Journal of Exercise Science & Fitness 19 (2021) 40–46

Contents lists available at ScienceDirect

Journal of Exercise Science & Fitness

journal homepage: www.elsevier.com/locate/jesf

Game format alters the physiological and activity demands encountered during small-sided football games in recreational players

Emilija Stojanović [a, b], Nenad Stojiljković [a], Ratko Stanković [a], Aaron T. Scanlan [c], Vincent J. Dalbo [c], Zoran Milanović [a, d, *]

[a] Faculty of Sport and Physical Education, University of Niš, Niš, Serbia
[b] Faculty of Medical Sciences, University of Kragujevac, Kragujevac, Serbia
[c] Human Exercise and Training Laboratory, School of Health, Medical and Applied Sciences, Central Queensland University, Rockhampton, Australia
[d] Science and Research Centre Koper, Institute for Kinesiology Research, Koper, Slovenia

ARTICLE INFO

Article history:
Received 22 July 2019
Received in revised form
6 May 2020
Accepted 7 May 2020
Available online 28 May 2020

Keywords:
Movement pattern
Soccer
Heart rate
Blood lactate concentration

ABSTRACT

Background: Conditioning in the form of football small-sided games (SSG) is being increasingly utilized as a health-promoting and performance-enhancing activity.
Objective: The aim of this study was to quantify and compare the physiological responses and activity demands encountered during 3-a-side, 4-a-side, and 5-a-side football SSG in recreational players.
Method: Heart rate, blood lactate (BLa), rating of perceived exertion (RPE) and activity demands were measured across 2 × 20-min football sessions played on a 40 × 20-m pitch in 12 recreationally active college students. Data were collected over a period of two weeks using a repeated-measures crossover design.
Results: Mean heart rate was higher (moderate) during 5-a-side than 4-a-side ($p = 0.02$) and 3-a-side SSG ($p < 0.001$). BLa tended to be higher (small) in 3-a-side compared to 4-a-side ($p = 0.12$) and 5-a-side SSG ($p = 0.46$). The total distance covered was lower (large) during 5-a-side than 4-a-side SSG ($p = 0.02$), while the total number of accelerations ($p = 0.01$) and decelerations ($p = 0.02$) were higher (large) during 5-a-side than 4-a-side SSG.
Conclusion: These data suggest: 1) 5-a-side SSG require a greater intermittent workload and exacerbated HR responses; 2) 4-a-side SSG require more sustained activity (distance); and 3) 3-a-side SSG result in higher BLa compared to other SSG formats. The observed intermittent workload and exacerbated HR response in 5-a-side SSG were likely due to greater turnover rates with more frequent interceptions. Sustained activity in 4-a-side SSG might be underpinned by format-specific structures permitting optimal team work, while isolated guarding of players in 3-a-side SSG may have exacerbated BLa responses.

Introduction

Conditioning in the form of football small-sided games (SSG) is being increasingly utilized as a health-promoting and performance-enhancing activity irrespective of age and training status.[1–4] Given the link between training intensity and positive outcomes in cardiovascular, metabolic, and musculoskeletal health,[5,6] the high physiological and activity demands underpinning football SSG may be central to their use as a health promotion intervention.[7] Despite the popularity of football SSG, few studies[8–12] have identified the influence of game format (e.g. pitch size, team sizes) on the physiological and activity intensities encountered by recreational players.

One of the most common ways to manipulate the physiological and activity demands encountered by players during football SSG is to alter the numbers of players competing on each team. To our knowledge, only four studies[9–12] have examined the influence of team size on the physiological intensity of football SSG in recreational adult players. Specifically, Randers et al.[11] noted higher heart rate (HR) responses and ratings of perceived exertion (RPE) in 3-a-

* Corresponding author. University of Niš, Faculty of Sport and Physical Education, Čarnojevićeva 10a, 18000, Niš, Serbia.
E-mail address: zoooro_85@yahoo.com (Z. Milanović).

https://doi.org/10.1016/j.jesf.2020.05.001
1728-869X/

side and 5-a-side games than 7-a-side games, as well as higher blood lactate concentrations (BLa) in 3-a-side games than 7-a-side games using a fixed pitch size (20 × 40 m) during 48-min football SSG. Likewise, Aslan[10] reported higher HR responses during 5-a-side games than 7-a-side games using small (44 × 23 m) and large (57 × 30 m) pitches during 40-min football SSG. However, Randers et al.[12] noted comparable HR responses, RPE, and BLa during 3-a-side, 5-a-side, and 7-a-side formats using fixed relative pitch sizes (15.5 × 31 m, 20 × 40 m, and 23.5 × 47 m) across 48-min football SSG. Similarly, Randers et al.[9] reported comparable HR responses across 1-a-side, 3-a-side, and 7-a-side football SSG with variable pitch sizes (8 × 11 m, 33 × 44 m, and 40 × 60 m) and game durations (5 × 6 min, 4 × 12 min, and 4 × 12 min). Therefore, the collective evidence suggests more research is needed to develop a definitive consensus regarding the influence of team size on the physiological intensities of football SSG in recreational players.

