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Influence of scoring methods and numerical superiority on physical demands in elite young soccer players

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Abstract:

Small-sided games (SSGs) are a useful strategy to optimize the training process in soccer. The modification of some variables simultaneously implies several physical adaptations in soccer players. Thus, the aim of this study was to analyze the differences in the physical demands encountered by soccer players in different SSGs formats focusing on the scoring methods (i.e., mini-goals and regular goals with goalkeepers) and to the numerical superiority situations (i.e., no superiority, variable superiority, and fixed superiority). Eight elite young soccer players from the same team (age: 17.9 ± 1.1 years) randomly completed six SSG formats. Physical parameters (i.e., total distance [TD], distance covered at different speeds [D1, D2, D3, D4, D5 and D6], and distance covered accelerating [ACC] and decelerating [DEC]) were collected. The main results showed that the variable superiority (i.e., 4vs4+1) situation is more demanding, in terms of TD and distance covered at D3 and D4, in comparison to no superiority (i.e., 4vs4) and fixed superiority (i.e., 5vs4) situations both SSGs played with mini-goals and regular goals with goalkeepers. Besides, higher physical demands were registered in fixed superiority (i.e., 5vs4) than in no superiority (i.e., 4vs4) situation. Finally, only in a no superiority (i.e., 4vs4) situation higher distances at D1 and D5 were registered during the SSG played with mini-goals but higher distance at D3 was covered in the SSG format with regular goals and goalkeepers. Playing SSGs in variable superiority situation is more demanding in comparison to no superiority (i.e., 4vs4) and fixed superiority situations both during those SSGs played with mini-goals and/or regular goals and goalkeepers. In addition, SSGs played with mini-goals induced higher physical demands than playing with regular goals and goalkeepers during no superiority games. These findings could be useful for coaches in order to periodize the training drills within the microcycle to modulate the training session intensity.

Keywords: quantification; training drills; floaters; goalkeeper; mini-goals.

1. Introduction

In recent years, small-sided games (SSGs) have become a useful strategy to optimize the training process in soccer, mainly because these drills present a similar structure to the real game (Impellizzeri et al., 2006). Thus, coaches have included SSGs as a fundamental strategy within the weekly periodization aimed to replicate the technical-tactical and conditional match demands (San Roman-Quintana et al., 2013). In this sense, it has been shown that SSG-based training programs are effective to improve the players' physical fitness at different competitive-levels (Hammami, Gabbett, Slimani, & Bouhlel, 2018). Therefore, it would be convenient to use the SSGs in soccer training to induce positive physical performance effects by replicating the specific situations occurring during real competition (Bujalance-Moreno, Latorre-Román, & García-Pinillos, 2018).

One of the most important challenges for coaches is to design an appropriate soccer training periodization within a microcycle (Delgado-Bordonau & Mendez-Villanueva, 2012). In this way, they should know the physical demands encountered by players during the training drills (Morgans, Orme, Anderson, & Drust, 2014). Scientific literature has shown that a modification of some variables such as pitch size, bouts duration, number of players, verbal encouragement and rules of the game may influence players' physical demands (Fanchini et al., 2011; Köklü, 2012; Owen, Wong, McKenna, & Dellal, 2011; Rampinini et al., 2007; San Roman-Quintana et al., 2013). However, the effect of modifying other variables commonly used by coaches during soccer training drills such as the scoring method (Castellano, Casamichana, & Dellal, 2013; Castellano, Silva, Usabiaga, & Barreira, 2016), the numerical superiority/inferiority (i.e., fixed or variable) (Moreira, Custódio, & Greco, 2015; Sanchez-Sanchez, Hernández, et al., 2017) and the order of presentation within the whole training session (Sanchez-Sanchez et al., 2018) have been less studied.

