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Influence of different small-sided games on physical and physiological demands in rugby union players

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Abstract

This study aimed to describe the influence of four different small-sided games with 15-min duration on physical and physiological demands in rugby union players. Fourteen rugby union players (22.4 ± 3.2 years) participated in the study that was conducted during the competitive period of final-four first Division of 2012–2013 qualifying competition. Time-motion and body impact data were collected using global positional systems technology with heart rate monitored continuously across training sessions. The present study found that interaction between speed zones, impacts zones and small-sided game formats was significant. No differences were found in the distance covered per minute or the interaction of heart rate values; however, players spent the majority of time above 90% of the HR_{max}. The SSG 1 presents significant lower values in body impacts per minute compared with the other small-sided games. The results of this study demonstrate that small-sided games with evasion skills showed different levels of physical performance, and skill qualities of rugby union players. Although HR responses were similar between all small-sided game formats, the high levels of individual variability may explain the obtained results. Future use of this technology may help practitioners in design and implementation of individual position-specific training programs with appropriate management of player exercise load.

Keywords

Physical fitness, position-specific training, rugby football, skill-based conditioning

Introduction

Given the demands upon the rugby professional athlete, the specificity of the physical preparation should reflect the degree to which each component of fitness is relied upon in competition.[1] The importance of the physical characteristics of a rugby player is reduced if the desired physical attributes do not transfer to improved playing performance.[2]

The association between rugby competition performance and physical characteristics is evident; however, the available research is scarce under this perspective.[3] Recent studies use global positional systems (GPS) to assess time-motion and physiological profiles[4–7]; however, no study has investigated the influence of different small-sided games (SSGs) formats on physiological demands in rugby union players.

In rugby union, the studies of physical characteristics of players, fitness requirements and movement patterns have contributed to the development of more effective conditioning.[5] Indeed, studies have examined the relationship between physical characteristics and measures of playing ability[8,9]; however, an inherent issue with these studies is the measurement and rating of the skill in a controlled training environment, which will have limited application when applied in a competitive setting.[9] SSGs are increasingly being used in rugby as a means of improving the skill and physical fitness levels.[10–12]

The use of rugby SSGs allows the simulation of movement patterns of rugby matches, while maintaining a competitive environment in which athletes must

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perform under pressure and fatigue.[13] In rugby league, Foster et al.[14] studied the heart rate (HR) responses to SSGs among elite junior rugby players.

The findings demonstrate that SSGs generate physiological responses suitable for aerobic conditioning that, although unaffected by the size of the area used, are sensitive to the player number. A study made by Vaz et al.[5] compared the physical exertion and game performance indicators of experienced and novice rugby union players when playing SSGs. The results suggested the possibility of specific physical conditioning might be achieved regardless of never reaching technical and tactical excellence.

Skill qualities of rugby players vary according to playing position[15] and previous studies have documented these differences. The relationships between playing ability and skill execution in drills simulating games have been examined in rugby league[8,16]; however, the relevance of skill assessment in such simulations to game performance is uncertain.

Because of a lack of knowledge in rugby union, no study has compared the effectiveness of different rugby SSGs for improving physical fitness and skills in rugby players. In this sense, the aim of this study was to investigate the influence of different SSGs training sessions on physiological demands in rugby union players. Furthermore, the influence of each SSGs training session will be assessed to differentiate the player's performance.

Method

Participants

Fourteen rugby union players (mean ± SD age, 22.4 ± 3.2) participated in this study. The players belonged to a senior rugby team and were competing in the elite national championship (2012/2013 season). They were training with their team 5 times per week (i.e. 10 to 12 h/week). The dietary intake was assessed and administrated by the Federation nutritionist who supervised all nutritional menus and liquid ingestion for the players. The study was conducted between October 2012 and March 2013 during the competitive period for the final-four first Division of 2012–2013 qualifying competition.

All participants and coaches agreed with the protocol description and were notified that they could withdraw from the study at any time. All participants gave their informed consent and authority for the data to be used for research purposes. The university ethic committee approved this protocol.

