

Playing Area Dimensions in Soccer

Analysis of Playing Area Dimensions in Spanish Professional Soccer: Extrapolation to the Design of Small-Sided Games With Tactical Applications

Oscar Caro¹, Asier Zubillaga², Luis Fradua¹, Javier Fernandez-Navarro¹

¹Department of Physical Education and Sport, University of Granada, Granada, Spain;

²Department of Physical Education and Sport, UPV/EHU University of the Basque Country, Vitoria-Gasteiz, Spain

Corresponding author:

Javier Fernandez-Navarro

Department of Physical Education and Sport, Faculty of Sport Sciences, University of Granada. Faculty of Sport Sciences. Carretera de Alfacar s/n 18071, Granada, Spain.

Phone: +34 958244370

Fax: +34 958244369

Email: javierfernandez@ugr.es

Playing Area Dimensions in Soccer

1 **Abstract**

2 The aims of this study were to examine: (1) the width and length dimensions of the playing
3 area in 4v4 situations during competition, (2) the influence of the pitch zone where the ball is
4 on 4v4 dimensions, and (3) the influence of match status on the dimensions of 4v4 situations.
5 Data were collected from 25 matches from the Spanish *La Liga* of the 2007–08 season using
6 the Amisco[®] system. Length, width and individual playing area of the rectangle that included
7 the nearest four players to the ball ~~from~~ each team were collected in a total of 8,727 4v4
8 game situations. The pitch-zone and match status were also considered for these 4v4
9 situations. To determine factors that affect 4v4 game situations, one-way ANOVA was used.
10 The influence of the pitch-zone where 4v4 situations took place showed significant
11 differences ($p < 0.001$) between the zones where different principles of the game apply. The
12 areas of the 4v4 situations ranged from $14.70 \pm 4.69 \times 17.18 \pm 6$ m to $17.09 \pm 5.16 \times 20.34 \pm 5.93$
13 m, and the individual playing area of the 4v4 playing rectangle ranged from 46.33 ± 20 to
14 35.48 ± 16.95 m², being larger in the central zones of the pitch. The length of the 4v4 rectangle
15 showed a significant reduction in the closer zones to the goal. Match status ~~did seem~~ not to
16 affect the dimensions of these 4v4 game situations significantly. The findings of this study
17 suggest that the size of 4v4 situations proposed for training should be designed according to
18 the pitch-zone where playing actions take place.

19 **Keywords**

20 match analysis, individual playing area, playing tactics, soccer training, soccer drills

21

22 INTRODUCTION

1
2
3 23 Small-Sided Games (SSGs) are a popular soccer training method applied in team sports due to
4
5 24 their high efficiency (30). The possibility to combine the technical and tactical demands of
6
7 25 competition besides sport-specific conditioning stimulus has caused SSG to increase their
8
9
10 26 popularity in adult and youth soccer (35), and to be analyzed in scientific studies from
11
12 27 different perspectives (1), with 4v4 SSGs one of the most popular ones. However, few studies
13
14 28 have analyzed the tactical implications of SSGs, mainly because of limitations in defining
15
16
17 29 tactical playing behaviors and evaluating them (15). These tactical behaviours related to SSGs
18
19 30 are determined by the constant interaction between team-mates and opponents (10), and by
20
21
22 31 the principles of the game (18) that take place at every moment. A collective analysis of
23
24 32 positional variables about the relative position of the players on the pitch should be made to
25
26
27 33 know the tactical involvement in SSGs (15). Variables considering the position of players
28
29 34 such as covered area or centroids are useful for evaluating tactical behaviors in SSG (17, 36)
30
31
32 35 as they provide measures of players distribution ~~on~~ the pitch. Therefore, including
33
34 36 positional variables in SSG analysis would help to gain insight into their tactical demands.

35
36
37
38
39 38 The work by Folgado, Lemmink, Frencken and Sampaio (15), made a novel proposal about
40
41 39 the consideration of players positioning on the playing space as a tactical variable. The
42
43
44 40 relationship between length and width of each team in the playing space, understood as the
45
46 41 distance between the farthest players in the spatial axis x (length) and y (width) (Figure 1),
47
48
49 42 was considered as the variable of tactical involvement in the SSGs proposed in this study. In
50
51 43 an analysis of a soccer game using scientifically validated match analysis technologies (e.g.
52
53
54 44 Amisco, Prozone, Opta) (4, 12, 28), a rectangle of play with dimensions of length in the *x*-
55
56 45 *axis* and width in the *y-axis* can be formed. This rectangle of play can entail only players
57
58
59 46 directly involved in the action with the ball, especially in situations where possession is

Playing Area Dimensions in Soccer

47 controlled by either of the two teams (16), in accordance to the principle of play of keeping
48 the ball (18). This playing rectangle defines a small playing area within the official pitch,
49 where furthest players away in that selected small group determine the outer limits of the
50 playing area (Figure 1).

51

52 [insert Figure 1 here]

53

54 Location of the ball on the pitch during the game influences tactical behaviors of
55 players (37), while the position of players and distances between them vary depending on the
56 pitch-zone where the ball is (16). Moreover, match status also seems to affect tactical
57 behaviors of players (40). A team winning, drawing, or losing employs different tactics
58 depending on these situations to achieve their aims. Therefore, the location of the ball on
59 the pitch and match status could also influence small playing area game situations during a
60 soccer game.

61 One of the most important aspects attributed to SSGs is that it is a method that allows a
62 specific and transferable preparation for the competition (7, 29). SSGs are considered as
63 optimal tasks used to fulfill the fitness requirements while developing decision-making and
64 technical and tactical performance (1). This approach presents an advantage in comparison
65 with running conditioning drills because players can achieve the conditioning training doing a
66 more specific task. The use of SSGs requires proper understanding of the design variables,
67 especially the size of the playing area, that may determine the achievement of the intended
68 aim. In previous studies, a game situation with a specific size is usually designed and then the
69 physiological, technical or tactical requirements are analyzed. However, the dimensions of the
70 playing area proposed lack a rationale related to the situations of interaction in limited spaces
71 that appear during competition and which may justify even further the value of SSGs. The

Playing Area Dimensions in Soccer

72 spatio-temporal requirement of SSGs designed in training is determined by the available
73 playing space for each player within the total space, defined as *Individual Playing Area* (IPA),
74 and it should be considered as a critical variable for the ~~right~~-appropriate design of SSGs. In
75 previous studies in which 4v4 SSGs were analyzed, the proposed IPA of the playing rectangle
76 was highly variable; between 67 m² (29) and 250 m² (33), with a mean length of 31.7m and a
77 mean width of 25.9 m.