In addition to quantifying internal physiological responses, quantification of the external activity demands provides insight into the physical workloads imposed upon players during football SSG. In this regard, inconsistent findings have been reported regarding the external demands encountered relative to team size during football SSG in recreational players.[11,12] Specifically, Randers et al.[11] observed higher total and high-intensity distances in 3-a-side than 5-a-side and 7-a-side football SSG with a fixed pitch size (40 × 20 m). In contrast, Randers et al.[12] noted similar total and high-intensity distances across 3-a-side, 5-a-side, and 7-a-side football SSG using fixed relative pitch sizes (15.5 × 31 m, 20 × 40 m, and 23.5 × 47 m). Consequently, conflicting and limited evidence is available regarding the activity demands elicited during football SSG using different team sizes in recreational players, with most of the available data limited to distance measures. Consequently, further investigation using a wider assortment of metrics is needed to better understand the impact of varying team size on the external demands encountered during football SSG in recreational players.

While the available studies examining the demands of football SSG in recreational players have utilized team sizes spanning 1, 3, 5, and 7 players, comprehensive reviews[1,13] indicate 4-a-side SSG are predominantly used in recreational football. In turn, the physiological and activity demands during 4-a-side football SSG have not yet been compared with other formats. Therefore, examination of the demands encountered during 4-a-side football SSG in recreational players relative to other game formats are needed for enhanced practical translation. Consequently, the aim of this study was to quantify and compare the physiological responses and activity demands encountered during 3-a-side, 4-a-side, and 5-a-side football SSG in recreational players. We hypothesized 3-a-side would elicit greater physiological responses and activity demands than 4- and 5-a-side game formats.

Materials and methods

Participants

Initially 22 participants volunteered to participate in the investigation (n = 20 outfield players and n = 2 goalkeepers). Two goalkeepers participated in each session. Only players who participated in all game formats were included for analysis with goalkeepers removed given their restricted movement requirements.[14] As a result 12 healthy, recreationally active (3–5 h.wk^{-1}), male college students (age: 20.9 ± 1.6 yr; stature: 178.6 ± 5.3 cm; body mass: 76.6 ± 8.1 kg; body fat: 15.8 ± 6.3%; football experience: 5.5 ± 3.0 yr; maximal running speed in 30-15 Intermittent Fitness Test [30-15IFT]: 16.5 ± 2.1 km h^{-1}; HR_{peak}: 206.3 ± 9.4 b min^{-1}) were included in the final dataset (Fig. 1). All participants were informed of the study procedures, benefits and risks involved in participation. Written informed consent was obtained from all participants prior to testing. All procedures were approved by an institutional Human Research Ethics Committee and were conducted in accordance with the Declaration of Helsinki.

Experimental design

This study was conducted over a 3-week period across nine sessions. The first session was used to familiarize participants with wearing the global positioning system (GPS) devices and HR monitors (Polar Team Pro, Kempele, Finland), as well as each of the football SSG formats. During the second session, anthropometric measures were taken for each participant. Percent body fat was determined using a multi-frequency bioelectrical impedance analyzer (InBody 770, Biospace Co. Ltd, Seoul, Korea) following standard measurement procedures [interclass correlation coefficient (ICC) = 0.98; standard error of the measurement = 0.91].[15] Stature was measured using a portable stadiometer (Seca 220, Seca Corporation, Hamburg, Germany) with a graduation of 0.1 cm. The third session was used to determine maximal heart rate (HR_{max}) using the 30-15 Intermittent Fitness Test (ICC = 0.96; coefficient of variation = 0.6%).[16] The remaining six sessions were used to administer each of the SSG formats. A schematic illustration of the study design is shown in Fig. 1. Participants were divided into two groups with 10 players per group. The first group completed 5-, 4-, and 3-a-side game format across the first week, while the second group completed the same game formats the following week in reverse order. One participant from each team was randomly excluded or included across game formats when team size was modified.

During each SSG, participants were matched for game fitness using data from the 30-15 Intermittent Fitness Test (30-15IFT) and previous football-playing experience. Each SSG session lasted 60 min, consisting of a 10-min warm-up followed by 2 × 20-min periods of recreational football SSG with a 5-min half-time break and a 5-min cool-down following game completion.[8,17] Participants completed a standardized warm-up consisting of moderate-intensity jogging (4 min), static and dynamic stretching (4 min), and accelerative running bouts (2 min). Participants were permitted to consume water *ad libitum* between halves and following games. Data collected during the warm-up, half-time break, and cool-down periods were not included for analysis. Sessions were carried out at the same time of day (10:00–11:00 h) to avoid any effect of circadian rhythm on the measured variables.[18] All testing sessions were performed in similar environmental conditions (temperature: 15.3 ± 0.6 °C, humidity: 49.9 ± 6.8%) on the same indoor football court. The pitch size of all SSG was fixed at 40 × 20 m with consistent goal sizes (2 m high x 3 m wide). A single standard-size football was used in each SSG.

