

# KINEMATIC DEMANDS OF TWO SMALL-SIDED GAMES OF COSTA RICAN COLLEGE SOCCER PLAYERS<sup>1</sup>

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**Summary:** The purpose of this paper was to compare two small-sided games kinematics of Costa Rican college soccer players. Two SSG (2x10min, 3min rest in between), C1 (600m<sup>2</sup>) and C2 (1200m<sup>2</sup>), where played by 14 college soccer players of Costa Rica. Global Positioning System was used to measure kinematic and physiological variables in both conditions. A mixed ANOVA was used, results suggested C1 and C2 were statistically different in speed (C1 < C2), distance (C1 < C2) and heart rate (C1 > C2). When analyzing the distance covered by speed category; low, moderate and high running actions; results suggest, C2 had higher intensities compared to C1. This research confirms the findings of previous studies on the effectiveness of SSG to simulate real game conditions in short periods of time. Conclusions: C2 had higher intensities compared to C1 game with lower physiological demand. Likewise, the C2 resembles more accurately matches in official conditions of Costa Rican players.

**Keywords:** Global Positioning Systems (GPS), youth, sports, speed, distance.

## Introduction

Soccer is probably the most popular sport in the world, with millions of active players globally. As explained by Jones and Drust (2007), soccer performance is a result of the player's physiological capabilities, psychological and social factors, and technical and tactical skills. Today, this game demands high intensity, in order to execute a dynamic and

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fast performance (Safania, Alizadeh & Nourshahi, 2011). The demands required in this sport, where high intensity efforts are interspersed with periods of low intensity load (Romero & Fernandez, 2015), require professional field staff to improve their methodologies during training, with the aim of achieving physiological adaptations and performance required by changes in the gameplay dynamics.

Due to the great influence of this discipline, technology has become an essential tool for improving the quality and efficiency of the game. Recent advances to technology resources allow maintaining best controls on training, and get more rigorous and accurate planning and prescription of training loads (Barbero, Vera, & Castagna, 2006; Casamichana & Castellano, 2010).

Currently, technology such as heart rate monitors, lactate analyzers, Global Positioning System (GPS), respiratory rate monitors, remote monitoring thermometers, video analysis, among other devices have facilitated measurements, assessments and monitoring of physiological demands in sport like soccer (Barbero, Barbero, Gomez & Castagna, 2009; Casamichana & Castellano, 2010; Hill-Haas, Dawson, Impellizzeri & Coutts, 2011). These devices allow better control of the training and performance of the players, whether during practice or in official games.

Daneshjoo, Halim, Rahnama and Yusof (2013) and Stolen, Chamari, Castagna and Wisloff (2005) mention that these technological advances allow detecting changes such as variation in game intensity more accurately, in soccer various intermittent actions of high intensity and short duration and aerobic base exercises are combined, causing an impact on the morphological and mechanical lower limb muscles characteristics, such as increased stiffness and muscle tone (Kubo, Kanehisa, Ito & Fukunaga, 2001).

In soccer, the small sided games (SSG) are used as a method to achieve high intensities simulating an official game's characteristics (Aguilar, Botelho, Lago, Macas, & Sampaio, 2012; Casamichana, Castellano, González, García & García, 2011; Katis & Kellis, 2009; Safania, Alizadeh & Nourshahi, 2011). This training activity is an adaptation of the real game situation applied in practice, varying the dimensions of the playing field, reducing the number of players participating and modifying official rules, such as the participation of the goalkeeper and duration of physical work (Casamichana & Castellano, 2010; Casamichana & Castellano, 2011; Dellal et al., 2012; Hill-Haas, et al., 2011; Jones &

Drust, 2007; Katis & Kellis, 2009; Safania, Alizadeh & Nourshahi, 2011). SSG are a simpler but highly effective and efficient method; the results of studies suggest that this methodology increases the player's physiological capabilities significantly. Mainly, it seeks to translate the complexity of the game situation at training sessions, through a holistic improvement, where beyond the physical and technical and tactical advances, you must use a fast and efficient decision-making (Dellal et al., 2012).

The use of GPS has been incorporated to control training sessions to quantify the physical and physiological loads that a physical exercise causes, through variables such as heart rate, average speed, impacts and total distance covered by a player, allowing daily, weekly or even full-season volume quantification, for groups and individuals, in real time (Gómez, Pallarés, Diaz & Bradley, 2013).