78
79 Changes in the size of the pitch area influence the intensity of SSGs (21). Previous research
80 showed that HR, RPE and blood lactate concentration increased when the pitch area was also
81 increased (31, 35). Similarly, Casamichana and Castellano (5) revealed that the physical and
82 physiological workload was higher when the individual playing area increased in SSGs. Their
83 findings showed an increment in total distance covered; distances covered in low-intensity
84 running, medium-intensity running, and high-intensity running; maximum speed; and sprint
85 frequency when using larger areas with the same number of players. This suggests that
86 increasing the individual playing area in SSGs would be useful to make the SSG more
87 physically demanding. Therefore, the size of the pitch area in SSGs is a variable that coaches
88 and practitioners should consider in soccer training.

89
90 The present study analyzed playing area dimensions of reduced space situations during elite
91 competition involving the nearest four players from each team to the ball to obtain objective
92 information from soccer match play to extrapolate it to training drills. Based on the analysis
93 of competition, the aim is to obtain new knowledge to enable a more specific design of 4v4
94 SSGs about the variable size of the playing area employed, thereby enhancing the overall
95 training process in soccer. Therefore, considering this novel design and approach, the aims of
96 this study were to analyse (1) the width and length dimensions of the playing area besides the

Playing Area Dimensions in Soccer

97 spaces of individual interaction in 4v4 situations generated during competition, (2) the
98 influence of the pitch zone where the ball is on 4v4 dimensions in match play, and (3) the
99 influence of match status on the dimensions of 4v4 situations.

100

101 METHODS

102 Experimental Approach to the Problem

103 Match-play data of the Spanish *La Liga* soccer league were collected from the season 2007-
104 2008. Data sample were collected from 25 matches involving five teams (five matches for
105 each team). The Amisco[®] match analysis system was used to gather the width, length and
106 Individual Playing Area of 8,727 4v4 situations during games. The variables width and length
107 were provided by the match analysis system, and to calculate the Individual Playing Area, the
108 playing area of the 4v4 situation (width x length) in m² was divided by the eight players
109 involved. The position of the ball was also recorded according to the 6 different areas of the
110 pitch done by the match analysis system to analyze its influence on the dimensions of the 4v4
111 situations. Zone 1 corresponded to the zone closer to the own goal and zone 6 corresponded to
112 the zone closer to the opposite goal. Match status, considering 5 different levels (losing by 2
113 goals or more, losing by 1 goal, drawing, winning by one goal, and winning by 2 goals or
114 more) was also recorded in order to analyze the effect on the dimensions of the 4v4 match-
115 play situations.

117 Subjects

118 Twenty-five Spanish matches from the Spanish *La Liga* involving five different teams were
119 monitored during the 2007–08 season using a multiple-camera match analysis system
120 (Amisco Pro[®], version 1.0.2, Nice, France). ~~Length and width of the rectangle that included~~
121 ~~the nearest four players to the ball of each team were obtained from collected data using the~~

Playing Area Dimensions in Soccer

122 ~~Animation Mode of the Amisco[®] semi-computerized match analysis system.~~ Ethics approval
1 123 for all experimental procedures was granted by the Human Research Ethics Committee from
2
3
4 124 the local university. Written permission from the company Amisco[®] was obtained prior to the
5
6
7 125 start of the study.
8
9

10 126

11 127 **Procedures**

12 128 The movements of all 22 players were observed during the entire duration of the match using
13
14 129 eight synchronised cameras located in the stadium (sampling frequency 25 Hz). Previous
15
16
17 130 research proved that the Amisco[®] system provides reliable and valid data (32), and other
18
19
20 131 studies have employed this technology to investigate physical (6) and tactical aspects in
21
22
23 132 soccer (14, 24, 34).
24
25

26 133

27
28
29 134 For data collection, a total of 8,727 4v4 game situations were recorded. We considered the
30
31 135 4v4 playing area rectangle as the area formed by the nearest four players of each team to the
32
33
34 136 ball. Players on the periphery of the selected area defined the limits of the rectangle (Figure
35
36 137 1). The cases where the nearests players to the ball did not allow an equal distribution of 4
37
38
39 138 players per team (e.g. a fifth player from one team included in the selected area to obtain the
40
41 139 fourth player of the opposite team) were not considered for data collection. The 4v4 playing
42
43
44 140 area was selected by observers according to previous criteria, and then length and width
45
46 141 measurements of these areas were retrieved from the software. The 4v4 situations were
47
48
49 142 registered every 5 seconds throughout the game, only including the 4v4 situations where the
50
51 143 players were in possession of the ball in open play. The individual playing area of SSGs can
52
53 144 be calculated by dividing the pitch size by the number of participating players (5, 20). In the
54
55
56 145 present study, the individual playing area in 4v4 situations was determined by dividing the
57
58 146 area of the rectangle that included an interaction between 4 players of each team by 8 (the
59
60
61
62
63
64
65

Playing Area Dimensions in Soccer

147 total number of players involved). The referred rectangle was defined as the one composed by
148 two horizontal lines parallel to the touchlines and two vertical lines parallel to the goal lines
149 (Figure 1). The pitch zone was recorded for each 4v4 game situation. Depending on the
150 position of the ball, the collected data corresponded to one of the 6 zones in which Amisco®
151 divides the pitch (Figure 2). The team in possession of the ball determined the playing pitch
152 zone. Zone 1 was the nearest zone to the goal of the team with the ball, and zone 6 was the
153 nearest zone to the opponent's goal. To evaluate the reliability of the observation process,
154 four matches were double checked, obtaining acceptable levels for Kappa index ($k > .96$) and
155 intraclass correlation ($ICC > .98$) for the following variables: the position of the ball, length
156 and width. The latter two corresponding to the 4v4 situations.

157

158 [insert Figure 2 here]

159

160 For the variable match status, it was divided into five levels, taking the home team as a
161 reference when the 4v4 game situation was registered; winning by one goal (+1), winning by
162 two goals or more (+2), drawing (0), losing by one goal (-1), and losing by two goals or more
163 (-2).

164

165 We conducted a pilot study prior to the data collection procedure and based on its results we
166 decided to use data collected every five seconds and only when the ball was in play. This
167 procedure was deemed adequate considering our study aims as well as the feasibility of the
168 whole procedure. To exclude the influence of set plays on players' positions, we decided to
169 use the data collected from five seconds after the set play was taken and only at the moments
170 where one team had the possession of the ball under control. Duels, long pass, kick off, throw

Playing Area Dimensions in Soccer

171 in, goal kick, free kick, corner kick and penalty kick were all considered as set plays and were
172 not considered for the record.

173

174 **Statistical Analyses**

175 A one-way analysis of variance (ANOVA) was used to compare differences in the individual
176 playing area, length, and width of 4v4 game situations according to the six pitch zones and the
177 five match status levels. Data are presented as means and standard deviations, and
178 corresponding 95% confidence intervals were also calculated. When significant effects were
179 found, Games-Howell post-hoc comparisons were applied between individual pairs of pitch
180 zones and match status levels. The effect size was calculated using eta squared (η^2). An eta
181 squared effect size of $\eta^2 = 0.01$ was considered a small effect size, an effect size of $\eta^2 = 0.06$
182 was considered a medium effect size, while $\eta^2 = 0.14$ was considered a large effect size (8).
183 All statistical analyses were carried out using IBM SPSS Statistics 19.0 for Windows, and
184 alpha levels were set at $p < 0.05$ for ANOVAs and $p < 0.01$ for the post-hoc comparisons.

