

Physical Performance Differences Between Starter and Non-Starter Players During Professional Soccer Friendly Matches

by

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The aim of this study was to investigate the physical performance differences between players that started (i.e. starters, ≥ 65 minutes played) and those that were substituted into (i.e. non-starter) soccer friendly matches. Fourteen professional players (age: 23.2 ± 2.7 years, body height: 178 ± 6 cm, body mass: 73.2 ± 6.9 kg) took part in this study. Twenty, physical performance-related match variables (e.g. distance covered at different intensities, accelerations and decelerations, player load, maximal running speed, exertion index, work-to-rest ratio and rating of perceived exertion) were collected during two matches. Results were analysed using effect sizes (ES) and magnitude based inferences. Compared to starters, non-starters covered greater match distance within the following intensity categories: $>3.3 \leq 4.2$ m/s (very likely), $>4.2 \leq 5$ m/s (likely) and $>5 \leq 6.9$ m/s (likely). In contrast, similar match average acceleration and deceleration values were identified for starters and non-starters (trivial). Indicators of workloads including player loads (very likely), the exertion index (very likely), and the work-to-rest ratio (very likely) were greater, while self-reported ratings of perceived exertion were lower (likely) for non-starters compared to starters. The current study demonstrates that substantial physical performance differences during friendly soccer matches exist between starters and non-starters. Identification of these differences enables coaches and analysts to potentially prescribe optimal training loads and microcycles based upon player's match starting status.

Key words: acceleration, competition, measurement, performance, team sport.

Introduction

Soccer is a team sport played at different competitive levels (e.g. junior, senior, amateur and professional) with an emphasis on intermittent movements including brief bouts of high-intensity exercise and longer periods of low-intensity exercise (Rampinini et al., 2007a, b). Soccer players require a high level of aerobic fitness in order to generate and maintain power output during repeated high-intensity efforts (Van Winckel et al., 2014; Holdys et al. 2013; Karpowicz et al. 2018). The ability to recover between bouts of high intensity activity and subsequently, repeating these efforts has been reported as a critical physical ability of modern-

day soccer players (Gabbett and Mulvey, 2008). Consequently, the physical preparation of elite soccer players has become an important component of professional training to deal with the increasing energy demands of match play (Carling et al., 2008; Iaia et al., 2009).

The physical preparation of elite soccer players for match-play has been well described with elite players reported to cover approximately 9.1 km during a match including 1-3 km at a high intensity (Bradley et al., 2009; Di Salvo et al. 2009). A large number of studies have reported on the specific energetic and physical performance demands of elite soccer players, including the effects of positional variation, using time motion

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analysis (Bradley et al., 2009; Di Salvo et al., 2009; Rampinini et al., 2007). For example, central midfielders were reported to cover more total distance than any other positions with the wide midfielders and fullbacks also displaying superior high-intensity efforts during a match (Bradley et al., 2009; Di Salvo et al., 2009; Rampinini et al., 2007). In contrast, attacking forwards and central defenders consistently exhibited poorer physical performance during matches (Bradley et al., 2009). These results clearly demonstrated the importance of training specificity for different playing positions within a team and the need for specialist players to maximize team success. Typically, this specialization is focused upon when formulating a team of players that start and compete for the majority of a match (i.e. starters). However, during official matches the players are substituted due to injury or as a strategy to enhance success. These players (i.e., non-starters) may possess different physical abilities and match skills that reflect unique demands of playing roles within the team. For example, Bradley et al. (2014) studied physical performance differences between starter and non-starter players in the English Premier League. Those authors demonstrated that high intensity running distance (m/min) was greater for non-starter compared to starter players (9.1 ± 3.6 and 8.2 ± 2.3 m/min, respectively).

However, these comparisons were undertaken without consideration of playing time with non-starters engaging in a substantially smaller amount of match time compared to starters. Hence, this prior comparison may be skewed by the different match time for each player role. To date, there has been limited research that analysed the match physical performance demands of soccer players according to their primary team role (starter or non-starter). Examination of these roles over the same time-period during official matches (90 minutes) may highlight the key characteristics of each player role to enable coaches to utilise these contributions optimally for competition and success (Bradley et al., 2014). Furthermore, differences between starters and non-starters may highlight potential weaknesses for coaches that need to be addressed in team preparation and the selection of players for the starting team to maximise success. Therefore, the aim of this study was to document the match, physical performance

demands between starter and non-starter professional soccer players.