Due to the necessity for soccer trainers and coaches to control the intensity of training and competition, it is essential to conduct studies focused on determinate the intensity variations depending on pitch dimensions. The purpose of this study was to compare two small-sided games kinematics of Costa Rican college soccer players.

## **Methodology**

### *Participants*

A total of 14 male players (age  $20.9 \pm 1.92$  years, weight  $69.6 \pm 7.3$  kg, height  $172 \text{ cm} \pm 6.3$ ) participated. These players were training 3 to 4 times per week and were competing regularly, at least once a week belonging to a college soccer team of Costa Rica, who were in preparation for the 2015 inter-university knockout phase.

All subjects were informed of the details of the experimental procedures and the associated risks and discomforts. Each subject gave written informed consent according to the criteria of the Declaration of Helsinki regarding biomedical research involving human subjects (18th Medical Assembly, 1964; revised 2013 in Fortaleza).

## *Instruments*

Body weight measurement was performed using a digital scale (sensitivity  $\pm 0.1$  kg) (Elite Series BC554, Tanita-Ironman, Illinois, United States) and to know the height of the players a wall stadiometer was used.

To measure kinematic variables as speed and distance, a Global Positioning System (GPS) (SP PRO X II GPSports®, 15Hz, Canberra, Australia) was used. The validity and reliability of 15 Hz GPS devices have been demonstrated by Barbero et al. (2009). According to the authors this equipment has a high speed and sprint tests correlation values ( $r^2 = .87, p < .001$ ;  $r^2 = .94, p < .001$ ). Likewise, the cumulative maximum speed and the maximum speed reached recorded a low coefficient of variation (CV = 1.7% and 1.2% respectively). In turn, Johnston, Watsford, Kelly, Pine and Spurs. (2014) report acceptable reliability through a temporary test (test, re-test,  $r = .75$ ). This instrument was used to quantify the variables: average of distance in meter covered per min (m/min), average heart rate (beats/min) and average speed (km/h). Team AMS®, V2.5.4 (GPSports, Canberra, Australia) software was used for information analysis.

To perform the analysis of the information collected by GPS, the distance covered (m) were categorized by intensity of motion according to Di Salvo et al. (2007) in: *standing-jogging* (0-11 km/h), % *low intensity running* (11.1-14 km/h), % *moderate intensity running* (14.1-19 km/h) and % *high intensity running* (19.1-23 km/h).

## *Procedures*

An information session with participants and informed consent sign was made. Weight and height were measured for each participant.

Two different SSG conditions were measured on consecutive days, 24 hours apart, and were performed before normal training (7:00 am) and with activation/warm up 10 minutes prior to C1 and C2. Condition 1 (C1) had dimensions of 20x30 meters (600m<sup>2</sup> total pitch area – 42.86m<sup>2</sup> area per player [APP]) and condition 2 (C2) had 30x40 meters (1200m<sup>2</sup> total pitch area – 85.1m<sup>2</sup> APP). Both sessions were held on the same pitch (natural turf), with the same players (7vs7, two teams randomly selected and maintained in both conditions), same balls and same total playing time (2x10 min, with 3 minutes' rest and hydration). Goal lines were 3 meters wide, there weren't goalkeepers, and there were two

balls on each side of the field to maintain the dynamic of the game reducing breaks. The players were asked not perform strenuous exercise at least 24 hours prior to performing both conditions.

### Statistical analysis

Results are expressed as means  $\pm$  standard deviation (SD). Data were tested for normal distribution using the Shapiro-Wilk test. Data of heart rate, distance, speed and % distance covered at standing-jogging, low, moderate and high running intensities was subjected to a 2 (condition) x 2 (period) mixed model ANOVA with an alpha set prior at  $p < .05$ . The magnitudes of the differences for all variables were analysed using the omega partial squared ( $\omega_p^2$ ) for ANOVA analysis and qualitatively categorized as follow  $\omega_p^2 = .15$  *high* effect,  $\omega_p^2 = .06$  *moderate* effect and  $\omega_p^2 = .01$  as *small* effect (Cohen, 1977), this analysis was implemented because  $\omega_p^2$  is not affected by small size samples (Moncada, Solera & Salazar, 2002). The data analysis was performed using Statistical Package for the Social Sciences (SPSS, IBM, SPSS Statistics, V 22.0 Chicago, IL, USA).

## Results

**Table 1.**

Descriptive statistics of the variables distance, speed and heart rate by period and condition.