Procedures

Four different rugby SSGs (see Table 1) sessions with 15-min duration were planned for this study (1 vs. 1 and 2 vs. 1 evasion skills in SSGs, 7 vs. 7) SSG and Match (Rugby sevens 7 × 7). Please The study was carried during the competitive season and all players were free from injury at the time of testing. All the practice sessions were performed at the same time of day (from 18.30 h to 21.00 h) on a natural turf pitch, under similar environmental conditions (temperature 17–19°C, relative humidity 58–69%). Participants trained 5 times per week for a total of 180 min on a rugby field. The average number of rugby players per training unit was 26 ± 2. All were instructed to complete their regular post match recovery session.

All practice sessions started with low intensity running with touch rugby warm up and ended with a standardized cool down consisting of stretching exercises common to rugby union. Four different rugby SSGs (see Table 1) were planned for this study with 15-min duration and within a 4-week period.

1. SSG 1: Skill-based conditioning with evasion skills SSG were used. In the one-on-one, the player with ball possession move the defender away from the contact and beating a player in defence position. A training drill with 30 m of size, (98 ft) long × 30 m (98 ft) wide, was designed to allow the simulation of movement patterns in rugby enviroment competition.
2. SSG 2: Skill-based conditioning with evasion skills SSG. In the two-on-one, the players with ball possession move the defender away from the contact and beating a player in defence position. A training drill with 30 m (98 ft) long × 30 m (98 ft) wide was used as it allows the simulation of movement patterns in a rugby competition environment.
3. SSG 3: Rugby small-sided match (7 × 7) with an official referee and in a 50 m (164 ft) long × 35 m (114 ft) wide field. In attack situations, players gaining possession; retaining possession, creating space; penetrating and using the space; supporting and scoring. In defence situations, contesting possession; denying space; tackling the ball carrier and regaining ball possession.
4. SSG 4: Match (Rugby Seven's i.e. 7 × 7) with an official referee – Played on a standard rugby union playing field. Teams are composed of three forwards, one scrum half and three backs.

Rugby Sevens matches consist of two halves of 7 min with a 1-min half-time break. Players were allowed to consume water during a specific training session recovery period (approximately 3 min).

All assessments were performed at the same time of day for all participants and in different weeks. No specific rules were utilised in the SSGs to influence the

Table 1. Standard technical criteria used to assess the skills and physiological demands evaluations in different sessions.

Rugby SSGs sessions 15-min duration each evaluation	Skills/physiological demands	Criteria
SSG 1 Evasion skills in SSGs SSG 2 Evasion skills in SSGs 30 m (98 ft) long × 30 m (98 ft) wide	Evasion skills Beating a player (1 vs. 1) Beating a player (2 vs. 1) Total distance covered and distances at different speed zones: % HR_{max} Impact classification system G forces	Inside, outside, in and out, stop and go, accelerate away With ball possession, move the defender away from the support player, deliver a timed pass to the support player and beating a player in defence position. Zone 1 (0–6.9 Km·h^{-1}), zone 2 (7.0–9.9 Km·h^{-1}), zone 3 (10.0–12.9 Km·h^{-1}), zone 4 (13–15.9 Km·h^{-1}), zone 5 (16–17.9 Km·h^{-1}) and zone 6 (≥18.0 Km·h^{-1}). Zone 1 (below 75%), zone 2 (75–84.9%), zone 3 (85–89.9%) and zone 4 (above 90%) Zone 1 (below 5.0–6.0 g), zone 2 (6.1–6.5 g), zone 3 (6.5–7.0 g), zone 4 (7.1–8.0 g), zone 5 (8.1–10.0 g) and zone 6 (above 10.1 g).
SSG 3 Rugby small-sided match (7 vs. 7) with an official referee. 50 m (164 ft) long × 35 m (114 ft) wide	Summary of outcome goals Attack Defence Total distance covered and distances at different speed zones: % HR_{max} Impact classification system G force	Gaining possession; Retaining possession; Creating space; Penetrating using the space; Supporting and scoring Contesting Possession; Denying Space; Tackling the Ball carrier and regaining possession. Zone 1 (0–6.9 Km·h^{-1}), zone 2 (7.0–9.9 Km·h^{-1}), zone 3 (10.0–12.9 Km·h^{-1}), zone 4 (13–15.9 Km·h^{-1}), zone 5 (16–17.9 Km·h^{-1}) and zone 6 (≥18.0 Km·h^{-1}). Zone 1 (below 75%), zone 2 (75%–84.9%), zone 3 (85–89.9%) and zone 4 (above 90%). Zone 1 (below 5.0–6.0 g), zone 2 (6.1–6.5 g), zone 3 (6.5–7.0 g), zone 4 (7.1–8.0 g), zone 5 (8.1–10.0 g) and zone 6 (above 10.1 g).
SSG 4 Match (Rugby sevens, i.e. 7 vs. 7) is played on a standard rugby union playing field with a official referee. The field measures up to 100-m long and 70-m wide/(330 ft) long × (230 ft) wide On each goal line are H-shaped goal posts. Teams are composed of three forwards, one scrum half and three backs. A normal sevens match consists of two halves of 7 min with a 1-min half-time break.	Summary of outcome goals Attack Defence Total distance covered and distances at different speed zones: % HR_{max} Impact classification system G force	Gaining possession; retaining possession; creating space; penetrating using the space; supporting and scoring Contesting possession; denying space; tackling the ball carrier and regaining possession. Zone 1 (0–6.9 Km·h^{-1}), zone 2 (7.0–9.9 Km/h), zone 3 (10.0–12.9 Km·h^{-1}), zone 4 (13–15.9 Km·h^{-1}), zone 5 (16–17.9 Km·h^{-1}) and zone 6 (≥18.0 Km·h^{-1}). Zone 1 (below 75%), zone 2 (75–84.9%), zone 3 (85–89.9%) and zone 4 (above 90%). Zone 1 (below 5.0–6.0 g), zone 2 (6.1–6.5 g), zone 3 (6.5–7.0 g), zone 4 (7.1–8.0 g), zone 5 (8.1–10.0 g) and zone 6 (above 10.1 g).