185

186 **RESULTS**

187 Position of the ball proved to have a significant small effect on width ($F = 73.26, p < .001, \eta^2$
188 $= 0.040, 90\% \text{ CI } [0.033, 0.047]$), length ($F = 31.58, p < .001, \eta^2 = 0.018, 90\% \text{ CI}$
189 $[0.013, 0.022]$) and Individual Playing Area ($F = 60.91, p < .001, \eta^2 = 0.034, 90\% \text{ CI}$
190 $[0.027, 0.040]$) of the 4v4 game situations. Match status seemed to have a statistically
191 significant but trivial effect on width ($F = 5.06, p < .001, \eta^2 = 0.002, 90\% \text{ CI } [0.001, 0.004]$),
192 length ($F = 3.50, p < .01, \eta^2 = 0.002, 90\% \text{ CI } [<0.001, 0.003]$) and Individual Playing Area (F
193 $= 5.58, p < .001, \eta^2 = 0.003, 90\% \text{ CI } [0.001, 0.004]$) of the 4v4 game situations.

194 The IPA in 4v4 game situations during competition presented significant differences
195 depending on the pitch zone where the action took place, except between zone 1 with zones 5

Playing Area Dimensions in Soccer

196 and 6, zone 5 with zone 6, and zone 2 to zone 3 (Table 1). The statistical similarity appears in
 197 those zones of the pitch with similar tactical objectives.

198
 199 The IPA values obtained varied from 46.33, SD = 20 m² to 35.48, SD = 16.95 m² (Table 1).

200 The IPA was greatest in the central pitch zones (2, 3 and 4) and significantly reduced ~~on~~ the
 201 pitch zones closest to the goals (1, 5 and 6). The action in zone 1 showed the smallest IPA
 202 value (35.48, SD = 16.95 m²), increasing in zone 2 (p<0.001) and reaching its highest value in
 203 zone 3 (46.33, SD = 20 m²), although the differences between the IPA in zones 2 and 3 were
 204 not statistically significant. The IPA in zone 4 decreased as the action was approaching the
 205 opponent's goal, and the IPA decreased again significantly (p<0.001) in zones 5 and 6 with
 206 smaller values than in the central zones of the pitch (p<0.001).

207

208 [insert Table 1 here]

209

210 Width was greater than length in all the areas of the playing rectangle determined in 4v4 game
 211 situations (Figure 3). The length of the playing rectangle showed the smallest values in zones
 212 1 and 6, being greater in zones 2, 3 and 4 (p<0.001). No significant differences appeared
 213 between zones close to the goals (1, 5 and 6) or between zones 2 and 3. In these central zones,
 214 the playing area was also greater in width, reaching the highest value in zone 3 (20.34, SD =
 215 5.93 m²).

216

217 [insert Figure 3 here]

218

Playing Area Dimensions in Soccer

219 The differences in length and width and the IPA values in relation to the five match status
 220 levels considered were not significant in any case, except between the 4v4 game situations
 221 registered in which the home team is drawing in comparison with moments in which the same
 222 team is losing for one goal of difference (Table 2). The IPA was greatest when the home team
 223 was losing for one goal of difference (44.30, SD = 21.06 m²). The greatest value of length
 224 (19.5, SD = 6.11 m) during the game situation with this match status could determine this
 225 high value of the IPA. The lowest value of the IPA (41.45, SD = 19.15 m²), maybe also
 226 determined by the lowest length value of the playing rectangle, appeared with a match status
 227 in which the home team was winning by two goals or more (+2).

228

229 [insert Table 2 here]

230

231 DISCUSSION

232 The aims of the present study were to analyse the width and length dimensions of the playing
 233 area ~~besides~~and the spaces of individual interaction in 4v4 game situations during
 234 competition, as well as the influence of the pitch zone where the ball is on 4v4 dimensions in
 235 match play and the influence of match status on the dimensions of 4v4 situations. Among the
 236 main findings of this study it should be noted that the mean dimensions of the playing area in
 237 4v4 situations during competition were 16.34, SD = 5.11 m long, 19.08, SD = 5.98 m wide,
 238 and 42.38, SD = 19.71 m² for the IPA. These results were lower in comparison with other
 239 studies in which the IPA of the 4v4 SSGs were, for example, 94 m² (22), 187 m² (27), or even
 240 250 m² (23). These results showed considerably smaller areas in comparison with the
 241 dimensions proposed so far in previous works that have analyzed and justified the use of 4v4
 242 SSGs as a training method in soccer (9, 11, 13, 19, 20, 22, 26, 27, 29, 31, 33). The use of
 243 these 4v4 match play situations in training would improve more specifically the technical-

Playing Area Dimensions in Soccer

244 tactical demands. However, a complete conditioning training would not be achieved by only
1
2 245 using SSGs in training. Coaches and practitioners should also implement Large Sided Games
3
4 246 or other running drills to cover the physical demands typical of soccer.
5
6

7 247
8
9 248 To the best of our knowledge, this is the first study that analyzed elite soccer match-play to
10
11 249 adapt playing area dimensions of SSGs during training. The work by Owen, Twist and Ford
12
13 250 (29) gives the smallest value of IPA proposed so far regarding 4v4 games (62,5 m²), which is
14
15 251 still much greater than the value of 42.38 m² obtained from this study. Therefore, it seems that
16
17 252 playing space available for players in 4v4 situations during competition is smaller than the
18
19 253 ones suggested for SSG training drills. These smaller distances to the opponents will
20
21 254 influence technical and tactical behaviours associated with the decision-making process (2).
22
23 255 Time and space available for playing actions seem to be more limited in situations of reduced
24
25 256 interaction than appear in competition, increasing the difficulty in developing a satisfactory
26
27 257 move.
28
29
30
31
32

33 258
34
35 259 The results also showed that the 4v4 playing area size during competition was wider than
36
37 260 longer in all zones of the pitch. According to the studies reviewed, most of them suggested a
38
39 261 SSGs size longer than wider, except the studies by Fradua, Zubillaga, Caro, Fernandez-
40
41 262 Garcia, Ruiz-Ruiz and Tenga (16) and Rampinini, Impellizzeri, Castagna, Abt, Chamari,
42
43 263 Sassi and Marcora (31). The present study used data from official match-play that showed
44
45 264 that playing space in 4v4 situations is wider than longer. Previous research did not have any
46
47 265 reference of 4v4 playing areas in competition. Therefore, this is a possible reason why the
48
49 266 vast majority of studies used SSGs sizes resembling the soccer pitch proportions (i.e. longer
50
51 267 than wider).
52
53
54
55
56
57