Variable	Period	C1 (600 m <sup>2</sup> )	C2 (1200 m <sup>2</sup> )
Distance (m/min)	First	107.4 $\pm$ 8.3	115.7 $\pm$ 7.4
	Second	105.9 $\pm$ 9	116.3 $\pm$ 10.5
Speed (km/h)	First	6.4 $\pm$ .5	6.9 $\pm$ .4
	Second	6.4 $\pm$ .5	7 $\pm$ .6
Heart Rate (bpm)	First	163.3 $\pm$ 9.2	152.1 $\pm$ 11.3
	Second	166 $\pm$ 10.2	155.1 $\pm$ 18.6

The 2x2 mixed model ANOVA showed no statistically significant interaction (condition vs period) in distance,  $F(1, 13): .366, p = .551, \omega_p^2 = 0$  (*low*). Nevertheless, there were significant main effect by condition  $F(1, 13) = 11.833, p = .002, \omega_p^2 = 0.27$  (*high*), been C2

higher than C1 in distance, there were no significant difference in main analysis by period  $F(1, 13): .068, p = .796, \omega_p^2 = 0$  (low).

ANOVA showed no statistically significant interaction (condition vs period) in speed,  $F(1, 13): .380, p = .543, \omega_p^2 = 0$  (low). Nevertheless, there was a significant main effect by condition  $F(1,13) = 11.833, p = .002, \omega_p^2 = 0.27$  (high), being C2 higher than C1 in speed, there were no significant difference in main analysis by period  $F(1, 13): .026, p = .872, \omega_p^2 = 0$  (low).

Results showed no statistically significant interaction (condition vs period) in heart rate,  $F(1,13): .009, p = .924, \omega_p^2 = 0$  (low). Nevertheless, there was a significant main effect by condition  $F(1,13) = 6.048, p = .021, \omega_p^2 = .15$  (high), being C1 higher than C2 in heart rate, there were no significant difference in main analysis by period  $F(1, 13): .2418, p = .132, \omega_p^2 = .04$  (low).

**Table 2.**

Descriptive statistics of the distance covered (m) by intensity in period and condition.

Variable	Period	C1 (600 m <sup>2</sup> )	C2 (1200 m <sup>2</sup> )
Standing-Jogging (m)	First	848 ± 47.5	816.2 ± 65.3
	Second	826.5 ± 56.5	819 ± 64.68
Low intensity (m)	First	152.1 ± 38.5	198 ± 24.6
	Second	145.6 ± 32.9	193.6 ± 50.1
Moderate intensity (m)	First	70.4 ± 28.7	121.9 ± 42.4
	Second	75.6 ± 14.6	121.4 ± 50.2
High intensity (m)	First	3.9 ± 5	17.9 ± 14.4
	Second	9.7 ± 9.2	23.9 ± 25.9

The 2x2 mixed model ANOVA for distance covered based in intensity, showed no statistically interaction in *standing-jogging*,  $F(1, 26): .313, p = .581, \omega_p^2 = 0$  (low); *low intensity*,  $F(1, 26): .015, p = .904, \omega_p^2 = 0$  (low); *moderate intensity*,  $F(1, 26): .537, p = .470, \omega_p^2 = 0$  (low); *high intensity*,  $F(1,26): .052, p = .822, \omega_p^2 = 0$  (low). The main effects analysis by condition of this kinematic variables indicated that there were significant differences in:

*standing-jogging*,  $F(1,26)= 23.639$ ,  $p= .000$ ,  $\omega_p^2= .45$  (*high*); *low intensity*,  $F(1,26)= 7.009$ ,  $p= .014$ ,  $\omega_p^2= .18$  (*high*); *moderate intensity*,  $F(1,26)= 15.82$ ,  $p= .000$ ,  $\omega_p^2= .35$  (*high*); and in *high intensity*,  $F(1,26)= 13.871$ ,  $p= .001$ ,  $\omega_p^2= .31$  (*high*). The main effects analysis by period of the distance covered based in intensity indicated there were no significant differences in: *standing-jogging*,  $F(1,26)= 1.469$ ,  $p= .236$ ,  $\omega_p^2= .02$  (*low*); *low intensity*,  $F(1,26)= .387$ ,  $p= .539$ ,  $\omega_p^2= -.02$  (*low*); *moderate intensity*,  $F(1,26)= .09$ ,  $p= .766$ ,  $\omega_p^2= -.03$  (*low*); and in *high intensity*,  $F(1,26)= 2.888$ ,  $p= .101$ ,  $\omega_p^2= .06$  (*moderate*).