30-15 Intermittent Fitness Test

Individualized HR_{max} was determined as the highest value reached during the 30-15IFT for each participant.[19] The 30-15IFT consists of repeated 30-s runs across a 40-m course, interspersed with 15 s of recovery at a walking speed between each run. The speed of the initial run was 8 km h^{-1}, which increased by 0.5 km·h^{-1}each run thereafter (every 45 s) as indicated by audio signals. Participants were encouraged verbally throughout testing to maintain the required pace as long as possible and to produce maximal effort. The test was completed upon volitional exhaustion from each participant or when the required speed could not be maintained for three consecutive runs.

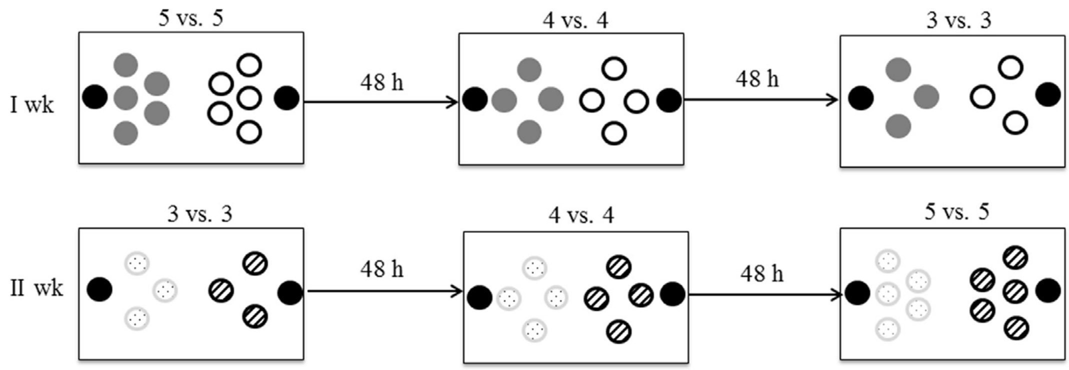

Fig. 1. A schematic illustration of the study design.

Heart rate monitoring

Participants wore HR monitors (affixed to their chest at the level of the xiphoid process) that continually recorded HR at 1-s intervals (Polar Electro, Kempele, Finland). HR responses were expressed as a percentage of the individualized HR_{max}. All HR data were stored by the Polar Team Pro HR monitors throughout the SSG and transferred to an iPad (A1822; Apple; California, USA) using the Polar Pro Team dock (Polar Electro, Kempele, Finland). Data were then exported to Microsoft Excel (v15.0; Microsoft Corporation; Redmond, WA, USA) to calculate the time spent in the following HR-mediated intensity zones[20]: ≤70%HR_{max}, 71–80%HR_{max}, 81–90% HR_{max}, and 91–100%HR_{max}. Mean and peak HR responses were also determined.

Blood lactate concentration

BLa (mmol·L^{-1}) was determined using earlobe capillary blood samples measured with a handheld analyzer (Lactate Scout, EKF, SencLab, Magdeburg, Germany)[21] immediately following each SSG.[22]

Rating of perceived exertion

Each participant gave an individualized RPE immediately following each SSG using Borg's 10-point Likert scale (with '1' indicating a minimum response and '10' indicating a maximum response).[23] All RPE were recorded in arbitrary units (AU).

Activity demands

The activity demands were measured using portable GPS devices (10 Hz, Polar Team Pro, Kemple, Finland). The 10-Hz GPS technology has been previously determined as reliable and valid for assessing team sport movement profiles.[24] The following categorization was used to indicate different activity intensities[25]: standing/walking, ≤6 km.h^{-1}; low-speed running, 6.01–12 km.h^{-1}; moderate-speed running, 12.01–18 km.h^{-1}; high-speed running, 18.01–24 km.h^{-1}; and maximal-speed running, >24 km.h^{-1}. The frequency of accelerations and decelerations were measured using accelerometers within the Polar Team system sampling at 200 Hz (Polar Team Pro, Kemple, Finland). The following categorization was selected to indicate different acceleration/deceleration intensities[26]: low, 0.5–0.99 m.s^{-2}; medium, 1–1.99 m.s^{-2}; and high, ≥2 m.s^{-2}).

Statistical analysis

A priori analysis using G*Power software (version 3.1.9.4; Heinrich Heine University Düsseldorf, Düsseldorf, Germany) recommended a sample size of 12 [alpha = 0.05; effect size (ES) = 0.40; and power = 0.80], supporting the present analysis.[27] Data analyses were performed using IBM SPSS software (v25.0, IBM Corporation; Armonk, NY, USA). Normality of all data was confirmed with the Shapiro-Wilk test. Mean ± standard deviation was calculated for each dependent variable. Differences in HR, RPE, BLa, and activity demands were analyzed using separate one-way repeated measures analysis of variance with Bonferroni post hoc tests to locate significant pairwise differences. The magnitude of pairwise differences in each dependent variable was quantified with ES analyses and interpreted as: *trivial*, <0.2; *small*, 0.2–0.59; *moderate*, 0.6–1.19; *large*, 1.2–1.99; *very large*, >2.[28] Statistical significance was set at $p \leq 0.05$.