Methods

Participants

Fourteen players (age 23.2 ± 2.7 years, body height 177.9 ± 6.1 cm, body mass: 73.2 ± 6.9 kg, body fat $12.6 \pm 2\%$, training experience 14 ± 5 years, playing experience at Division 3 ± 1 years) within the same team and professional club participated in this study. Participants were fully informed of any risks and discomforts associated with the study before providing their informed written consent to participate. The study was approved by the professional soccer club and the local Polytechnic University of Madrid Ethics Committee in accordance with the latest version of the Declaration of Helsinki.

Experimental design

Each player participated in two friendly matches consisting of 11 players per side under the same environmental conditions ($16 \pm 1^\circ\text{C}$; $87 \pm 5\%$ relative humidity). Matches were separated by 1 week and played during the second round of the 2014 competition. The matches were played at the home training venue of the club that housed a regular artificial turf soccer field (90 x 60 m). For both matches, participants were allocated to separate teams according to their habitual outfield position and coaches' recommendation for playing status (i.e. starter or non-starter). For each match, there were 9 starters and 3 non-starters (all played 90 minutes of the matches) examined in the current study resulting in a total of 18 and 6 sets for starters and non-starters, respectively. To obtain a homogeneous sample, only the players who played regularly in official league matches ($n = 14$ players) were considered for the study with categorisation of player role based upon their match playing time during the season (i.e., the inclusion criterion for starter players was those who played more than 65 minutes per match during the regular season, whereas non-starter players did not participate or played less than 65 minutes per match during the regular season). The decision to select starter and non-starter players during the experimental friendly matches was random and independent of the head coach to ensure minimal bias. The sample was considered as a valid elite group given their professional experience and current playing

competition with the number of players examined similar to that reported in other studies of physical demands in elite soccer players (Halouani et al., 2017; Vilar et al., 2014).

All matches followed the official FIFA rules with the team's coaches officiating the match. During each match, players wore their competition clothes and carried a GPS device inserted into a small harness (Catapult Innovations, Melbourne, Australia) attached to their back to record match demands. Participants were allowed to consume fluids *ad libitum* during rest periods of the matches. To minimize the influence of hydration status on performance, and to avoid dehydration (Convertino et al., 1996), all participants were advised to maintain their normal pre-match diet with a greater focus being placed on high intake of water and carbohydrate (i.e. 50-60% of total energy intake) (Kirkendall, 1993).

Experimental protocol

At 10:00, participants arrived at their habitual training stadium and prepared for the matches by positioning the GPS units under their competition clothes. All participants then performed a standardized 20-min warm-up consisting of general movement patterns, specific movement patterns with a ball, and specific movement patterns without a ball, as previously described (Zois et al., 2011). Matches then commenced with the GPS units continuously monitoring participants as previously reported (Boyd et al., 2011; Castellano et al., 2011; Varley et al., 2012). Within 5 minutes of match completion, participants individually self-rated their perception of exertion (RPE) using a 1 to 10 point, visual analogue scale (Foster et al., 2001).

The day before each match, participants were instructed to avoid caffeine-containing products and the technical staff programmed a low-intensity, low-volume recovery session. The player's diet was standardized for the 24 hours before the matches while compliance was verified by self-reported diaries. On the day of each match, participants arrived at their habitual training facility and body mass (± 0.05 kg) and body height (± 0.1 cm) were measured (Seca 285, Germany). The body fat percentage was estimated by using segmental bioimpedance scales (BC-418, Tanita, Japan) in line with standardised procedures for this measurement. Participants

then completed the standardized warm-up followed by the match. In order to minimise stoppage time, several balls were placed around the pitch area for immediate access by players. Additionally, there were two assistant coaches positioned outside the playing area to provide encouragement and support for continuous play. The two assistant coaches monitored the timing and rule compliance (referees) for each match.

During each match, the movement patterns and time-motion characteristics (i.e. match performance demands) of players were monitored by calibrated GPS devices (Catapult Innovations, Melbourne, Australia) that operated at a sampling frequency of 10 Hz. The players utilised the same GPS unit for each match to avoid any variability amongst GPS devices. This GPS technology has been previously validated and reported to be reliable for monitoring movements and activities of different intensities for soccer players (Boyd et al., 2011; Castellano et al., 2011; Varley et al., 2012). Similarly to previous studies (Casamichana et al., 2014; Castellano et al., 2013; Krustrup et al., 2009), the total running distance was examined across six zones of increasing speed: walking (≤ 2.2 m/s), jogging ($>2.2 \leq 3.3$ m/s), low speed running ($>3.3 \leq 4.2$ m/s), moderate speed running ($>4.2 \leq 5.0$ m/s), high speed running ($>5.0 \leq 6.9$ m/s) and sprint speed running (>6.9 m/s). The accelerations and decelerations of player movements were also measured within ± 2 m/s² intervals (Minetti et al., 2013; Osgnach et al., 2010). The work to rest ratio was calculated as the distance covered by the player at a displacement speed >2.2 m/s (period of work) divided by the distance covered at a speed of 0 to 2.2 m/s (period of recovery). All match recordings from the GPS units were analyzed based upon an *a priori* importance for performance in soccer such as player and ball movements, interaction of players, and involved elements of speed, time and space (location) (Randers et al., 2010). All data analyses were performed with the manufacturer's dedicated software package (Team AMS software V R1.2011.6). All GPS data were downloaded using commercial GPS software (Catapult Sprint, version 5.0.9.2; Firmware 6.75) and transferred to a statistical software package (IBM SPSS Statistics for Windows, v20; SPSS Inc, Chicago, IL, USA) for further analysis.