58 268
59
60
61
62
63
64
65

Playing Area Dimensions in Soccer

269 SSGs are considered a valuable training method due to the specific preparation of players and
1
2
3 270 the high transfer of acquired learning to competition (29). However, we believe that a proper
4
5 271 choice of playing area size is important for the success of this training method (38). Reducing
6
7 272 the size of the playing area, as well as keeping the length-width ratio and justification of the
8
9 273 dimensions based on conditional or technical training objectives, do not seem to generate
10
11 274 SSGs representative of real competition situations. In addition, neither the proportional size
12
13 275 reduction from overall game situations as argued in the study by Fradua, Zubillaga, Caro,
14
15 276 Fernandez-Garcia, Ruiz-Ruiz and Tenga (16) seems to generate representative SSGs. To our
16
17 277 knowledge, this mentioned work is the only one with a similar approach to the objectives of
18
19 278 this study; the design of more specific SSGs based on prior analysis of competition. The
20
21 279 Amisco[®] system can analyze playing area size in 10v10 situations, considering the
22
23 280 rectangular area of the pitch which includes all players from both teams, excluding
24
25 281 goalkeepers. The study by Fradua, Zubillaga, Caro, Fernandez-Garcia, Ruiz-Ruiz and Tenga
26
27 282 (16) proposed a proportional extrapolation of the dimensions obtained in this global 10v10
28
29 283 situation to design specific SSGs related to real game situations, taking as reference the mean
30
31 284 value of the IPA proposed for 10v10 situations in the study (84.1 m²). However, specific
32
33 285 analysis of 4v4 situations measured in this study showed a smaller mean value of the IPA
34
35 286 (42.38 m²), probably due to the focus of attention that the ball generates that cause
36
37 287 concentration of players around it. We also consider, according to the results of this study,
38
39 288 that it is essential to change the orientation of the playing rectangle in SSGs so that the area is
40
41 289 greater in width than length.
42
43
44
45
46
47
48
49
50

51 290
52
53 291 Another major finding ~~of this study~~ was the significant differences between playing area
54
55 292 dimensions depending on the zone where the action took place. The tactical objectives for
56
57 293 each zone (3) and the principles of play associated with them (18) seem to affect the
58
59
60
61
62
63
64
65

Playing Area Dimensions in Soccer

294 characteristics of the game situations. For instance, as the action gets closer to the goals (zone
1
2 295 1 and 6), dimensions of playing areas decrease. Decisive actions may occur in these zones
3
4 296 that result in scoring or preventing a goal. Playing areas with a larger length facilitate
5
6
7 297 attackers' actions (38). Therefore, defenders seek to hinder the action of the player with the
8
9
10 298 ball through a reduction of interpersonal distance; and therefore, time to execute the action,
11
12 299 that moreover prevents opponents from maintaining ball possession or produce shots on goal.
13
14 300 Furthermore, ~~the study by Vilar et al.~~ (39) stated that when defending team players reduced
15
16
17 301 the distances with respect to the player with the ball, the attacking team-mates also tend to get
18
19 302 closer to the player with the ball to facilitate passing options that will enable the team to keep
20
21
22 303 possession of the ball. As a result of these collective movements towards the ball holder,
23
24 304 playing area dimensions of the primary game situations are reduced. These tactical behaviors
25
26 305 characteristic of being near the goals may justify the reduced values obtained, especially in
27
28
29 306 relation to the length of the rectangle generated in 4v4 situations recorded during competition.
30
31 307 The intention of attacking players to reach the opposite goal and the central zones that allow
32
33
34 308 shots may determine that significantly smaller widths appear in zones 1, 5 and 6 in
35
36 309 comparison with the central areas of the pitch.

39 310
40
41 311 The results obtained in central zones of the pitch could also be associated with the tactical
42
43 312 behaviors of players in relation to momentary positional variables, which may explain the
44
45
46 313 greatest dimensions of 4v4 game situations in central zones. A possible reason for the highest
47
48 314 length value in zone 3 could be the increase of the distance between players when the
49
50
51 315 defending team retreats. The retreat of the defending team that usually happens during
52
53 316 matches increases the distance between players, which could generate the highest length value
54
55
56 317 in zone 3 of all those obtained although the width of the playing rectangle was still higher.
57
58 318 The work by Vilar et al. (39) confirmed that although the distance of individual interaction
59
60

Playing Area Dimensions in Soccer

1 319 between the player with the ball and the nearest defender is reduced, the furthest defenders
2 320 from the player with the ball tend to move backwards to put themselves in advantageous
3
4 321 defensive positions to defend the player with the ball if he overcomes the nearest defender.

5
6
7 322 We believe that these movements may also be associated with the aim of occupying a larger
8
9 323 amount of space on the pitch, limiting possibilities for the attacking team to progress through
10
11 324 long passes.

12
13 325
14
15
16 326 It should be noted that in all zones of the pitch, especially in central zones, the reduced
17
18 327 playing rectangle is larger in width than in length. Usual tactical behaviours and players
19
20 328 positioning in offensive phases of the game may account for these results. It could be
21
22 329 considered that when the team intends to advance towards scoring areas, it is usually
23
24 330 necessary to overcome the position of defenders. This progression through the defensive lines
25
26 331 is generally complex. At the moments when defenders reduce the distance to the player with
27
28 332 the ball, the movements by his attacking team-mates to help him to keep the ball (39) can be
29
30 333 considered as supportive movements that allow safer play in width (*y-axis* of the playing
31
32 334 space). Especially in central zones of the pitch, one of the most important principles of the
33
34 335 game is keeping the ball. The retreat of the farthest defenders from the ball and these tactical
35
36 336 behaviours that generate greater security for the player with the ball to pass could explain why
37
38 337 the greatest dimensions of 4v4 situations arose in central zones of the pitch.

39
40 338
41
42 339 Previous studies showed influences of match status in tactical, technical and physical aspects
43
44 340 in soccer (22, 25). According to the results of this study, the position of players and
45
46 341 dimensions of the playing rectangle registered were not significantly affected by match status.
47
48 342 Differences appeared only between scores 0 and -1. However, the dimensions of the playing
49
50 343 rectangle created when the team was losing for one goal could be associated with the frequent
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

Playing Area Dimensions in Soccer

344 tactical behaviors of forward movements to reach the opposite goal, therefore increasing the
 345 distance between the players. It could be the reason for the highest value of the playing
 346 rectangle dimensions in which the nearest eight players (4v4) to the ball are involved and can
 347 be considered a research objective in futures studies.

348
 349 This study presents some limitations. Although the Amisco® match analysis system has been
 350 proved to provide valid and reliable data (32), it only considers the official soccer pitch
 351 measurements. It is possible that the size of 4v4 situations varies in larger or smaller pitches.
 352 We are aware of the need to adapt SSGs playing area dimensions according to the age and
 353 level of soccer players in a team (38). Another limitation of the study could be that data was
 354 collected only from a specific elite level and should be considered with caution. Sizes for 4v4
 355 situations could be different for lower level and youth players. Therefore, the sizes proposed
 356 for 4v4 situations should be adapted by coaches and practitioners according to the level and
 357 age of players. However, the results of this study can be used as a reference for the design and
 358 development of new research with similar approaches.