Results

Physiological responses

Mean ± standard deviation HR responses, RPE, and BLa for each SSG format are given in Table 1. Absolute and relative HR_{mean} was significantly higher during 5-a-side than 4-a-side and 3-a-side SSG. RPE and BLa tended to be higher in 3-a-side than in 4-a-side and 5-a-side SSG. The proportions of playing time spent in each HR intensity zone during different SSG formats are shown in Fig. 2. There were non-significant, *trivial* to *small* differences in the percentage of time spent working at <70%HR_{max}, 71–80%HR_{max}, and 81–90% HR_{max} between SSG formats. 5-a-side SSG yielded a significantly higher proportion of playing time working >90%HR_{max} compared to 3-a-side SSG ($p = 0.03$; ES = 0.85, *moderate*).

Activity demands

The total distance covered was significantly lower during 5-a-side (2027 ± 532 m) than 4-a-side SSG (2870 ± 695 m; $p = 0.02$; ES = −1.36, *large*) but not 3-a-side games (2200 ± 635 m; $p = 0.72$; ES = −0.30, *small*), corresponding to 50.7 ± 13.3 m.min^{-1}, 71.9 ± 17.5 m.min^{-1}, 59.9 ± 23.6 m.min^{-1}, respectively. The distance covered working at different intensities is shown in Fig. 3. Non-significant, *small* to *moderate* differences in distance covered standing/walking, high-intensity running, and maximal-speed running were evident between SSG formats. In the 4-a-side SSG, players covered greater distance performing low-speed running ($p = 0.03$; ES = 1.33, *large*) and moderate-speed running ($p = 0.02$; ES = 1.36, *large*) than in 5-a-side SSG.

Table 1
Physiological responses during different football small-sided game formats in recreational players (n = 12).

Variable	Small-sided game format			Pairwise comparisons					
	5-a-side	4-a-side	3-a-side	5- vs 4-a-side		5- vs 3-a-side		4- vs 3-a-side	
	Mean ± SD	Mean ± SD	Mean ± SD	ES (95% CI)	P	ES (95% CI)	P	ES (95% CI)	P
HR_{mean} (beats·min^{-1})	176.1 ± 10.6	167.3 ± 14.8	166.8 ± 12.4	0.68 (−0.16 to 1.48)	0.02	0.81 (−0.05 to 1.61	0.00	0.04 (−0.76 to 0.84	1.00
HR_{peak} (beats·min^{-1})	193.5 ± 8.8	190.0 ± 11.2	191.2 ± 8.6	0.35 (−0.47 to 1.14)	0.20	0.26 (−0.55 to 1.06)	0.14	−0.12 (−0.92 to 0.68)<	1.00
HR_{mean} (%HR_{max})	85.4 ± 6.3	81.5 ± 9.3	80.9 ± 7.1	0.49 (−0.34 to 1.29)	0.05	0.67 (−0.17 to 1.47)	0.00	0.07 (−0.73 to 0.87)	1.00
HR_{peak} (%HR_{max})	94.1 ± 6.0	92.3 ± 7.5	92.9 ± 6.0	0.27 (−0.55 to 1.06)	0.22	0.20 (−0.61 to 1.00)	0.12	−0.09 (−0.89 to 0.72)	1.00
Blood lactate concentration (mmol·L^{-1})	4.5 ± 1.8	4.4 ± 1.1	5.2 ± 1.6	0.07 (−0.74 to 0.87)	1.00	−0.41 (−1.20 to 0.41)	0.46	−0.58 (−1.38 to 0.25	0.12
Rating of perceived exertion (AU)	5.0 ± 1.5	5.0 ± 2.1	5.5 ± 1.8	0.00 (−0.80 to 0.80)	1.00	−0.30 (−1.10 to 0.51)	0.93	−0.26 (−1.05 to 0.56)	0.83

Note: ES – effect size; CI – confidence interval.