Although some authors support that SSGs reflect the demands of real competition, including collaboration and opposition between players, rules and scoring situations (Casamichana, San Román, Calleja-Gonzalez, & Castellano, 2015), it would be of relevance to analyze the independent effect of goalkeepers presence and the effect of numerical superiority/inferiority situations (Sanchez-Sanchez, Hernández, et al., 2017). On the one hand, some authors have demonstrated that playing with goalkeepers (7vs7) is less demanding than playing with mini-goals (total distance [TD] = 462.8 ± 37.9 vs. 499.1 ± 58.7 m; maximum speed = 20.1 ± 2.3 vs. 21.1 ± 2.8 $km \cdot h^{-1}$) (Castellano et al., 2013). On the other hand, Hill-Haas et al. (2010) observed that playing with fixed superiority (i.e., 6vs5) induces greater high-intensity distance covered than playing with variable superiority (5vs5+1). Although the scoring method and the numerical superiority/inferiority have been studied separately, no investigation has analyzed how the combination of the aforementioned variables affects the players' physical demands. Variations of the scoring methods and the inclusion of floaters (i.e., player that generate superiority, fixed or variable, during SSG) are some of the main strategies used by coaches in order to modify the SSG drills (Sanchez-Sanchez, Hernández, et al., 2017) and develop some tactical principles of play (i.e., offensive amplitude and offensive depth) (Castellano et al., 2016).

Due to the modification of some variables simultaneously implies several physical adaptations in soccer players (Hammami et al., 2018), the aim of this study was to analyze the differences in the physical demands encountered by soccer players in different SSGs formats focusing on the scoring methods (i.e., mini-goals and regular goals with goalkeepers) and to the numerical superiority situations (i.e., no superiority, variable superiority and fixed superiority).

Based on previous studies (Castellano et al., 2013; Hill-Haas et al., 2010), we hypothesized that the inclusion of floaters increases the SSGs physical demands and playing with mini-goals is more demanding compared to playing with regular-goals/goalkeepers.

2. Materials and Methods

Subjects — Eight elite male soccer players (age: 17.9 ± 1.1 years; body height: 176.8 ± 7.7 cm; body mass: 70.0 ± 7.7 kg; training experience: 11.0 ± 0.9 years) belonging to the same Spanish team playing at the national level took part in the study. All the players regularly participated in three 90-120 min training sessions per week and in an official match on Saturdays. Subsequently, players and parents or legal guardians were informed of the research procedures, requirements, benefits, and potential risks before providing written informed consent (parents) and assent (players). Players participated voluntarily and had the possibility to withdraw at any time from the investigation without any penalty. The study was performed in accordance with the Declaration of Helsinki and the protocol was fully approved by the Ethics Committee of the Isabel I University (PUi1-001).

Design— A cross-sectional design was used to analyze the differences in the physical demands during different SSG formats varying the scoring methods and numerical superiority. For each SSG formats, a total of 8 observations were considered, since that eight players were monitored in each SSG. The data from each player for each SSG format was average from his participation. This investigation was conducted over three weeks during the in-season competitive period (i.e., April). Players were familiarized with the use of global positioning system (GPS) devices and SSG formats during the previous month. Soccer players' physical responses were recorded during six training sessions maintaining at least 48 h of recovery from the last competitive match. In addition, players performed the training sessions at the same time of the day (18:00 – 20:00 h). Due to their specific field role, goalkeepers and floaters (i.e., fixed or variable) were not included in the main analyses. Prior to the experimental protocol players undertook a 15 min standardized warm-up, consisting of 5 min of slow jogging followed by 7 min of specific soccer drills to finish with 3 min of progressive sprints and accelerations. Players participated in SSGs wearing their soccer boots to play on a third-generation artificial grass field. Likewise, players were instructed to maintain their usual habits, which included 8 hours of night-time sleep before each data collection session and optimal hydration and carbohydrate intake over the 24 hours prior to each experimental SSG (Sanchez-Sanchez et al., 2018).