Statistical analysis

Data were initially tested and confirmed for normal distribution using the Shapiro-Wilk test ($p > 0.05$) and expressed as mean \pm SD, unless otherwise stated. The match performance demands (i.e. time-motion characteristics) between groups were examined using magnitude-based inferences with standardized mean differences and their respective 90% confidence intervals (CI) reported (Hopkins, 2006). Magnitude-based inferences were assessed by examining the smallest worthwhile difference, calculated as 0.2 times the between-subject standard deviation. Differences were defined as unclear if the confidence intervals for the difference in the means included substantial positive and negative values simultaneously (Hopkins et al., 2009). The magnitude of clear differences was assessed qualitatively as follows: $<0.25\%$, *trivial*; $0.25-75\%$ *possibly*, $75-95\%$ *likely*, $95-99\%$ *very likely*, and $>99\%$ *most likely* (Hopkins, 2007; Maszczyk et al., 2014, 2016). Effect sizes (ES, standardized Cohen's d) for between group comparisons were also determined using the following criteria: ≤ 0.2 as trivial; ≤ 0.6 as small; ≤ 1.2 as moderate; ≤ 2.0 as large; > 2.0 as very large (Hopkins et al., 2009).

Results

Table 1 shows the match performance demands for starters and non-starters during matches. Non-starters *likely* to *very likely* covered more distance than starter players at running speeds of $>3.3 \leq 4.2$ m/s, $>4.2 \leq 5$ m/s, and $>5 \leq 6.9$ m/s (Table 1) with small to large ES (Figure 1). In contrast, measures of acceleration and deceleration were similar between starter and non-starter players with trivial differences (Table 1) and trivial to moderate ES (Figure 1).

For workload indicators, non-starters exhibited *very likely* greater values for player loads, the exertion index and the work to rest ratio (Table 1) compared to starters with moderate to large ES (Figure 1). Conversely, the starter players exhibited *likely* greater self-reported RPE values than non-starters (Table 1) with a moderate ES (Figure 1).

Discussion

The aim of this study was to document the match performance demands between starter and non-starter professional soccer players. The

current findings demonstrated that non-starter players covered greater distances at 3.3-6.9 m/s, presented greater player loads, the exertion index and the work to rest ratio, and lower self-reported RPE values compared to starters. Collectively, these results highlight the unique match performance demands between different player roles that should be considered by coaches for team preparation and selection.