360 PRACTICAL APPLICATIONS

361 ~~The results of this study show that new approaches should be made for the design of 4v4~~
 362 ~~SSGs when aiming at a specific preparation for elite players. The Our~~ results suggested that
 363 coaches and practitioners of elite level teams should use smaller area sizes ~~inof~~ 4v4 SSGs for
 364 soccer training in comparison with the sizes proposed in previous studies. Moreover, these
 365 playing areas should be wider than longer to recreate the match-play conditions. Sizes from
 366 around 15 m long x 17 m wide to 17 m long x 20 m wide are the ones advised for training 4v4
 367 match-play situations. It would also be recommended to use bigger sizes of that range for
 368 training 4v4 situations concerning the central areas of the pitch, and smaller sizes for areas

Playing Area Dimensions in Soccer

369 close to the goals. A reduction of the IPA will result in less space and time available for the
 1
 2 370 task, preparing for the decision-making process and optimal technical execution for the game.
 3
 4 371 Moreover, it is necessary to adapt training drills according to different tactical requirements of
 5
 6
 7 372 each pitch-zone. Practical applications of the present findings from elite soccer analysis can
 8
 9
 10 373 increase the specificity of SSGs, improving their relationship with the real game, and thereby
 11
 12 374 allowing a player preparation through the most appropriate and effective training.
 13
 14
 15
 16
 17

REFERENCES

- 21 375 1. Aguiar M, Botelho G, Lago C, Macas V, and Sampaio J. A Review on the Effects of Soccer
 22
 23 376 Small-Sided Games. *J Hum Kinet* 33: 103-113, 2012.
- 24
 25
 26 377 2. Aguiar M, Goncalves B, Botelho G, Lemmink K, and Sampaio J. Footballers' movement
 27
 28 378 behaviour during 2-, 3-, 4- and 5-a-side small-sided games. *J Sport Sci* 33: 1259-1266, 2015.
- 29
 30 379 3. Bangsbo J and Peitersen B. *Soccer Systems and Strategies*. Champaign, IL: Human Kinetics,
 31
 32 380 2000.
- 33
 34
 35 381 4. Bradley P, O'Donoghue P, Wooster B, and Tordoff P. The reliability of ProZone
 36
 37 382 MatchViewer: a video-based technical performance analysis system. *Int J Perf Anal Spor* 7: 117-129,
 38
 39 383 2007.
- 40
 41
 42 384 5. Casamichana D and Castellano J. Time-motion, heart rate, perceptual and motor behaviour
 43
 44 385 demands in small-sides soccer games: Effects of pitch size. *J Sport Sci* 28: 1615-1623, 2010.
- 45
 46 386 6. Castellano J, Alvarez-Pastor D, and Bradley PS. Evaluation of Research Using Computerised
 47
 48 387 Tracking Systems (Amisco (R) and Prozone (R)) to Analyse Physical Performance in Elite Soccer: A
 49
 50 388 Systematic Review. *Sports Med* 44: 701-712, 2014.
- 51
 52
 53 389 7. Clemente FM, Martins FML, and Mendes RS. Periodization Based on Small-Sided Soccer
 54
 55 390 Games: Theoretical Considerations. *Strength Cond J* 36: 34-43, 2014.
- 56
 57 391 8. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NY: Lawrence
 58
 59 392 Erlbaum Associates, 1988.

Playing Area Dimensions in Soccer

- 393 9. Coutts AJ, Rampinini E, Marcora SM, Castagna C, and Impellizzeri FM. Heart rate and blood
 1 lactate correlates of perceived exertion during small-sided soccer games. *J Sci Med Sport* 12: 79-84,
 2 394
 3
 4 395 2009.
 5
- 6 396 10. Davids K, Araujo D, and Shuttleworth R. Applications of Dynamical Systems Theory to
 7
 8 397 Football, in: *Science and Football V*. T Reilly, J Cabri, D Araujo, eds. London: Routledge, 2005, pp
 9
 10 398 537-550.
 11
- 12
 13 399 11. Dellal A, Chamari K, Pintus A, Girard O, Cotte T, and Keller D. Heart Rate Responses During
 14
 15 400 Small-Sided Games and Short Intermittent Running Training in Elite Soccer Players: A Comparative
 16
 17 401 Study. *J Strength Cond Res* 22: 1449-1457, 2008.
 18
- 19 402 12. Di Salvo V, Collins A, McNeill B, and Cardinale M. Validation of Prozone : A new video-
 20
 21 403 based performance analysis system. *Int J Perf Anal Spor* 6: 108-119, 2006.
 22
 23
- 24 404 13. Fanchini M, Azzalin A, Castagna C, Schena F, McCall A, and Impellizzeri FM. Effect of Bout
 25
 26 405 Duration on Exercise Intensity and Technical Performance of Small-Sided Games in Soccer. *J*
 27
 28 406 *Strength Cond Res* 25: 453-458, 2011.
 29
 30
- 31 407 14. Fernandez-Navarro J, Fradua L, Zubillaga A, Ford PR, and McRobert AP. Attacking and
 32
 33 408 defensive styles of play in soccer: analysis of Spanish and English elite teams. *J Sport Sci* 34: 2195-
 34
 35 409 2204, 2016.
 36
 37
- 38 410 15. Folgado H, Lemmink KAPM, Frencken W, and Sampaio J. Length, width and centroid
 39
 40 411 distance as measures of teams tactical performance in youth football. *Eur J Sport Sci* 14: S487-S492,
 41
 42 412 2014.
 43
- 44 413 16. Fradua L, Zubillaga A, Caro O, Fernandez-Garcia AI, Ruiz-Ruiz C, and Tenga A. Designing
 45
 46 414 small-sided games for training tactical aspects in soccer: Extrapolating pitch sizes from full-size
 47
 48 415 professional matches. *J Sport Sci* 31: 573-581, 2013.
 49
 50
- 51 416 17. Frencken W, Lemmink K, Delleman N, and Visscher C. Oscillations of centroid position and
 52
 53 417 surface area of soccer teams in small-sided games. *Eur J Sport Sci* 11: 215-223, 2011.
 54
- 55 418 18. Grehaigne JF and Godbout P. Tactical Knowledge in Team Sports From a Constructivist and
 56
 57 419 Cognitivist Perspective. *Quest* 47: 490-505, 1995.
 58
 59
 60
 61
 62
 63
 64
 65