Methodology—*Small-sided games (SSGs)*

Six SSG formats were composed to manipulate the following variables: scoring methods and numerical superiority situations. The SSGs were played with mini-goals or with regular goals and goalkeepers with no superiority (4vs4), variable superiority (4vs4+1) and fixed superiority (5vs4) on a 40 x 30 m soccer pitch. Four repetitions of 4 min with a 2 min rest were used for each SSG. All SSGs followed the ordinary soccer rules except of the off-side rule, which was omitted. The teams were organized by the coaches and the same teams faced each other in each SSG format. Coaches motivated the players to give their best in all SSGs formats and positioned several soccer balls around the pitch in order provide as much continuity to the matches as possible (Arslan et al., 2017).

Physical demands — To quantify soccer players' physical demands in each SSG bout, GPS devices (K-Sport®, Montelavate, Italy) operating at a sampling frequency of 10 Hz were used. The GPS devices were inserted in a pocket located in the upper portion of the player's back, inside a vest specifically designed to carry the measurement unit. Microsensor devices were activated 15 min before the start of each testing session, in accordance with the manufacturer's recommendations. Data were downloaded post-intervention protocol to a computer and analyzed using a customized

software package (K-Fitness, K-Sport®, Montelavate, Italy). The TD covered, distance covered at different speeds (D1: standing, 0-0.4 km·h^{-1}; D2: walking, 0.5-3.0 km·h^{-1}; D3: jogging, 3.01-

8.0 km·h^{-1}; D4: cruising, 8.01-13.0 km·h^{-1}; D5: high-intensity, 13.01-18.0 km·h^{-1}; D6: sprinting, ≥18.01 km·h^{-1}) and distance covered accelerating (>1.5 m·s^{-2}) (ACC) and decelerating (<-1.5 m·s^{-2}) (DEC) were recorded (Castagna, D'Ottavio, & Abt, 2003). The reliability (intraclass correlation coefficient, ICC = 0.71-0.99) and validity of this microsensor (K-Sport®, Montelavate, Italy) for the measurement of several external load variables were reported previously (Sanchez-Sanchez et al., 2018).

Statistical Analysis— Results were calculated as mean ± standard deviations (SD). Shapiro-Wilk test was used to analyze if the data shows a normal distribution. Firstly, a traditional null-hypothesis testing was conducted. The repeated-measured ANOVA with the Bonferroni post hoc test was used to identify significant differences in physical demands between the numerical superiority situations (i.e., 4vs4, 4vs4+1 and 5vs4) with mini-goals and with regular-goals/goalkeepers as well as to detect significant differences between the mini-goals and regular-goals/goalkeepers SSGs demands in each numerical superiority situation. Thereafter, effect sizes (ES) with uncertainty of the estimates shown as 90% confidence limits (CL) were used to quantify the magnitude of the difference between SSG formats (Hopkins, Marshall, Batterham, & Hanin, 2009). The ES were classified as trivial (<0.2), small (0.2–0.6), moderate (0.6–1.2), large (1.2–2.0), very large (2.0–4.0) and extremely large (>4.0) (Hopkins et al., 2009). A threshold value of 0.2 between-subject standard deviations was set as the smallest worthwhile change, and inference was then based on the disposition of the confidence interval for the mean difference to this smallest worthwhile effect; the probability (percent chances) that the true difference between tests is substantial (beneficial/detrimental) or trivial was calculated as per the magnitude-based decisions approach (Hopkins, 2006). These differences were then qualified via probabilistic terms and assigned using the following scale: possibly (25-75%); likely (75-95%); very likely (95–99.5%); and most likely (>99.5%) (Hopkins et al., 2009). Inference was classified as unclear if the 90% CL overlapped the thresholds for the smallest worthwhile positive and negative effects (Hopkins et al., 2009). The mean differences, confidence intervals, ES and magnitude-based decisions were calculated using a custom-made spreadsheet (Hopkins, 2006). Additionally, ANOVA analysis was carried out using the Statistical Package for Social Sciences (SPSS 25.0, Chicago, IL, USA), with statistical significance set at $p \leq 0.05$.