intensity of the matches. A large number of rugby balls were placed around the pitch perimeter to ensure quick replacement of the ball when it went out of play. To encourage the high work-rate, coach encouragement (but not feedback) was given to players during each session. The Federation nutritionist supervised all liquid ingestion for the players during the recovery periods.

A GPS unit (SPI Pro, *GPSports Systems*, Australia) was used for each player to capture movement data at 5 Hz during all training sessions. The validity and reliability of these devices has been stated by the manufacturer and in previous research.[17,18] The variables recorded were the total distance covered and distances at different speed zones: zone 1 (0–6.9 $Km{\cdot}h^{-1}$), zone 2 (7–9.9 $Km{\cdot}h^{-1}$), zone 3 (10–12.9 $Km{\cdot}h^{-1}$), zone 4 (13–15.9 $Km{\cdot}h^{-1}$), zone 5 (16–17.9 $Km{\cdot}h^{-1}$) and zone 6 ($\geq$18.0 $Km{\cdot}h^{-1}$). The very high intensity activity (above 18 $Km{\cdot}h^{-1}$) was also measured by number of sprints, average time interval and average distance covered per sprint.

As in previous studies,[14,19,20] the HR data were recorded continuously with individual monitors (Polar Team System, Polar, FI) and grouped into four zones of $\%HR_{max}$: zone 1 (below 75%), zone 2 (75–84.9%), zone 3 (85–89.9%) and zone 4 (above 90%). Finally, the GPS devices are coupled with a 100 Hz tri-axial accelerometer, which allowed the estimation of body impacts.

The impact classification system used in this study was based on methods used in rugby[6,21] and the manufacturers' guidelines. This variable was grouped into six zones of *G* force: zone 1 (below 5.0–6.0 g), zone 2 (6.1–6.5 g), zone 3 (6.5–7.0 g), zone 4 (7.1–8.0 g), zone 5 (8.1–10.0 g) and zone 6 (above 10.1 g).