Playing Area Dimensions in Soccer

- 420 19. Hill-Haas S, Coutts AJ, Rowsell G, and Dawson B. Variability of acute physiological
1 responses and performance profiles of youth soccer players in small-sided games. *J Sci Med Sport* 11:
2 421 487-490, 2008.
3
4 422
5
6 423 20. Hill-Haas S, Dawson B, Coutts AJ, and Rowsell G. Physiological responses and time-motion
7 characteristics of various small-sided soccer games in youth players. *J Sport Sci* 27: 1-8, 2009.
8 424
9
10 425 21. Hill-Haas S, Dawson B, Impellizzeri FM, and Coutts AJ. Physiology of Small-Sided Games
11 Training in Football A Systematic Review. *Sports Med* 41: 199-220, 2011.
12 426
13
14 427 22. Jones S and Drust B. Physiological and technical demands of 4 v 4 and 8 v 8 games in elite
15 youth soccer players. *Kinesiology* 39: 150-156, 2007.
16 428
17
18 429 23. Kelly DM and Drust B. The effect of pitch dimensions on heart rate responses and technical
19 demands of small-sided soccer games in elite players. *J Sci Med Sport* 12: 475-479, 2009.
20 430
21
22 431 24. Lago-Ballesteros J, Lago-Peñas C, and Rey E. The effect of playing tactics and situational
23 variables on achieving score-box possessions in a professional soccer team. *J Sport Sci* 30: 1455-1461,
24 432 2012.
25
26 433
27
28 434 25. Lago C and Martin R. Determinants of possession of the ball in soccer. *J Sport Sci* 25: 969-
29 974, 2007.
30 435
31
32 436 26. Little T and Williams AG. Suitability of Soccer Training Drills for Endurance Training. *J*
33 *Strength Cond Res* 20: 316-319, 2006.
34 437
35
36 438 27. Little T and Williams AG. Measures of Exercise Intensity During Soccer Training Drills With
37 Professional Soccer Players. *J Strength Cond Res* 21: 367-371, 2007.
38 439
39
40 440 28. Liu H, Hopkins W, Gomez MA, and Molinuevo JS. Inter-operator reliability of live football
41 match statistics from OPTA Sportsdata. *Int J Perf Anal Spor* 13: 803-821, 2013.
42 441
43
44 442 29. Owen A, Twist C, and Ford P. Small-sided games: the physiological and technical effect of
45 altering pitch size and player numbers. *Insight* 7: 50-53, 2004.
46 443
47
48 444 30. Owen AL, Wong DP, McKenna M, and Dellal A. Heart Rate Responses and Technical
49 Comparison Between Small- vs. Large-Sided Games in Elite Professional Soccer. *J Strength Cond Res*
50 25: 2104-2110, 2011.
51 445
52
53 446
54
55
56
57
58
59
60
61
62
63
64
65

Playing Area Dimensions in Soccer

- 447 31. Rampinini E, Impellizzeri FM, Castagna C, Abt G, Chamari K, Sassi A, and Marcora SM.
1
2 448 Factors influencing physiological responses to small-sided soccer games. *J Sport Sci* 25: 659-666,
3
4 449 2007.
5
6 450 32. Randers MB, Mujika I, Hewitt A, Santisteban JM, Bischoff R, Solano R, Zubillaga A, Peltola
7
8 451 E, Krustup P, and Mohr M. Application of four different football match analysis systems: A
9
10 452 comparative study. *J Sport Sci* 28: 171-182, 2010.
11
12 453 33. Safania AM, Alizadeh R, and Nourshahi M. A comparison of small-side games and interval
13
14 454 training on same selected physical fitness factors in amateur soccer players. *Journal of Social Sciences*
15
16 455 7: 349, 2011.
17
18 456 34. Santos P, Lago-Peñas C, and Garcia-Garcia O. The influence of situational variables on
19
20 457 defensive positioning in professional soccer. *Int J Perf Anal Spor* 17: 212-219, 2017.
21
22 458 35. Sarmento H, Clemente FM, Harper LD, da Costa IT, Owen A, and Figueiredo AJ. Small sided
23
24 459 games in soccer - a systematic review. *Int J Perf Anal Spor* 18: 693-749, 2018.
25
26 460 36. Silva P, Duarte R, Sampaio J, Aguiar P, Davids K, Araujo D, and Garganta J. Field dimension
27
28 461 and skill level constrain team tactical behaviours in small-sided and conditioned games in football. *J*
29
30 462 *Sport Sci* 32: 1888-1896, 2014.
31
32 463 37. Tenga A, Zubillaga A, Caro O, and Fradua L. Explorative Study on Patterns of Game
33
34 464 Structure in Male and Female Matches from Elite Spanish Soccer. *Int J Perf Anal Spor* 15: 411-423,
35
36 465 2015.
37
38 466 38. Vilar L, Duarte R, Silva P, Chow JY, and Davids K. The influence of pitch dimensions on
39
40 467 performance during small-sided and conditioned soccer games. *J Sport Sci* 32: 1751-1759, 2014.
41
42 468 39. Vilar L, Esteves PT, Travassos B, Passos P, Lago-Peñas C, and Davids K. Varying Numbers
43
44 469 of Players in Small-Sided Soccer Games Modifies Action Opportunities During Training. *Int J Sports*
45
46 470 *Sci Sci Coach* 9: 1007-1018, 2014.
47
48 471 40. Vogelbein M, Nopp S, and Hokelmann A. Defensive transition in soccer - are prompt
49
50 472 possession regains a measure of success? A quantitative analysis of German Fussball-Bundesliga
51
52 473 2010/2011. *J Sport Sci* 32: 1076-1083, 2014.
53
54
55
56
57
58
59
60
61
62
63
64
65

Playing Area Dimensions in Soccer

1
2 Figure 1. The playing area involving four players from each team closest to the ball at the
3 time of possession of a controlled ball. Length (x-axis) and width (y-axis) dimensions in
4 meters generated using the Amisco[®] system.
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

