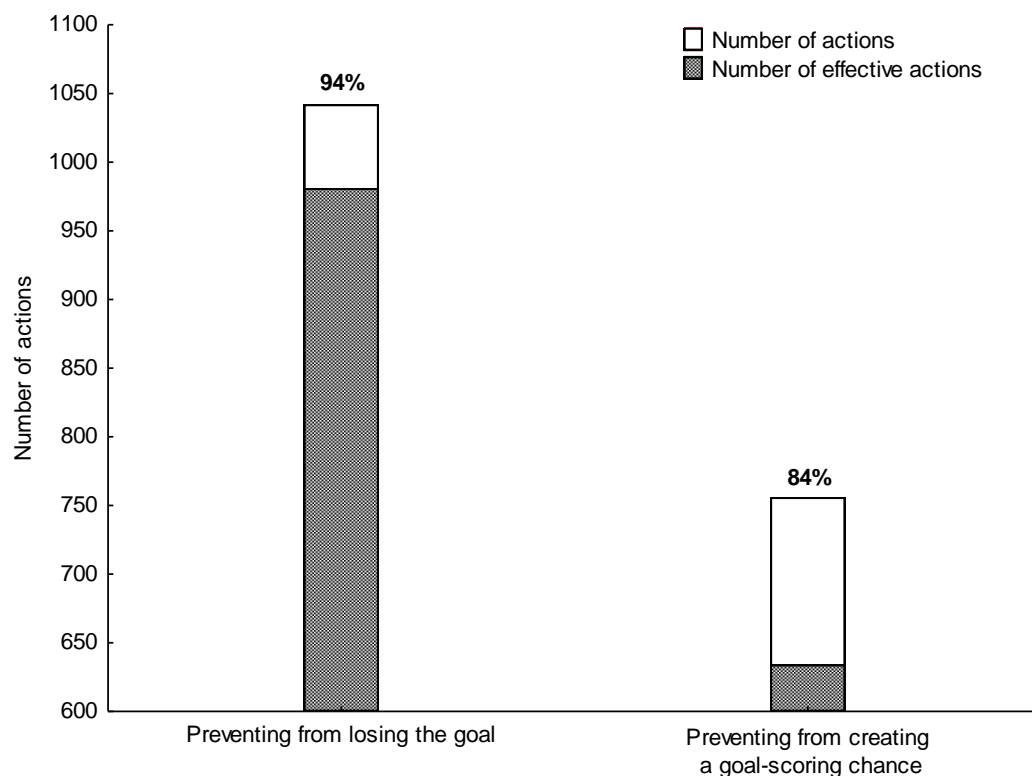


Fig. 2. The model of the efficiency of defensive actions of top-level goalkeepers.

3.2.1. Preventing the Loss of a Goal

Table 4 demonstrates that, when preventing the loss of a goal, the examined goalkeepers most often used defense without contact with the ball (269 actions with 95% reliability), and they caught the ball (239 actions with 98% reliability). They used defense without contact with the ball and without falling to the ground more often than with falling to the ground while catching the ball with a fall more often than without falling (each goalkeeper in one match: 2.76 and 2.22 as well as 2.68 and 1.74 interventions). The investigated goalkeepers used punching and pushing the ball twice less often (respectively: 118 and 113 actions with 84% and 96% reliability). On average, each goalkeeper in one match punched and pushed the ball twice. It is worth noting that in cooperation against losing a goal –

consequential doubling (performed on average 1.66 times by defenders of each team in one match), they also achieved a very high, 97% reliability. In turn, the lowest reliability (25%) was shown when defending penalty shots.

Table 4. Characteristics of actions taken by top-level goalkeepers to prevent losing a goal