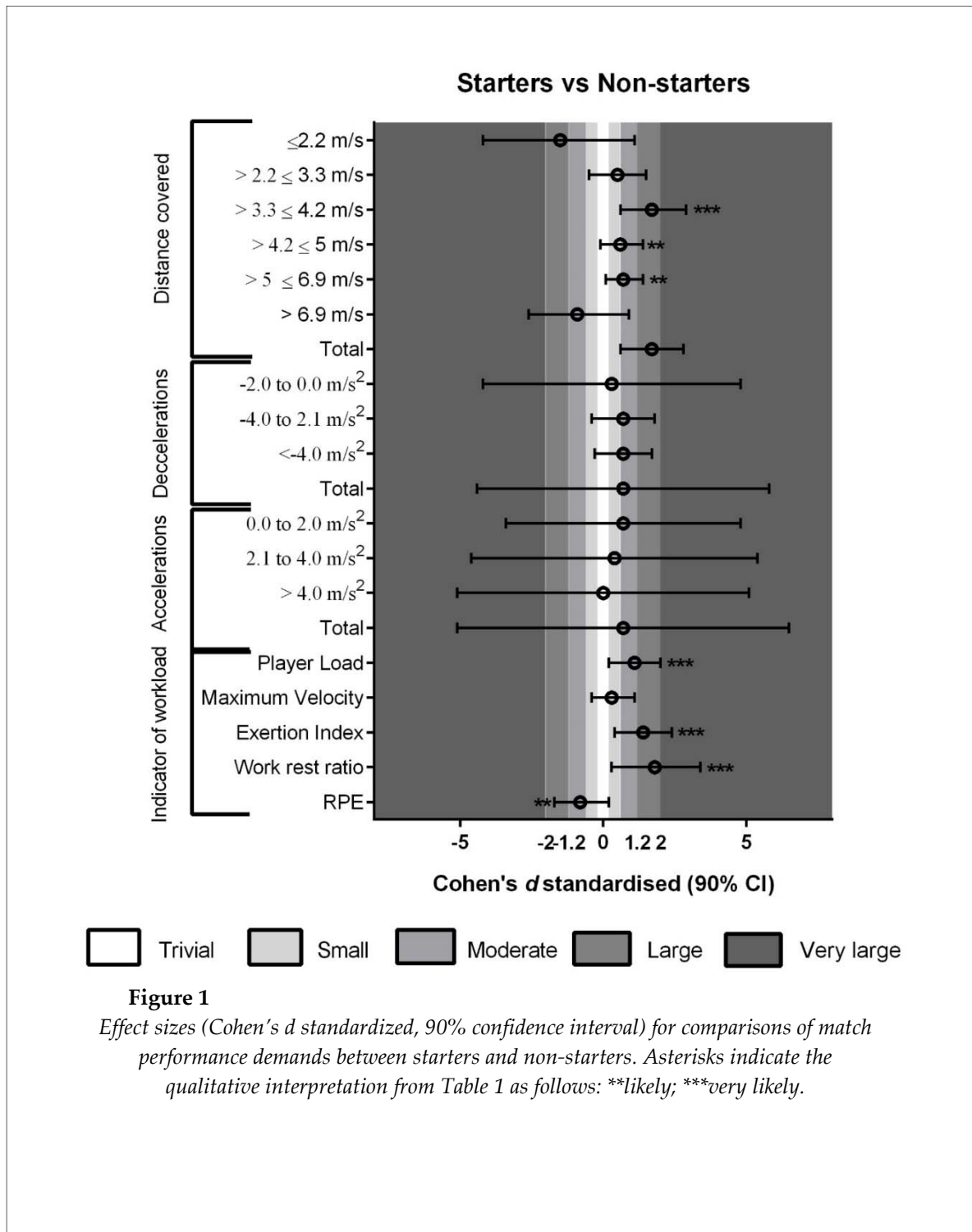
Previous studies with soccer players have reported that performance levels of starters were affected more (i.e. greater reductions) than of non-starters over the course of the competitive season (Kraemer et al., 2004). Although the extra muscle stimulus provided by more playing time has been postulated to maintain or improve performance levels (Stevens et al., 2017), such a stimulus may actually cause muscular fatigue and subsequent decreased physical performance during matches (Florini, 1987). In the current study, starters reported greater RPE values and reduced match demands (e.g. workload indicators) compared to non-starters that may have resulted from an accumulation of match play during the season. Subsequently, differences in match performance demands between starters and non-starters may provide an early indication of fatigue for starters that may lead to poorer performance in future matches. Comparison of match performance demands between starters and non-starters during simulated matches may provide coaches with a simple tool to assist in identification of accumulated stress/fatigue in starters for management by appropriate strategies to maximize player and ultimately team performance.

While notable differences in some match performance demands were identified between player roles, the current findings of greater high-intensity-running distances (3.3-6.9 m/s) by non-starters were in accordance with a previous study examining players within the English Premier League (Bradley et al., 2014). The current study has extended upon these results and confirmed the unique match performance profiles of starters and non-starters, potentially as a result of accumulated competition fatigue (i.e., poorer performance due to a greater amount of minutes played for starters compared to non-starters during the regular season matches) (Fransson et al., 2017) and/or pacing strategies (Bradley et al., 2014).

Table 1
Match performance demands for starter and non-starter players.