Playing Area Dimensions in Soccer

Figure 2. Pitch Zones by Amisco Pro®

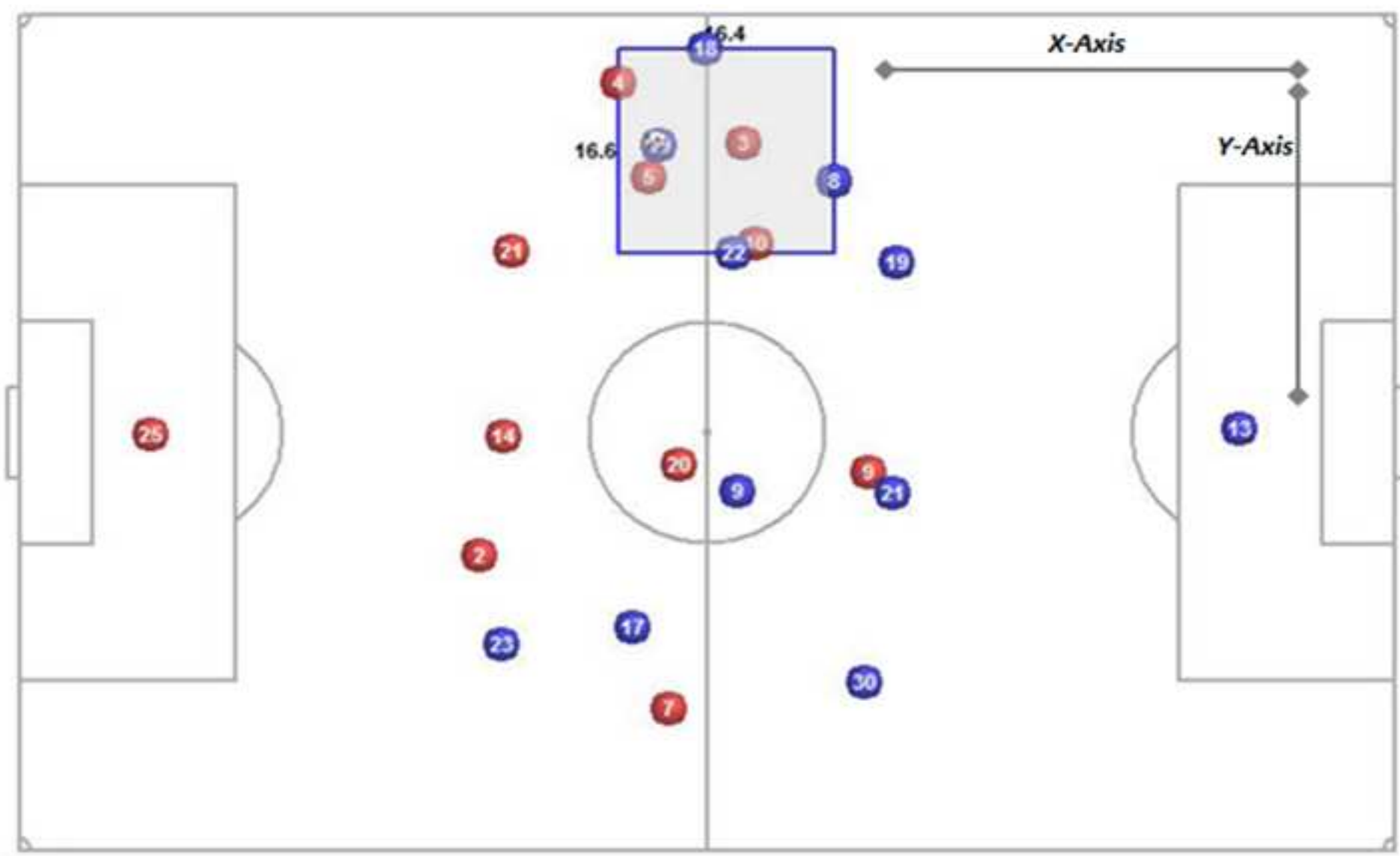
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

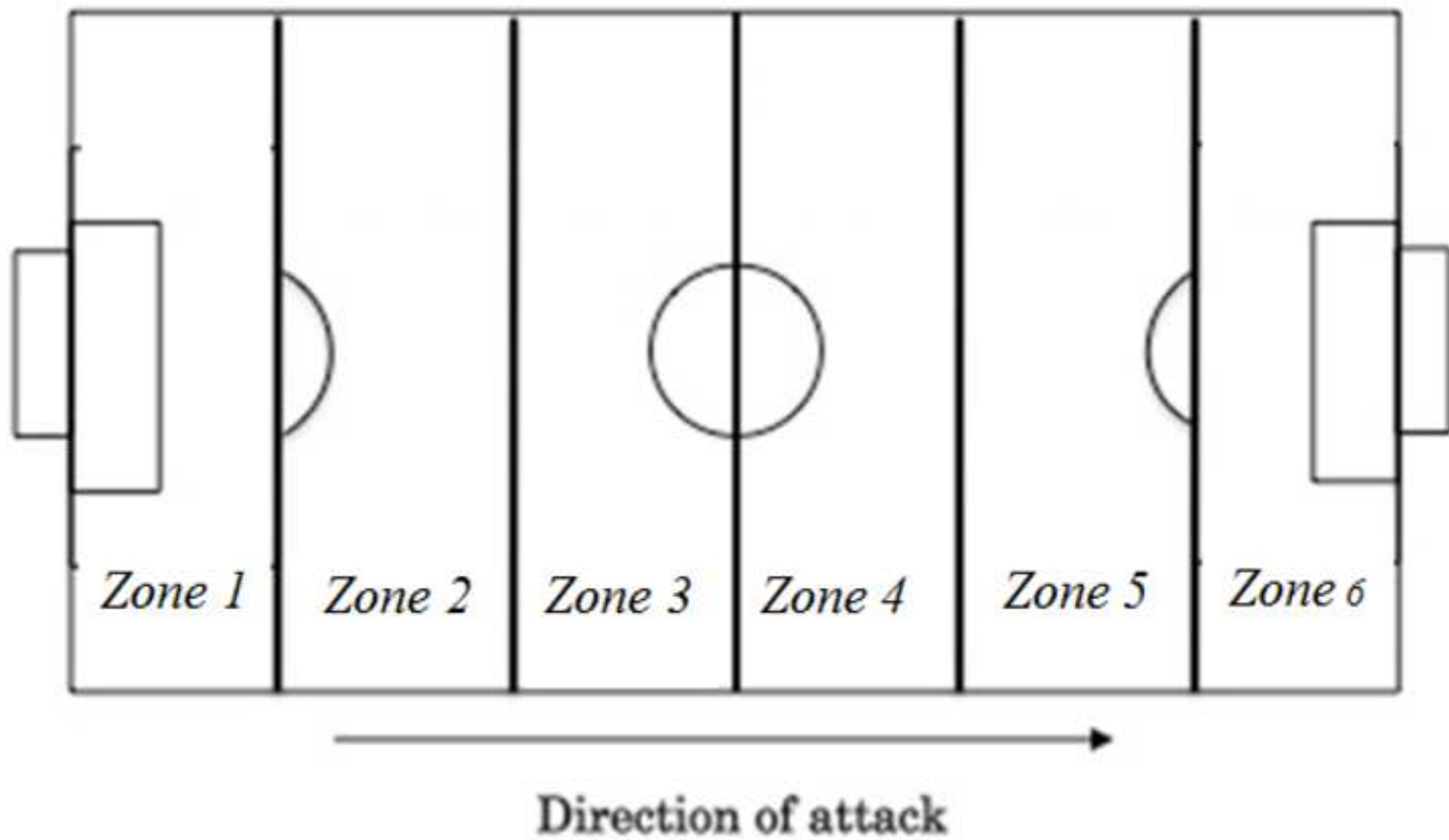
Playing Area Dimensions in Soccer

Figure 3. Length and width of the rectangle covering the nearest eight players to the ball (m) and individual playing area (m²) for different positions of the ball on the pitch.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