Forms of efficiency of action			Activity		Effectiveness		Reliability [%]		Total number of actions in matches		Average no. of actions per match		Reliability [%]	
Mode of action			Pitch zone						A	E	A	E		
			A1	A2	A1	A2	A1	A2						
Individual	Catching the ball	<i>with falling</i>	106	39	100	37	94	95	145	137	2.68	2.54	95	
		<i>without falling</i>	88	6	88	6	100	100	94	94	1.74	1.74	100	
	Punching	<i>with falling</i>	53	26	35	23	66	88	79	58	1.46	1.07	73	
		<i>without falling</i>	15	24	15	22	100	92	39	37	0.72	0.68	95	
	Pushing	<i>with falling</i>	72	31	67	26	93	84	103	93	1.91	1.72	91	
		<i>without falling</i>	10	0	10	0	100	0	10	10	0.18	0.18	100	
	defense in a 1x1 situation			56	29	45	27	80	93	85	72	1.57	1.33	85
	situational defense			32	25	27	22	84	88	57	49	1.05	0.91	86
	defense of a penalty kick			4	0	1	0	25	0	4	1	0.07	0.02	25
	defending an indirect and/or a direct free kick	<i>with falling</i>	45	0	44	0	97	0	45	44	0.83	0.81	98	
		<i>without falling</i>	22	0	20	0	91	0	22	20	0.41	0.37	91	
	save/intervention without contact with the ball	<i>with falling</i>	102	18	97	17	95	94	120	114	2.22	2.11	95	
		<i>without falling</i>	134	15	127	15	95	100	149	143	2.76	2.65	96	
	Sum of individual actions in the sector			739	213	669	205	–	–	952	874	17.63	16.2	92
	Cooperation	Consequential doubling		76	14	73	34	96	–	90	87	1.66	1.61	97
Total cooperation			76	14	73	34	–	–	90	87	1.66	1.61	97	
Total (all) actions			815	227	742	239	–	–	1042	981	19	18	95	

NOTE: A – activity, E – effectiveness; A1 – the goal area, A2 – the penalty area excluding the goal area.

On average, each goalkeeper made 19 interventions during the match, with 94% reliability, more often individually (91%) than in cooperation (9%). In particular, this was defense without contact with the ball (26%), catching (23%), punching (11%), and pushing the ball (11%), consequential doubling (9%), defense in a one-against-one situation (8%), saving kicks from set-pieces (7%), and situational defense (5%). The most frequent interventions took place in sector A1, and goalkeepers were almost three times less likely to save the goal in sector A2 (815 and 227 actions, respectively). On the other hand, in sectors A3 and B, the surveyed players did not take any actions aimed at preventing the loss of a goal.

3.2.2. Preventing the creation of a goal-scoring situation

The data presented in Table 5 show that the examined goalkeepers, when preventing the creation of goal-scoring situations, most often punched the ball (308 actions with 78% reliability) and caught the ball ($n = 260$, 89%). The surveyed goalkeepers much less frequently applied intercepting/clearing the ball ($n = 99$, 92%), pushing the ball ($n = 59$, 80%), and very rarely consequential doubling ($n = 30$, 80%). On average, in one match, each goalkeeper performed 14 interventions with 84% reliability, more often doing it individually (96%) than in cooperation (4%). Respectively, the above-mentioned actions accounted for 41%, 34%, 13%, 8%, and 4% of all actions against creating goal-scoring situations taken by each goalkeeper in the analyzed matches. The surveyed goalkeepers achieved the highest reliability when catching the ball with falling to the ground in sector A1 (96%) and intercepting/clearing the ball in sector A3 (94%), whereas the lowest reliability was achieved during joint interventions with partners in sectors A2 and A3 (57% and 60%, respectively) and during independent attempts to clear the ball in sector A1 (67%). In total, taking into account all actions against the creation of goal-scoring situations, the places of the most frequent goalkeeper's interventions were sectors in the following order: A1, A2, and A3 (50%, 37% and 13% of all actions, respectively). The examined goalkeepers did not take any actions against the creation of goal-scoring situations in sector B.

Table 6. Characteristics of actions taken by top-level goalkeepers to prevent the creation of goal-scoring situations.

Forms of efficiency of action			Activity				Effectiveness				Reliability [%]				Total number of actions in matches		Average number of actions per match		Reliability [%]	
Mode of action			Pitch zone																	
			A1	A2	A3	B	A1	A2	A3	B	A1	A2	A3	B	A	E	A	E		
Individual	Catching the ball	<i>with falling</i>	72	80	0	0	69	68	0	0	96	85	0	0	152	137	2.81	2.54	90	
		<i>without falling</i>	26	82	0	0	23	71	0	0	88	87	0	0	108	94	2.00	1.74	87	
	Punching	<i>with falling</i>	202	40	0	0	149	33	0	0	74	82	0	0	242	182	4.48	3.37	75	
		<i>without falling</i>	38	28	0	0	35	24	0	0	92	86	0	0	66	59	1.22	1.09	89	
	Pushing	<i>with falling</i>	18	17	0	0	12	15	0	0	67	88	0	0	35	27	0.65	0.50	77	
		<i>without falling</i>	13	11	0	0	10	10	0	0	77	91	0	0	24	20	0.44	0.37	83	
	Intercepting / clearing the ball	<i>with falling</i>	0	9	34	0	0	8	32	0	0	89	94	0	43	40	0.80	0.74	93	
		<i>without falling</i>	0	0	56	0	0	0	51	0	0	0	91	0	56	51	1.04	0.94	91	
	Sum of individual actions in the sector			369	267	90	0	298	229	83	0	-	-	-	-	726	610	13.44	11.30	84