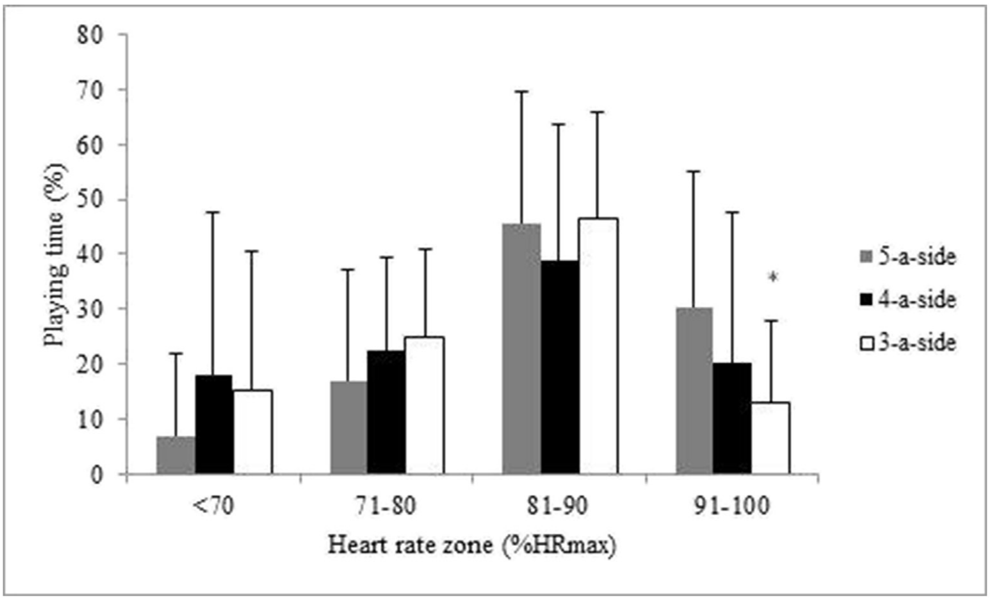

Fig. 2. The proportion (%) of playing time spent working in heart rate intensity zones during different soccer small-sided game formats. * Significantly different to the 5-a-side game format.

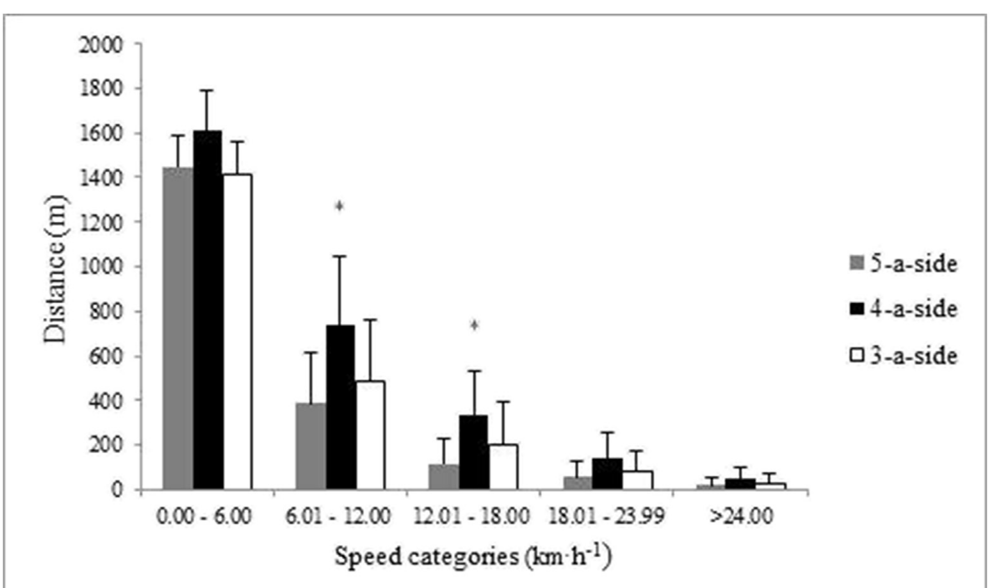

Fig. 3. The total distance covered standing/walking (<6 km h^{-1}), low-speed running (6.01–12 km h^{-1}), moderate-speed running (12.01–18 km h^{-1}), high-speed running (18.01–24 km h^{-1}), and maximal speed running (>24 km h^{-1}) during different soccer small-sided game formats. * Significantly different to the 5-a-side game format.

The frequency of accelerations and decelerations performed at different intensities are presented in Fig. 4. More total accelerations and decelerations were performed during 5-a-side than 4-a-side SSG (accelerations: 613 ± 59 vs 487 ± 105; p = 0.01; ES = 1.49, *large*; decelerations: 635 ± 56 vs 505 ± 113; p = 0.02; ES = 1.47, *large*). Likewise, more low-intensity accelerations (p = 0.03; ES = 1.28, *large*) and decelerations (p = 0.02; ES = 1.42, *large*) were apparent during 5-a-side than 4-a-side SSG. More medium-intensity accelerations were performed during 5-a-side SSG compared to 4-a-side (p = 0.01; ES = 1.64, *large*) and 3-a-side SSG (p = 0.04; ES = 0.84, *moderate*) and more medium-intensity decelerations were evident during 5-a-side than 4-a-side SSG (p = 0.02; ES = 1.52, *large*).

Discussion

Results from our investigation suggest recreational football players experienced greater HR responses as well as accelerations and decelerations during 5-a-side SSG compared with 4-a-side and 3-a-side SSG played on a 20- × 40-m pitch. In addition, 4-a-side SSG imposed a greater overall volume of activity compared to 3-a-side and 5-a-side SSG, while 3-a-side SSG resulted in higher BLa and RPE responses compared with 5-a-side and 4-a-side SSG.