3. Results

Table 1 shows the physical demands of each SSG corresponding to the scoring method and numerical superiority manipulation.

Table 1. Mean ± SD of the physical demands within each small-sided game (SSG) format attending to scoring method and numerical superiority.

	Mini-goals			Goalkeepers		
Variables	4x4	4x4+1	5x4	4x4	4x4+1	5x4
TD (m)	1312.76 ± 106.97	1703.46 ± 178.40	1545.91 ± 263.34	1272.66 ± 87.35	1747.78 ± 162.59	1586.98 ± 171.30
D1 (m)	5.71 ± 1.10	4.51 ± 0.58	4.59 ± 1.60	4.88 ± 1.16	4.57 ± 1.60	5.37 ± 0.98
D2 (m)	119.03 ± 23.07	81.20 ± 22.40	110.07 ± 46.59	134.95 ± 27.18	93.00 ± 43.74	103.43 ± 20.10
D3 (m)	413.37 ± 52.38	543.69 ± 58.42	472.74 ± 65.24	459.30 ± 35.86	536.47 ± 71.83	493.78 ± 62.40
D4 (m)	508.35 ± 121.38	670.39 ± 179.11	588.14 ± 172.34	503.96 ± 161.23	607.79 ± 181.66	619.11 ± 138.86
D5 (m)	257.53 ± 91.26	310.98 ± 64.81	296.92 ± 113.14	178.76 ± 63.00	310.40 ± 122.92	289.57 ± 89.93
D6 (m)	81.96 ± 39.71	101.69 ± 29.45	73.45 ± 47.66	40.81 ± 18.84	95.67 ± 60.21	84.47 ± 18.37
ACC (m)	9.68 ± 1.76	12.66 ± 1.57	11.08 ± 3.96	10.28 ± 1.15	12.88 ± 4.18	11.79 ± 1.26
DEC (m)	8.64 ± 1.49	11.56 ± 1.49	9.73 ± 3.77	8.59 ± 1.30	11.68 ± 4.45	10.87 ± 1.53

SD = standard deviation; TD = total distance covered; D1: distance covered standing (0.4 km·h-1); D2: distance covered walking (0.5-3.0 km·h-1); D3: distance covered jogging (3.01-8.0 km·h-1); D4: distance covered cruising (8.01-13.0 km·h-1); D5: distance covered at high-intensity (13.01-18.0 km·h-1); D6: distance covered sprinting (≥18.01 km·h-1); ACC: distance covered accelerating (>1.5 m·s-2); DEC: distance covered decelerating at (<-1.5 m·s-2).

Practical differences in SSGs played with mini-goals and among different numerical situations are presented in Figure 1. During the 4vs4+1 SSG format, players covered greater TD (most likely very large, $p < 0.01$) and higher distance at D3 and D4 (likely moderate to most likely very large, $p < 0.05$) than during 4vs4 SSG format. In addition, lower distance covered at D2 (very likely moderate to large, $p < 0.01$) was registered during 4vs4+1 than during 4vs4 SSG format (Figure 1A). The distance at ACC and DEC were most likely large ($p < 0.05$) greater during 4vs4+1 than during 4vs4. During 5vs4 SSG format, players covered higher distance at D3 (likely moderate, $p < 0.01$) than during 4vs4. (Figure 1B). Finally, regarding the type of superiority, non-significant differences were observed (Figure 1C).