Figure 1





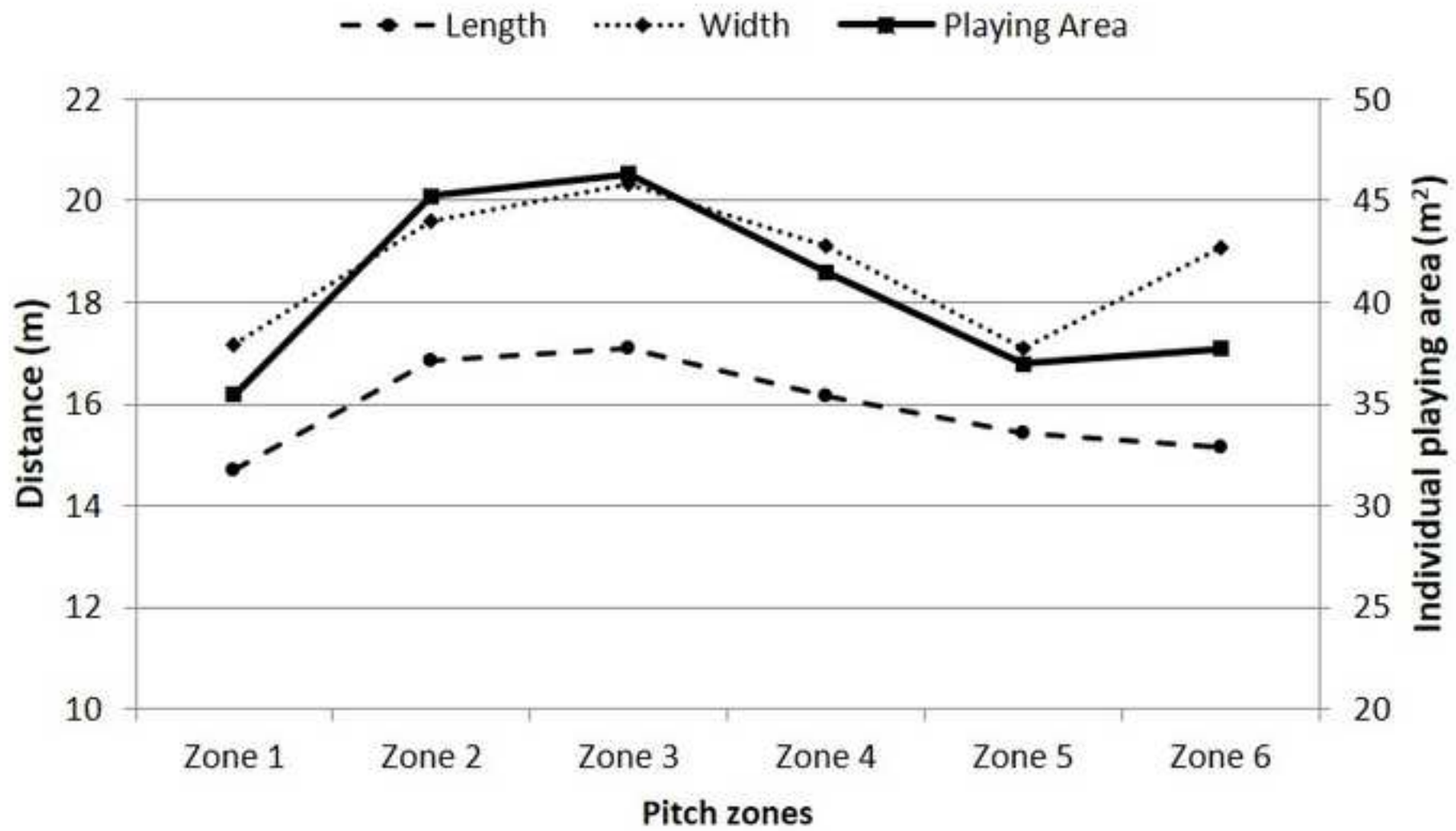


Table 1. Individual playing area (m²), length and width (m) of the rectangle covering the nearest eight players to the ball (four from each team), according to the six zones indicating the position of the ball on the pitch (mean \pm SD).

Position of the ball	Individual playing area (95% CI)	Length (95% CI)	Width (95% CI)
η^2	0.034	0.018	0.040
Zone 1	35.48 \pm 16.95 (32.52, 38.45)	14.70 \pm 4.69 (13.89, 15.53)	17.18 \pm 6.00 (16.14, 18.24)
Zone 2	45.24 \pm 22.12 (43.94, 46.55)	16.85 \pm 5.35 (16.54, 17.17)	19.59 \pm 6.25 (19.23, 19.97)
Zone 3	46.33 \pm 20* (45.58, 47.08)	17.09 \pm 5.16* (16.90, 17.29)	20.34 \pm 5.93 (20.13, 20.57)
Zone 4	41.49 \pm 17.77 (40.83, 42.15)	16.17 \pm 4.74 (16.00, 16.36)	19.12 \pm 5.57 (18.92, 19.34)
Zone 5	37 \pm 19.32 [†] (36.07, 37.94)	15.43 \pm 5.23 [†] (15.18, 15.69)	17.11 \pm 5.93 [†] (16.83, 17.40)
Zone 6	37.71 \pm 19.28 ^{†‡} (35.67, 39.76)	15.16 \pm 5.28 ^{†‡} (14.60, 15.72)	19.08 \pm 5.98 ^{†‡} (16.64, 17.90)

Note: Zone 1 is the nearest to the goal of the team in possession while Zone 6 is the nearest to the opponent's goal. There were differences ($P < 0.01$ or $P < 0.001$) between all positions of the ball, except:

* No difference to Zone 2; [†] No difference to Zone 1; [‡] No difference to Zone 5.

Table 2. Individual playing area (m²), length and width (m) of the rectangle covering the nearest eight players to the ball (4 from each team), according to the five levels of momentary score considered (mean \pm SD).

Match Status	Individual playing area (95% CI)	Length (95% CI)	Width (95% CI)
η^2	0.003	0.002	0.002
Home team losing by two goals or more (-2)	42.47 \pm 20.12 (40.67, 44.27)	16.11 \pm 5.19 (15.65, 16.58)	19.16 \pm 6.4 (18.59, 19.73)
Home team losing by one goal (-1)	44.30 \pm 21.06* (43.24, 45.38)	16.7 \pm 5.22* (16.44, 16.97)	19.5 \pm 6.11* (19.19, 19.81)
Drawing (0)	41.61 \pm 19.24 (41.03, 42.20)	16.17 \pm 5.07 (16.02, 16.33)	18.95 \pm 5.91 (18.77, 19.13)
Home team winning by one goal (+1)	42.73 \pm 19.62 (41.88, 43.58)	16.45 \pm 5.06 (16.23, 16.67)	19.23 \pm 5.97 (18.98, 19.49)
Home team winning by two goals or more (+2)	41.45 \pm 19.15 (39.75, 43.15)	16.48 \pm 5.2 (16.02, 16.94)	18.25 \pm 5.82 (17.73, 18.77)

Note: Home team were considered to analyse the influence of momentary match score. No difference appears, except: * Differences in IPA, length and width between -1 and 0 ($p < 0.05$).