The high relative HR responses across different football SSG formats in this study (80–85%HR_{max}) were similar to those previously reported in recreational[9,11] and elite players[29–31] during football SSG. Collectively, these data support football SSG as a training approach in providing a substantial stimulus to the cardiovascular system. Comparisons between SSG formats in our study yielded a higher HR_{mean} and greater playing time spent in the highest HR zone (>90% HR_{max}) during 5-a-side compared to 4-a-side and 3-a-side SSG. In contrast, Randers et al.[11] observed a higher HR_{mean} and more playing time at HR >90%HR_{max} in recreational players during 3-a-side than in 5-a-side and 7-a-side football SSG. The higher cardiovascular strain typically observed in football SSG with smaller team sizes is likely due to increased game involvement requiring players to make longer offensive and defensive runs.[11] However, disparities between our results and those observed previously may relate to variability of technical and activity demands, underpinned by the unpredictable and complex nature of SSG, requiring players to adapt their actions to situational demands.[17,32]

For instance, larger team sizes may have resulted in a greater turnover rate with more frequent interceptions[33] given more players are likely involved in decision-making processes, creating greater uncertainty and complexity in various situational requirements. In these situations, players should be able to quickly suppress their motor response (execute a pass, start a dribble or wait to make a move) and create a new decision if the teammate suddenly becomes defended. However, lower visual processing speed, difficulty concentrating and sustaining attention focus on a target, poor decision-making and reduced stress regulation at

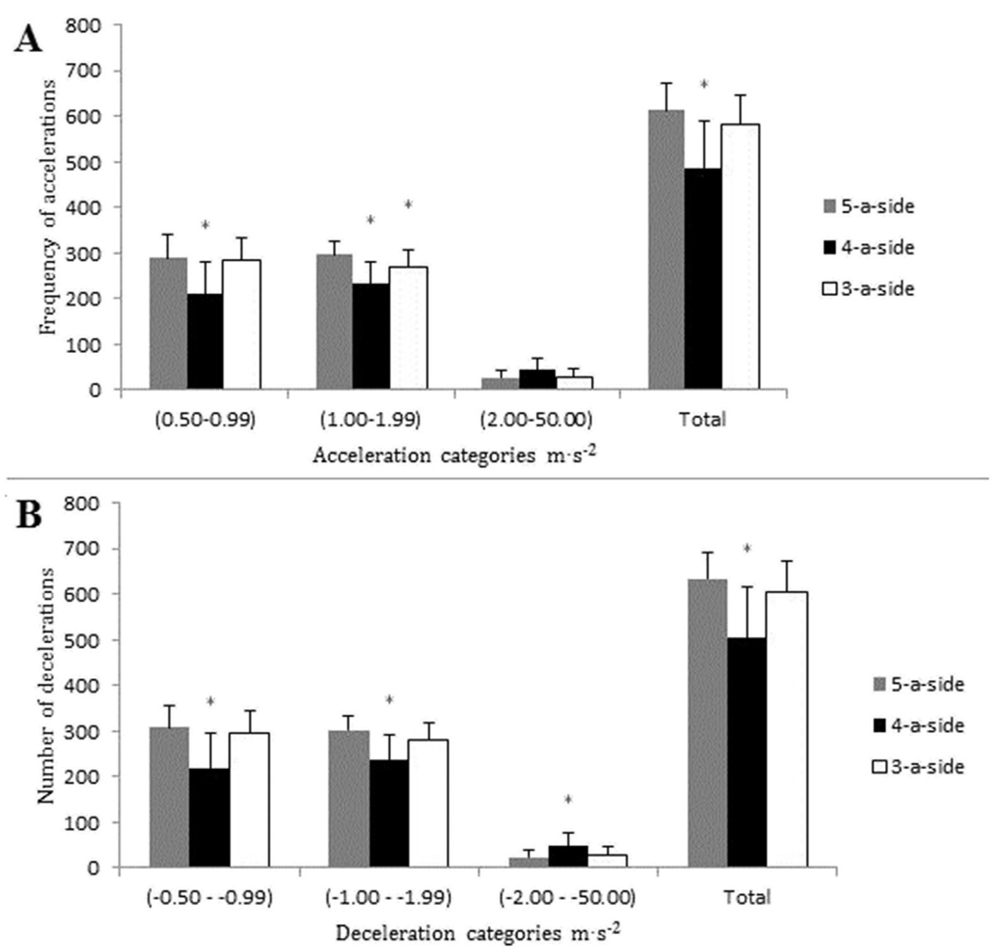

Fig. 4. Frequency of (A) accelerations and (B) decelerations performed at low (0.50–0.99 m s^{-2}), medium (1–1.99 m s^{-2}), and high (≥2 m s^{-2}) intensities during different soccer small-sided game formats. * Significantly different to the 5-a-side game format.

lower competition levels (such as recreational),[34] may have resulted in a greater turnover rate and consequently more frequent transitions up and down the pitch. In support of our theory we found 5-a-side SSG required players to perform a greater amount of accelerations and decelerations, exacerbating the HR response. In addition to tactical decisions, a smaller area per player accompanying larger team sizes may require greater execution of acceleration and deceleration actions to create space.[35] Therefore, game-based conditioning in the form of SSG, primarily 5-a-side, might include more intermittent-style training than previously thought, which has been suggested to heighten physiological demands placed on players in team sports.[35,36] Collectively, these results suggest the cardiovascular responses and acceleration/deceleration demands may be exacerbated with larger team sizes (5-a-side) compared to smaller teams (3- and 4-a-side) in recreational players during football SSG possibly due to greater turnover rate with more frequent interceptions. Further research examining technical actions (shot attempts, rebounds, interceptions, transitions) is needed to definitively identify the influence of these factors on the physiological responses and activity demands across different football SSG formats.