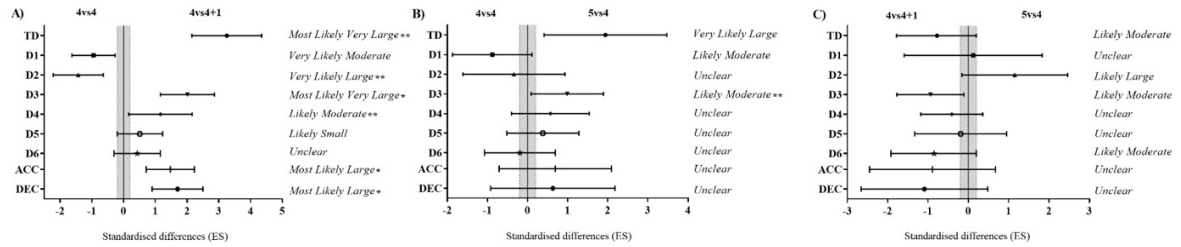

Figure 1. Practical differences in the small sided games (SSGs) played with mini-goals and among different numerical superiority situations.
* Significant differences between numerical superiority situations ($p < 0.05$)
** Significant differences between numerical superiority situations ($p < 0.01$)

Practical differences in SSGs played with regular goals and goalkeepers and among different numerical situations are shown in Figure 2. Higher TD ($p < 0.01$) and distance covered at D3 ($p < 0.05$) and D5 ($p < 0.01$) were observed during 4vs4+1 SSG format than during 4vs4 SSG format (Figure 2A). Likewise, greater TD ($p < 0.01$), distance covered at D4 ($p < 0.05$), D5 ($p < 0.01$), D6 ($p < 0.01$), ACC ($p = 0.07$) and DEC ($p < 0.05$) (most likely very large – very likely moderate to large – likely moderate) during 5vs4 format were registered in comparison to 4vs4 format (Figure 2B). In contrast, higher distance at D2 (very likely moderate, $p < 0.05$) was observed during 4vs4 SSG (Figure 2B). Finally, during 4vs4+1 SSG format players showed higher TD ($p < 0.01$) in comparison to 5vs4 SSG format (Figure 2C).

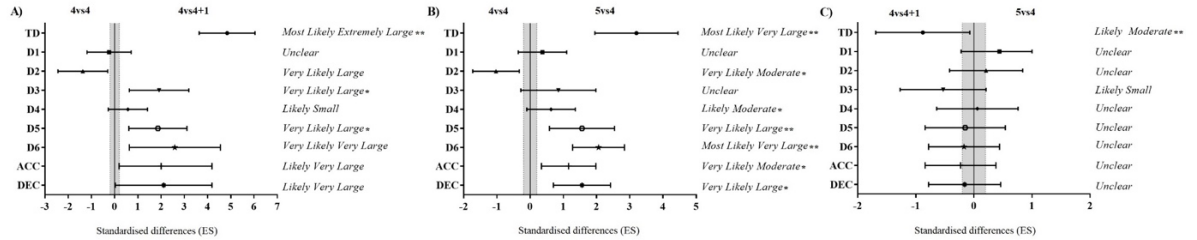

Figure 2. Practical differences in the small sided games (SSGs) played with goalkeepers and among different numerical superiority situations.
* Significant differences between numerical superiority situations ($p < 0.05$)
** Significant differences between numerical superiority situations ($p < 0.01$)

Practical differences between SSGs played with mini-goals and with goalkeepers in a no superiority, variable superiority and fixed superiority situations were presented in Figure 3. While higher distances at D1 ($p < 0.05$) and D5 ($p < 0.05$) (likely moderate to very likely moderate) were registered during the 4vs4 format with mini-goals than in those SSG played with goalkeepers, higher distance at D3 (likely moderate, $p < 0.05$) was covered in a 4vs4 SSG format with regular goals and goalkeepers (Figure 3A). Unclear differences were found between SSGs played with mini-goals and with goalkeepers in a variable superiority (4vs4+1) and fixed superiority (5vs4) situations (Figures 3B and 3C).