	Starters (n=18) M ± SD	Non-starters (n=6) M ± SD	Difference (%); ± 90%CL	Qualitative interpretation
Distance Covered (m)				
< 2.2 m/s	2,352 ± 72	2,241 ± 273	0.11 ± 191	Trivial
> 2.2 ≤ 3.3 m/s	1,390 ± 205	1,536 ± 366	-0.15 ± 220	Trivial
> 3.3 ≤ 4.2 m/s	621 ± 108	902 ± 267	-281 ± 134	Very Likely
> 4.2 ≤ 5 m/s	351 ± 104	467 ± 161	-116 ± 98	Likely
> 5 ≤ 6.9 m/s	256 ± 134	403 ± 119	-147 ± 116	Likely
> 6.9 m/s	28 ± 32	12 ± 21	16 ± 20	Trivial
Total	4,998 ± 285	5,581 ± 531	-581 ± 281	Trivial
Decelerations (number)				
-2.0 to 0.0 m/s ²	00 ± 00	01 ± 00	-1 ± 1.5	Trivial
-4.0 to 2.1 m/s ²	11 ± 05	18 ± 08	-7 ± 3.9	Trivial
<-4.0 m/s ²	576 ± 24	574 ± 21	2 ± 15.9	Trivial
Total	587 ± 21	592 ± 24	-5 ± 15.4	Trivial
Accelerations (number)				
0.0 to 2.0 m/s ²	841 ± 35	869 ± 33	-28 ± 27.5	Trivial
2.1 to 4.0 m/s ²	08 ± 04	10 ± 06	-2 ± 2.2	Trivial
> 4.0 m/s ²	00 ± 01	01 ± 01	-1 ± 2.8	Trivial
Total	850 ± 35	879 ± 39	-29 ± 17.1	Trivial
Indicators of Workload				
Player Load	455.4 ± 48.4	523.1 ± 66.3	-67.7 ± 12.7	Very Likely
Maximum running speed	07 ± 01	07 ± 01	0 ± 0.1	Trivial
Exertion Index	45 ± 05	55 ± 09	-10 ± 0.9	Very Likely
Work Rest Ratio	01 ± 00	02 ± 00	-1 ± 0.2	Very Likely
Self-reported Exertion	06 ± 01	05 ± 01	1 ± 0.9	Likely

Values are mean ± SD unless otherwise stated; CI – confidence interval.



Bradley et al. (2014) reported that non-starter players adopted an unconstrained style of effort compared to when they started a match. Thus, starters may employ more effective pacing strategies, due to the anticipation of longer playing time, that result in lower match performance demands compared to a non-starter

role. More recently, Fransson et al. (2017) identified similar trends with non-starter players covering more distance at moderate and high intensity than starters during the last 15 minutes of the match. Therefore, non-starters may employ all of their effort during their short period of playing time that is then replicated when they

experience longer playing times. In contrast, starters may strategically manage their efforts (i.e. pace), and hence fatigue levels, during the match in order to compete at the highest level at the most relevant times of the match. Jasper et al. (2017) contended that player's exposure time to match conditions was significantly related to the positive and/or negative changes in players' physical performances in soccer. Pacing strategies by different team roles may therefore influence overall team performance that remains to be examined further in future studies.

An intriguing result was the absence of differences in accelerations and decelerations between starter and non-starter players during matches. This similarity may be due to both roles mastering basic and fundamental skills with the ball, and the high volume of specific, technical training undertaken by both within stable and predictable conditions (Anderson et al., 2016). Subsequently, this training may condition all players to engage/disengage instinctively with the ball or with a close opponent, irrespective of their fatigue level, pacing strategy or playing role. Future studies are encouraged to examine further the impact of these factors on movement patterns of players during different styles of soccer matches.

While novel differences were noted between playing roles, several limitations of the current study should be acknowledged. Physiological measures that contribute to player ability such as maximal oxygen uptake, sub-maximal endurance, or strength were not

examined with possible differences between playing roles that may have impacted the current results. These physiological differences were likely to be minor given the similarity of training by players in both roles and the potential for all players to compete at the elite level during the season. However, further research should account for potential physiological differences between starter and non-starter players. Finally, the current analysis was limited to a few players of each on-field position with repeated measures during the regular season allowing a more thorough examination of the impact of starter and non-starter roles per position during competitions.

Conclusions

The current study demonstrated that starter and non-starter players displayed different physical performances during entire, friendly soccer matches. Specifically, high-intensity running and workload indicators were substantially less for starters that may indicate greater fatigue and/or use of pacing strategies compared to non-starters. This information may assist coaches in their management of training tasks and foci (e.g. post-match or recovery) for the starter and/or non-starter players. While such data are insufficient to be considered "normative", they may provide greater insights into the physiological demands of the modern soccer match and the impact of player roles.

Acknowledgements

The authors wish to thank the athletes for their invaluable contribution to the study. We also want to thank Dr. HongYou Liu for assistance with the study design. This work was not supported by a funding source.

The coauthor Miguel-Ángel Gómez was supported by the Ministry of Education, Culture and Sport of Spain, under the mobility Grant "Salvador de Madariaga" (PRX18/00098) in cooperation with the James Cook University (Townsville, Australia).

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