Despite high cardiovascular stress across all SSG formats, the majority of the distance covered was performed while standing/walking or performing low-intensity running (84–92% of playing time), which confirms findings reported in other research examining the demands of football SSG in recreational players.[12,35] These results indicate smaller team sizes (3-a-side) may impose a shorter overall distance covered in recreational players, possibly due to a greater reliance on individual players during game scenarios leading to more dribbling and less passing among players.[33] On the other hand, the 4-a-side SSG may have permitted an optimal amount of teamwork in regards to consistency in player involvement across the team, resulting in more distance covered compared to the other SSG formats. Consequently, the greater volume of activity, particularly at low to moderate intensities, indicate 4-a-side football SSG could be an effective format to improve aerobic conditioning in recreational players.

While activity distance data provide useful information regarding physical demands, BLa has been used as an metabolic indicator of energy production via rapid glycolysis.[36] Our results indicate an important glycolytic energy contribution across football SSG formats (>4 mmol L^{-1}). The isolated guarding of players in 3-a-side SSG may have promoted more shuffling/lateral/static isometric work when defending opponents, which could have exacerbated the lactate response. Therefore, 3-a-side SSG may be an effective approach to optimize conditioning of anaerobic capacity in recreational football players.

Limitations

Although this study provides useful insight, some limitations should be acknowledged. First, researchers should consider the large test-retest variability of HR zones and distance zones when interpreting these measures across intervention-type studies.[17] Second, although the accuracy of GPS tracking system has improved, there are still limitations in interpreting short distance and high-velocity running from only two matches (per format) reported here. Third, BLa reflects the production of lactate in the contracting muscles, but such values should be interpreted carefully, as no significant correlation was found between muscle and BLa.[37] Fourth, our sample was limited to male, adult recreational players, so larger cohort studies are required utilizing female and male players of varying ages.

Conclusion

The results of this study suggest football SSG using 3–5 players in each team might be an effective form of training to improve cardiorespiratory and musculoskeletal fitness evidenced by a mean HR response >80%HR_{max} and high physical loading. The number of players competing in SGG affected the physiological responses and activity demands encountered by players with the highest mean heart rate, as well as acceleration and deceleration demands evident during 5-a-side games. In addition, the 4-a-side SSG format imposed a greater overall volume of activity (total distance), while the 3-a-side SSG resulted in higher BLa and RPE responses compared to other SSG formats.

Declaration of competing interest

The author(s) have no conflicts of interest relevant to this article.

Acknowledgments

The authors would like to thank the subjects who volunteered for this study. Funding for this manuscript was provided by the Ministry of Education, Science, and Technological Development within the project OI179019.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jesf.2020.05.001.

References

1. Milanović Z, Pantelić S, Čović N, et al. Broad-spectrum physical fitness benefits of recreational football: a systematic review and meta-analysis. *Br J Sports Med*. 2019;53:926–939.
2. Cvetković N, Stojanović E, Stojiljković N, et al. Effects of a 12 week recreational football and high-intensity interval training on physical fitness in overweight children. *Phys Educ Sport*. 2018;16:435–450.
3. Beato M, Jamil M, Devereux G. Reliability of internal and external load parameters in recreational football (soccer) for health. *Res Sports Med*. 2018;26: 244–250.
4. Hammami A, Gabbett TJ, Slimani M, et al. Does small-sided games training improve physical-fitness and specific skills for team sports? A systematic review with meta-analysis. *J Sports Med Phys Fit*. 2018;58:1446–1455.
5. Bendiksen M, Williams CA, Hornstrup T, et al. Heart rate response and fitness effects of various types of physical education for 8-to 9-year-old schoolchildren. *Eur J Sport Sci*. 2014;14:861–869.
6. Krustrup P, Hansen PR, Nielsen CM, et al. Structural and functional cardiac adaptations to a 10-week school-based football intervention for 9–10-year-old children. *Scand J Med Sci Sports*. 2014;24:4–9.
7. Beato M. Reliability of internal and external load parameters in 6 a-side and 7 a-side recreational football for health. *Sport Sci Health*. 2018;14:709–714.
8. Pantelić S, Rada A, Erceg M, et al. Relative pitch area plays an important role on movement pattern and intensity in recreational football. *Biol Sport*. 2019;36: 119–124.
9. Randers MB, Nybo L, Petersen J, et al. Activity profile and physiological response to football training for untrained males and females, elderly and youngsters: influence of the number of players. *Scand J Med Sci Sports*. 2010;20: 14–23.
10. Aslan A. Cardiovascular responses, perceived exertion and technical actions during small-sided recreational soccer: effects of pitch size and number of players. *J Hum Kinet*. 2013;38:95–105.
11. Randers MB, Ørntoft C, Hagman M, et al. Movement pattern and physiological response in recreational small-sided football—effect of number of players with a fixed pitch size. *J Sports Sci*. 2018;36:1549–1556.
12. Randers MB, Nielsen JJ, Bangsbo J, et al. Physiological response and activity profile in recreational small-sided football: No effect of the number of players. *Scand J Med Sci Sports*. 2014;24:130–137.
13. Krustrup P, Aagaard P, Nybo L, et al. Recreational football as a health promoting activity: a topical review. *Scand J Med Sci Sports*. 2010;20:1–13.
14. Randers M, Andersen TB, Rasmussen L, et al. Effect of game format on heart rate, activity profile, and player involvement in elite and recreational youth players. *Scand J Med Sci Sports*. 2014;24:17–26.
15. McLester CN, Nickerson BS, Kliszczewicz BM, et al. Reliability and agreement of various InBody body composition analyzers as compared to dual-energy X-ray