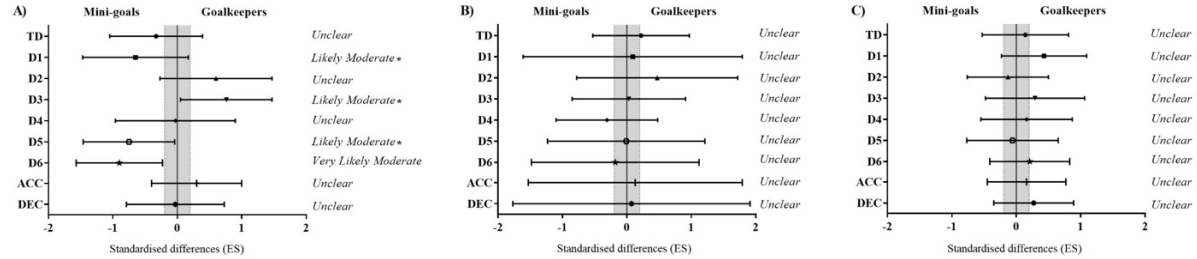

Figure 3. Practical differences between the small sided games (SSGs) played with mini-goals and with goalkeepers in no superiority (3A), variable superiority (3B) and fixed superiority (3C) situations.
* Significant differences between scoring target methods ($p < 0.05$)
** Significant differences between scoring target methods ($p < 0.01$)

4. Discussion

The aim of this study was to analyze the differences in the physical demands encountered by soccer players in different SSG formats regarding the scoring methods (i.e., mini-goals and regular goals with goalkeepers) and to the numerical superiority situations (i.e., no superiority, variable superiority and fixed superiority). To the best of our knowledge, this is the first study to combine the modification of both these variables (i.e., scoring methods and numerical superiority) during SSGs in elite soccer players. The main results showed that the variable superiority (i.e., 4vs4+1) situation induced higher demands in terms of TD, distance covered at high velocity and neuromuscular demand in comparison to no superiority (i.e., 4vs4) and fixed superiority (i.e., 5vs4), during both SSGs played with mini-goals and/or regular goals and goalkeepers. Besides, higher physical demands were registered in fixed superiority (i.e., 5vs4) than in no superiority (i.e., 4vs4) situation. Finally, only in the no superiority format (i.e., 4vs4) higher distances at D5 and D6 were registered with mini-goals in comparison to regular goals and goalkeepers.

Differences in numerical superiority situations with mini-goals — Our results

showed that when the SSG were played with mini-goals, playing the SSG in variable superiority (i.e., 4vs4+1) induced higher physical demands in comparison to playing in no superiority (i.e., 4vs4) or in fixed superiority (i.e., 5vs4). The differences in the physical demands caused by numerical superiority (i.e., variable vs. fixed) were not observed in previous studies (Hill-Haas et al., 2010). This may be due to the different number of players (i.e., 3vs3 vs. 4vs4) and the SSG total duration (i.e., 24 vs. 16 min). The differences observed in our study could be explained by the variable superiority situation providing a greater incentive for each team to work harder to gain possession and then gain the benefit of having a floater joining their team (Hill-Haas et al., 2010). On the other hand, it has also been observed that in a 4vs4 the internal load of the task is greater than in a 4vs4 + 2 (i.e., no superiority > variable superiority) (Sanchez-Sanchez, Sanchez, et al., 2017). Variable superiority can make teams have more pass options and their movements without a ball are reduced (Castellano et al., 2016). In addition, by introducing superiorities while maintaining the dimensions of the playing field (i.e., 40 x 30 m), the individual interaction space is reduced (Casamichana & Castellano, 2010). This could explain the increase of the distance in ACC and DEC in 4vs4 + 1 vs 4vs4 observed in our work. In the same way, the absence of changes in D5 may be due to the smaller space available to the player, which reduces the possibility of making "vertical" displacements, partly responsible for the increase in distance at high speed (Frencken, Lemmink, Delleman, & Visscher, 2011). Since the scarce research focused on the physical demands related to the presence of floaters or not in the SSG formats played with mini-goals during training sessions, analyzing the influence of varying the numerical superiority situation can help the coach to design the training microcycle. The formats with variable numerical superiority, due to the greater load, should be included in the central sessions of the microcycle. However, the games in numerical equality, due to the lower load, can be included in sessions closer to the competition, as an activation strategy.