The GPS and the HR devices were attached to the players and activated 15 min before the beginning of each training session, according to the manufacturer guidelines. A 10-min warm-up proceeded each session and a 10-min warm-down concluded each session. To measure the players' HR_{max}, the Yo-Yo intermittent recovery level 2 test was performed.[22]

Statistical analyses

A repeated measures analysis of variance (ANOVA) was performed to identify differences in time motion variables, HR and body impacts according to SSG's format. The differences in the distance per minute and impacts per min were identified using a one-way ANOVA. Pairwise differences were assessed with Bonferroni post hoc test. These calculations were done in SPSS Software (version 18.0, Chicago, IL, USA) and the statistical significance was maintained at 5%.

Results

Figure 1(a) presents the variation of distance covered at the considered speed zones for each SSG format. There was a significant effect of speed zones ($F = 598.3$, $p < .001$, $\eta^2 = .96$), with pairwise differences between all zones with exception of z2-z3 and z5-z6. In addition, the interaction between speed zones and SSG formats was significant ($F = 94.7$, $p < .001$, $\eta^2 = .78$).

Overall, the SSG 1 presents lower variability across the speed zones, with lower distance performed in the z6. Conversely, compared with SSG 1, 2 and 3, the SSG 4 showed higher mean values in z2, z3 and z6.

No differences were found in the distance covered per minute ($p = .197$, $\eta^2 = .06$); however, the SSG 1 presents significant lower values in body impacts per minute ($F = 10.5$, $p < .001$, $\eta^2 = .28$) compared with the other SSGs (Figure 1(b)).

Figure 1(c) presents the number of impacts in the six considered *G* force zones. There was a significant effect of zone ($F = 92.7$, $p < .001$, $\eta^2 = .77$) with pairwise differences in all zones with exception of z2-z4 and z5-z6.

Additionally, differences were found in the interaction between impacts zones and SSG formats ($F = 3.1$, $p < .05$, $\eta^2 = .10$) with exception in relation to the SSG 2–SSG 3, SSG 2–SSG 4 and SSG 3–SSG 4. Globally, the players performed a higher number of impacts in zone 1 (below 5.0–6.0 g).

Finally, the HR values (Figure 1(d)) showed significant effects of zones ($F = 88.3$, $p < .001$, $\eta^2 = .77$); however, no differences were identified in the interaction with SSG formats ($p = .085$, $\eta^2 = .07$). The players spent the majority of time above 90% of the HR_{max} in all formats of the SSG.

Discussion

The results of this study demonstrate that SSGs with evasion skills (i.e. ability to beat a player, 1 vs. 1 and 2 vs. 1) showed different levels of physical performance, and skill qualities of rugby union players. These findings suggest that SSGs with fewer players and limited field sizes elicit greater physiological responses and time-motion demands.[23] Although HR responses were similar between all SSG formats, the high levels of individual variability in HR responses may explain the obtained results.[24] Very similar data are already available in recent research that reported similar HR intensities in rugby league players during competition and training, using skill-based conditioning games.[25,26] The physical and physiological demands of training and competition in rugby union, varies according to player position due to variations in the frequency of substitutions and the time through matches/training at which they are made.[27]