absorptiometry in healthy men and women. *J Clin Densitom*. 2018;S1094–6950(18):30221–X. https://doi.org/10.1016/j.jocd.2018.10.008.
16. Scott TJ, Delaney JA, Duthie GM, et al. Reliability and usefulness of the 30-15 intermittent fitness test in rugby league. *J Strength Condit Res*. 2015;29(7):1985–1990.
17. Milanović Z, Rađa A, Erceg M, et al. Reproducibility of internal and external training load during recreational small-sided football games. *Res Q Exerc Sport*. 2019. https://doi.org/10.1080/02701367.2019.1697794.
18. Pavlović L, Stojiljković N, Aksović N, et al. Diurnal variations in physical performance: are there morning-to-evening differences in elite male handball players? *J Hum Kinet*. 2018;63:117–126.
19. Buchheit M. The 30–15 intermittent fitness test: 10 year review. *Myorobie J*. 2010;1:278.
20. Cvetković N, Stojanović E, Stojiljković N, et al. Exercise training in overweight and obese children: recreational football and high-intensity interval training provide similar benefits to physical fitness. *Scand J Med Sci Sports*. 2018;8:18–32.
21. Tanner RK, Fuller KL, Ross ML. Evaluation of three portable blood lactate analysers: lactate Pro, lactate Scout and lactate plus. *Eur J Appl Physiol*. 2010;109:551–559.
22. Köklü Y, Sert Ö, Alemdaroglu U, et al. Comparison of the physiological responses and time-motion characteristics of young soccer players in small-sided games: the effect of goalkeeper. *J Strength Condit Res*. 2015;29:964–971.
23. Foster C, Florhaug JA, Franklin J, et al. A new approach to monitoring exercise training. *J Strength Condit Res*. 2001;15:109–115.
24. Sekiguchi Y, Adams WA, Curtis R, et al. Factors influencing hydration status during a National Collegiate Athletics Association division 1 soccer preseason. *J Sci Med Sport*. 2019;22:624–628.
25. Puente C, Abián-Vicén J, Areces F, et al. Physical and physiological demands of experienced male basketball players during a competitive game. *J Strength Condit Res*. 2017;31:956–962.
26. Gimenes SV, Marocolo M, Pavin LN, et al. Compression stockings used during two soccer matches improve perceived muscle soreness and high-intensity performance. *J Strength Condit Res*. 2019. https://doi.org/10.1519/JSC.0000000000003048.
27. Beck TW. The importance of a priori sample size estimation in strength and conditioning research. *J Strength Condit Res*. 2013;27:2323–2337.
28. Hopkins W, Marshall S, Batterham A, et al. Progressive statistics for studies in sports medicine and exercise science. *Med Sci Sports Exerc*. 2009;41:3–13.
29. Hill-Haas SV, Dawson B, Impellizzeri FM, et al. Physiology of small-sided games training in football: a systematic review. *Sports Med*. 2011;41:199–220.
30. Halouani J, Chtourou H, Gabbett T, et al. Small-sided games in team sports training: a brief review. *J Strength Condit Res*. 2014;28:3594–3618.
31. Mallo J, Navarro E. Physical load imposed on soccer players during small-sided games. *J Sports Med Phys Fit*. 2008;48:166–172.
32. Bredt SdGT, Praça GM, Figueiredo LS, et al. Reliability of physical, physiological and tactical measures in small-sided soccer Games with numerical equality and numerical superiority. *Rev Bras Cineantropom Desempenho Hum*. 2016;18:602–610.
33. Owen AL, Wong DP, McKenna M, et al. Heart rate responses and technical comparison between small-vs. large-sided games in elite professional soccer. *J Strength Condit Res*. 2011;25:2104–2110.
34. Huijgen BC, Leemhuis S, Kok NM, et al. Cognitive functions in elite and sub-elite youth soccer players aged 13 to 17 years. *PLoS One*. 2015;10, e0144580.
35. Randers MB, Brix J, Hagman M, et al. Effect of boards in small-sided street soccer games on movement pattern and physiological response in recreationally active young men. *J Strength Condit Res*. 2017. https://doi.org/10.1519/JSC.0000000000002401.
36. Stojanović E, Stojiljković N, Scanlan AT, et al. The activity demands and physiological responses encountered during basketball match-play: a systematic review. *Sports Med*. 2018;48:111–135.
37. Krustrup P, Mohr M, Steensberg A, et al. Muscle and blood metabolites during a soccer game: implications for sprint performance. *Med Sci Sports Exerc*. 2006;38:1165–1174.