## Discussion

It is known that at present training methodologies have favored high-intensity work in conditions as close as possible to the competition. Small-sided games have come to meet these intensity requirements (Romero & Fernández, 2014). Because there are multiple interactions, the analysis is made based on the space in square meters each player has to run the game (Febré et al., 2015).

Age, height and weight of the participants in this study are similar to others, e.g.: Castellano, Fernández, Castillo, and Casamichana (2010) with a sample of university young players ( $20.1 \pm 1.2$  years, height  $176.3 \pm 9.9$  cm; weight  $63.5 \pm 8.4$  kg) and Vargas, Urkiza, and Gil (2015) who studied the behavior of different variables in players with similar anthropometric data ( $20.9 \pm 1.7$  years;  $1.80 \pm 0.05$  cm;  $73.1 \pm 5.3$  kg) during the performance of SSG in training and matches.

The results of this study showed that an increase of pitch dimensions leads to more demanding physical conditions, for example by comparing C1 with C2, the latter has significantly greater differences than C1 in first and second period's distance covered. The results of meters covered per minute in C1 and C2 are similar to those obtained by other studies of SSG under similar conditions to the current study (Casamichana, San Roman-Quintana, Castellano & Calleja-González, 2012, Casamichana & Castellano, 2010, Casamichana, Castellano & Hernández-Mendo, 2014, Hill-Haas, Rowsell, Dawson & Coutts, 2009, Rampinini, et al., 2007).

As for mean speed, there were significant differences between C1 and C2, in the first period and second period, being C2 significantly greater than C1. Previous studies mention that as they increase the dimensions of the pitch, the kinematic requirements

(average speed and distance) increase proportionally (Casamichana et al., 2012; Dellal et al., 2012; Nevado-Garrosa & Suarez-Arrones, 2015; Rampinini et al., 2007).

Results of this study suggest differences significantly higher in speed categories by condition, C2 being higher in all categories except in *standing-jogging*. This means, that there was higher intensity actions in C2. This is clear when observing the significant differences between C1 conditions and C2 not only in low intensity categories but in those that require high intensity and sprints, similar to previously reported by Nevado-Garrosa and Suarez-Arrones (2015), Casamichana, San Roman-Quintana, Castellano and Calleja-Gonzalez, (2013) and Dellal et al., (2012).

Analyzing the effectiveness of SSG to simulate real game conditions on Costa Ricans soccer players, it is stated that both the C1 and C2 simulate the kinematics and heart rate demands of official matches reported prior in a study with a sample of Brazilian players (Barros, et al., 2007) and Costa Rican players (Gutiérrez-Vargas et al., 2015), and analyses of the players from the South Africa World Cup in 2010 (Clemente, et al., 2013). Thus, the percentage distribution of distance covered by speed-intensity was similar to these prior studies made in 11 vs. 11 conditions (Barros et al., 2007, Gutiérrez-Vargas et al., 2015), which indicate that the higher percentage distance in official pitch dimension is executed at standing-jogging speed.

As for the physiological data, significantly higher differences in C1 compared to C2 were obtained, similar to those reported by Casamichana, et al. (2014) and Casamichana, Castellano, Gonzáles-García, and García (2011). These results are in disagreement with those mentioned by Kelly and Drust (2009) who indicated that heart rate did not vary significantly when running SSG in different pitch dimensions (600m<sup>2</sup>, 1200m<sup>2</sup> and 2500m<sup>2</sup>). According to Allen, Butterfley, Welsh, and Wood (1998) mean heart rate in a smaller pitch is higher because there is greater participation of players in the activity compared with larger pitch dimensions. Febré et al. (2015) noted that heart rate was significantly lower when playing in a smaller APP (90m<sup>2</sup>) than when playing in a larger one (150m<sup>2</sup> per player), contrary to the present study, where the smaller APP (42.86 m<sup>2</sup>) resulted in a higher average heart rate than the larger APP (85.71m<sup>2</sup>).

These results, related to kinematic variables behavior in SSG are relevant because of the extended use of this kind of training methods for soccer teams in Costa Rica and



worldwide, providing more information to coaches and staff of what kind of variables they got to change to obtain higher or lower responses in speed, distance or heart rate.

This study confirms the findings of previous studies on the effectiveness of SSG to simulate real game conditions in short periods of time. The results indicated C2 had higher intensities compared to C1 game with lower physiological demand. Likewise, the C2 resembles more accurately matches in official conditions of Costa Rican players.

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