Forms of efficiency of action			Activity				Effectiveness				Reliability [%]				Total number of actions in matches		Average number of actions per match		Reliability [%]
Mode of action			Pitch zone														A	E	
			A1	A2	A3	B	A1	A2	A3	B	A1	A2	A3	B	A	E	A	E	
Cooperation	Consequential doubling	<i>catching the ball</i>	8	5	0	0	8	5	0	0	100	100	0	0	13	13	0.24	0.24	100
		<i>intervention without contact, pushing</i>	5	7	5	0	4	4	3	0	80	57	60	0	17	11	0.31	0.20	65
Total cooperation			13	12	5	0	12	9	3	0	–	–	–	–	30	24	0.73	0.41	73
Total all actions			382	279	95	0	310	238	86	0	–	–	–	–	756	634	14.00	11.74	83

NOTE: A – activity, E – effectiveness; A1 – the goal area, A2 – the penalty area excluding the goal area, A3 – the area from the end line of from the pitch, excluding the penalty area, to the imaginary line of the beginning of zone B, B – the area from 33 m from team's own goal to 33 m in front of the opponent's goal.

4. Discussion

Due to different methodological approaches, the comparative analysis of goalkeepers' performance is very difficult. White et al. [12] and Peterson & Bruton [23] proved that only few of the indicators characterizing goalkeeping play can be compared. The main barrier is the discrepancy in defining particular actions of goalkeepers. Therefore, in this study, an attempt to characterize goalkeepers' efficiency in the game, taking into account a coherent, praxeological methodological interpretation was made. The activity and effectiveness of these players were examined in terms of their objectives of offensive and defensive games.

For decades, the goalkeeper's role has been reduced to saving the goal. A fundamental change in the rules of soccer, the so-called back-pass rule [24] (FIFA 1994, 2002), helped the game to evolve. In the modern game, the goalkeeper already has many more tasks in the offensive game. Previous research [16, 17, 25, 26] showed that the goalkeeper is currently 3–4 times more often involved in offensive actions than in defensive game, and the results presented in this research are in line with this statement. It shows that offensive actions constitute 62% and defensive – 38% of all actions performed in the game by goalkeepers of the top-level teams. Before changing the rules of the game, these proportions were reversed [12].

The examined players most often used actions aimed at positioning the game (gaining the playfield with the ball and keeping possession of the ball) and activities aimed to prevent the loss of a goal, which accounted for 60% (49% and 11%) and 22% of all actions, respectively. Actions creating goal-scoring situations and actions preventing such situations were executed much less frequently. They accounted for 3% and 15% of the goalkeepers' total activity, respectively. Similarly to previous studies [16, 17], actions aimed at scoring goals were not found. The results of our research confirmed earlier observations regarding the structure of goalkeepers' game, i.e., the dominance of positioning activities in attacking and preventing the loss of goals in defending [26].

Our detailed analyses of the elite goalkeepers' offensive game showed that the possession of the ball was dominated by cooperation over individual actions (68% and 32%, respectively), and gaining the playfield with the ball and creating goal-scoring situations were entirely the result of collective actions. Trying to keep possession of the ball, the examined goalkeepers did not take any risky actions. They intercepted and caught the ball almost flawlessly (with 99% reliability), primarily in the penalty area (sector A2). In turn, keeping possession of the ball through a sliding tackle happened much less often; it was of a situational nature and was forced by their partners' imprecisely passing the ball. Nevertheless, they also executed this action with high (92%) reliability in zone A and in zone B with a much lower (69%) reliability.

In gaining the playfield with the ball, passing the ball with a foot from sector A2 dominated, less frequently from sectors A1 and A3. Short passes were much more reliable than those sent to the offensive zone (sectors B and C). On the other hand, passes with a hand (throws) and hitting the ball dropped from the hand (kicks) were used much less frequently. Their reliability was 85%, while in the case of foot passes, especially at short distances, it was almost flawless (98%). This proves the changes in the offensive game taking place in recent years. Modern offensive actions are characterized by making up the game from one's own goal, and the goalkeepers' improving skills of "playing with the foot" only intensify this trend [17, 24–29]. Moreover, Sainz de Baranda et al. [30] proved that 63% of the attacks started by the goalkeeper allowed the team to keep the ball. The results of our analysis confirmed these observations (Table 2).