Differences in numerical superiority situations with regular goals and goalkeepers — Although playing with mini-goals in different numerical superiority situations has been scarcely investigated, the influence of playing with the presence of regular goals and goalkeepers has been analyzed (Hill-Haas et al., 2010; Moreira et al., 2015). Previous studies have shown greater physical demands, in terms of TD and distance covered accelerating, during no superiority situation (i.e., 3vs3) in comparison to the variable superiority situation (i.e., 3vs3+1) (Moreira et al., 2015), and higher high-intensity distances during fixed superiority (i.e., 6vs5) than in variable superiority (5vs5+1) (Hill-Haas et al., 2010). These results have demonstrated to be different to the results obtained in the current investigation in which the presence of an internal floater (i.e., variable and fixed superiority) increased the physical demands in terms of TD, distance covered at D3, D4, D5 and D6, and the distance covered ACC and DEC in comparison to no superiority situation (i.e., 4vs4). In the current investigation, it is possible that the no superiority SSG situation induced lower physical demands due to the different number of players who participated in comparison with previous studies and the lack of inclusion of floaters in the subsequent statistical analysis (Lacome, Simpson, Cholley, & Buchheit, 2017). Therefore, it seems that the inclusion of floaters might induce an increased external load in 4vs4 SSG formats performed with young soccer players. This information could help coaches to implement these SSG formats more effectively. Specifically, both superiority SSG modalities must be included when coaches want to increase the external load imposed to players.

Differences between scoring methods according to numerical superiority situations — Regarding the scoring methods (i.e., mini-goals vs. regular goals with goalkeepers), it is known that high-intensity physical demands decrease when SSGs are played with regular

goals and goalkeepers (Castellano et al., 2013). In this line, our results showed higher TD and distances at D5 during a no superiority situation when mini-goals were used in comparison to regular goals and goalkeepers. However, during superiority situations (i.e., fixed and variable superiority), no substantial differences were observed in physical demands when modifying the scoring methods. These results could be due to the combination of two aspects such as: i) when playing in equality, the number of attack-defense and defense-attack transitions is higher due to the fact that a greater number of turnovers occur because the distance between players is reduced, since there are many situations of 1vs1 and, ii) when playing with mini-goals, players defend differently than when a goalkeeper is present. In this sense, the players are located closer to the mini-goal and yet, with the goalkeeper, a certain distance is maintained. Given the scarce information regarding the simultaneous modification of both variables (i.e., scoring methods and numerical superiority situations), it would be interesting to analyze in future studies the influence of these two factors on the SSGs' physical demands at different competitive-levels.

This study is not exempt of limitations. The main one is the low sample size, although the access to elite athletes is hard. So, results must be taken with caution. Additionally, the investigation is focused only in one competitive-level (U18), so the results obtained should not be apply to other age-groups. It would be interesting to have access to a greater number of players in order to obtain more representative results.

5. Practical Applications.

From a practical point of view, the authors suggest that the inclusion of the floater role could be an appropriate strategy to increase the physical demands during SSGs mainly in those SSGs played with variable superiority in comparison to fixed superiority situations. On the other hand, modifying the scoring method in no superiority situations may induce changes in the physical demands registered by soccer players. Thus, these findings can offer valuable information for coaches in order to implement these SSG formats more effectively during training cycles.

6. Conclusions

Playing SSGs in variable superiority (i.e., 4vs4+1) situation is more demanding in terms of TD and distance covered at certain intensities in comparison to no superiority (i.e., 4vs4) and fixed superiority (i.e., 5vs4) situations both during those SSGs played with mini-goals and/or regular goals and goalkeepers. This information can be useful for coaches in order to periodize the training drills within the microcycle as it suggests that the numerical superiority situations impose high demands on players' physical performance. In addition, SSGs played with mini-goals induced higher physical demands than playing with regular goals and goalkeepers during no superiority (i.e., 4vs4) games. Thus, this knowledge could help coaches to plan and implement these SSG formats more effectively.

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Conflicts of Interest: The authors declare no conflict of interest.

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