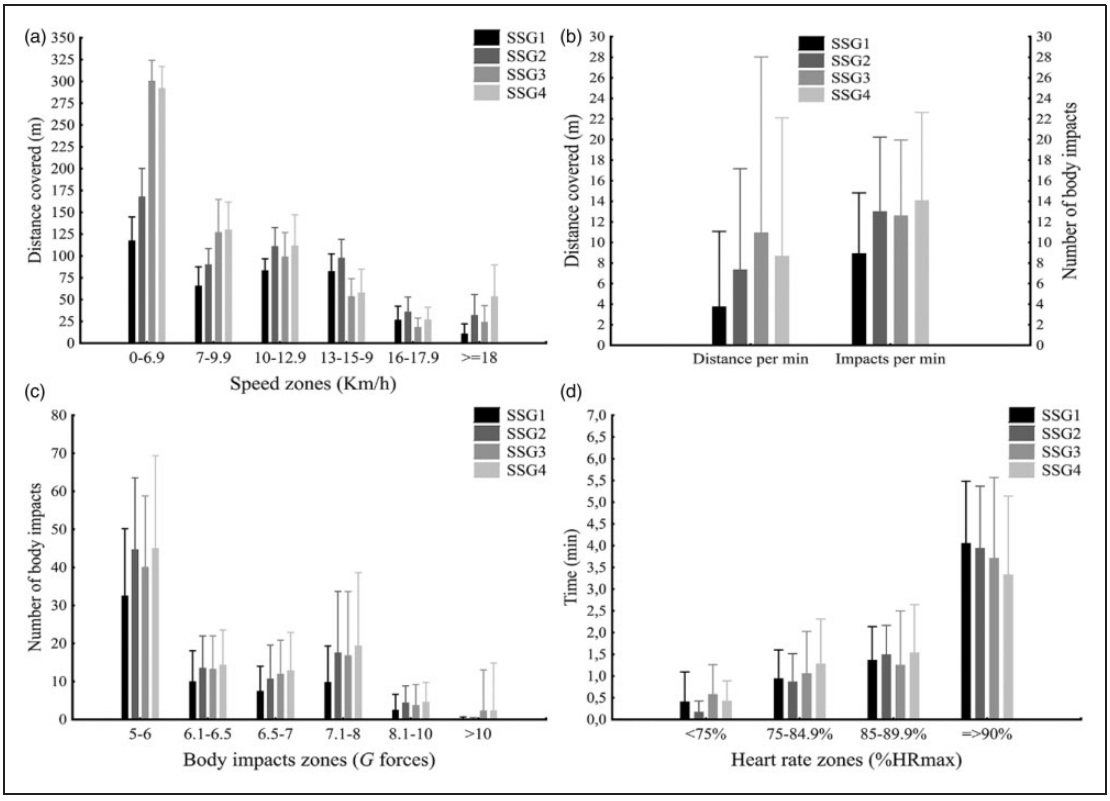

Figure 1. Results from distance covered for each speed zone (a), both distance covered and number of the impacts per minute (b), number of impacts for each intensity zone (c) and time spent in each heart rate zone (d).

The present study found no significant differences among HR value interaction with SSG formats. However, players spent the majority of time above 90% of the HR_{max}. Consistent with previous findings,[5,14,28] the results of this study showed that skill-based conditioning games and SSG match play offer a specific and different training stimulus to physiological demands of competition in rugby players. The greater improvements in physiological capacities may be linked to the training intensity, based on the SSGs HR values.[23] Also, it may be suggested that the improvements in agility, skills and aerobic power during SSGs can be consequence of the training specificity provided by rugby specific activities.

All SSGs training sessions showed significant effect of the considered speed zones for different SSGs. In fact, it is not surprising, because speed is important to gain an advantage over the opponents in all aspects of the rugby union game.[29]

Although the players cover relatively similar distances throughout the course of all SSGs, the typical distances that they cover at various speed zones varies considerably between individuals. The present results seem to be in accordance with available research that showed that skill-based conditioning with evasion skills (e.g. ability to beat a player 1 vs. 1)[24,28,30,31] presented lower variability across the speed zones, with lower distance performed in the z6 and lower values in body impacts per minute.

Collisions and tackles are widely acknowledged as the most demanding aspect of rugby league match-play.[32] In addition, recent research has shown that repeated high-intensity effort exercise (sprinting and tackling) is associated with greater HR and perceived exertion and poorer sprint performance than repeated-sprint exercise alone.[33] In this respect, the addition of tackling significantly increases the physiological response to repeated-sprint exercises and has the potential to reduce physical performance. Also, the increased number of impacts for each intensity zone and time spent in each HR zone may reflect the greater emphasis on physiological demands caused by physical collisions in SSG match sessions.

Given the importance of each SSG in the training session, it is important to evaluate the presence of their prompted behaviour in competition as well as to know if they differentiate the player performance. These findings lend support to the development of a well-known SSG training assessment for rugby union players.

Conclusion

The differences between SSGs training sessions may provide additional information to coaches and may

enhance the training organization by helping in the development of more adequate conditioning and recovery programs for rugby union players. Coaches can redesign SSGs training sessions to be more reflective of game demands. The movement activities and actions of the players occupying the positions while they are on the field, rather than for that position over the entire match need to be considered when constructing SSGs training programs designed to reflect the demands of match play.

Future use of this technology may help practitioners in the design and implementation of individual position-specific training programs with appropriate management of player exercise load.

Declaration of Conflicting Interests

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