Despite the fact that in positioning the game from own goal, the principle of avoiding risky interaction with the goalkeeper is still in force, they are more often involved in “making up the game” (receiving and/or dribbling the ball, passing it to partners with the foot), even under the opponent’s pressure in one’s own goal area.

In creating goal-scoring situations, although relatively rarely applied, the surveyed goalkeepers were the most efficient when throwing the ball by hand (86% reliability) and much less when passing the ball with the foot (about 60%). The growing importance of these actions in the modern goalkeeping game has been recognized for many years [31], especially the most effective way of creating scoring situations by throwing the ball with the hand with a side swing [11].

The goalkeepers observed in this study used individual rather than collective actions, both while defending the goal and during preventing the creation of goal-scoring situations (91% and 9%, and 96% and 4%, respectively). The most common methods of preventing the loss of a goal were interventions without contact with the ball (26% of all interventions). The research by Honz & Cepkova [25] showed that also in the case of the best European goalkeepers, participants in UEFA Euro 2016, individual interventions without the ball dominated over interventions with the ball (60% and 44% of the whole individual defensive play). The values in this research are much higher, but here the joint actions of goalkeepers and defenders while defending the goal were also taken into account, and their actions in terms of the objectives of the game were analyzed (separate actions against losing a goal and actions against creating goal-scoring situations). In addition, the goalkeeper’s actions when moving without the ball, settling in the goal, and going into position were not examined (limitations due to the nature of the TV broadcast of the match, in which the attention is focused on the ball and it is impossible to assess actions outside the current frame reliably).

The central zone of the penalty area and the goal area was the place of the goalkeepers’ highest activity while defending the goal, which is also confirmed by previous reports [17, 29, 30, 32, 33]. Sainz de Baranda et al. [17] observed that, on average, a goalkeeper performs 23 defensive technical actions with the ball in a match. The current research shows that goalkeepers perform an average of 33 actions in a match. The difference is significant, but only seemingly, since we also recorded actions without the ball (on average, almost seven such actions in a match). The players examined in this study achieved higher reliability in actions against losing a goal than in preventing the creation of goal-scoring situations (94% and 84%, respectively). This is obvious because, in the latter situations, actions are usually characterized by greater randomness [34]. However, the total 89% reliability of the intervention prove the high soccer competencies of the surveyed players. Previous research [35] showed that goalkeepers of top-level teams achieve over 80% reliability in defending the goal, a higher one for goalkeepers of the winning team than of the losing teams [16, 25, 30].

A further detailed description of defensive actions against losing a goal shows that the surveyed players most often caught the ball (each goalkeeper more than four times in a match) with high 98% reliability. They defended the goal twice less often by pushing the ball, punching, and by 1×1 defense and/or situational defense, and with lower reliability (96%, 84%, and 60%, respectively). Although comparing the activity in these actions with the results of other researchers is difficult (discrepancies in defining individual techniques), it can be noticed that during defending the shot, goalkeepers most often catch the ball without and with falling to the ground, and much less often they punch and push it [17, 36]. They also often intercept or clear the ball [36]. According to Sainz de Baranda et al. [17], of the technical actions performed by goalkeepers, the save was used 41.6%, foot control 27.8%, and the clear out 12.6% of the time. However, as emphasized by Liu et al.

[16] and Spalding [29], these events occur relatively infrequently during a match, although they may be modulated by various contextual factors.

To sum up, when defending, goalkeepers are more often forced to protect the goal than to prevent the creation of goal-scoring situations. In that, they show very high, almost 90% reliability. As a rule, they act independently (over 93%), very rarely interacting with partners. The frequency of applying particular types of action depends on many situational variables, but the most common techniques in defensive play include catching the ball, intercepting/clearing the ball with the foot (foot control), and pushing, punching, and situational defense.

5. Conclusions

When attacking, goalkeepers most often use collective actions aimed to keep possession of the ball and to gain the playfield with the ball, and when defending, individual actions against losing a goal. They achieve the highest reliability in offensive actions in receiving and/or dribbling the ball with the foot, short passes of the ball with the foot, whereas in defensive actions in catching the ball while saving the goal.

The created models mapping the top-skilled goalkeepers' actions allow improving the process of coaching players by referring their game to objective patterns.

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