Heart rate and lactate of 2 types of small-sided games vs. regular game in youth volleyball players

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Abstract:

Purpose:The aim of present study was to evaluate the effects of two different formats on physiological parameters(HR and[La−]) measured during small-sided games (SSGs) compared to regular game (RG) in youth volleyball players .

Methods:Twelve youth volley ball players (17.2 ± 7.44 years, 189.03 ±5.57 cm, 72.83 ± 8.57 kg;) completed three different games formats (RG: 6 vs. 6, SSG3: 3 vs. 3 and SSG2: 2 vs. 2). Heart rate (HR) and blood lactate ([La−]) were analyzed .

Results:Compared to RG, HR and [La−] were significantly greater within SSGs ($p < 0.05$). Moreover, HR were significantly higher in SSG2 when compared to SSG3. In contrast, no significant differences were observed in [La−] concentration between SSG2 and SSG3 .Conclusion:These results suggest that the number of players influences the exercise intensity in small-sided volleyball games in youth players. Therefore, the use of SSGs seems to be an alternative to coaches to increase cardiovascular and metabolic demands in youth volleyball players.

Key words: Small-sided games, regular game, heart rate, lactate, volleyball.

ملخص:

الغرض: كان الهدف من هذه الدراسة هو تقييم تأثيرات شكلين مختلفين على المعلمات الفسيولوجية (HR و [La−]) التي تم قياسها خلال الألعاب الصغيرة (SSGs) مقارنة باللعبة العادية (RG) في لاعبي الكرة الطائرة الشباب.

الأساليب: أكمل اثنا عشر لاعبًا للكرة الطائرة (17.2 ± 7.44 سنة ، 189.03 ± 5.57 سم ، 72.83 ± 8.57 كجم ؛) ثلاثة تنسيقات ألعاب مختلفة (RG: 6 مقابل 6 ، SSG3: 3 مقابل 3 و SSG2: 2 مقابل 2). تم تحليل معدل ضربات القلب (HR) و اللاكتات في الدم ([La−]).

النتائج: بالمقارنة مع RG، HR و [La−] كانت أكبر بشكل ملحوظ داخل SSGs ($p < 0.05$). علاوة على ذلك ، كانت الموارد البشرية أعلى بشكل ملحوظ في SSG2 بالمقارنة مع SSG3. في المقابل ، لم يلاحظ أي فروق ذات دلالة إحصائية في [La] تركيز بين SSG2 و SSG3.

الخلاصة: تشير هذه النتائج إلى أن عدد اللاعبين يؤثر على كثافة التمرين في ألعاب الكرة الطائرة ذات الجوانب الصغيرة لدى اللاعبين الشباب. لذلك ، يبدو أن استخدام SSGs هو بديل للمدربين لزيادة متطلبات القلب والأوعية الدموية والتمثيل الغذائي لدى لاعبي الكرة الطائرة الشباب.

الكلمات المفتاحية: الألعاب المصغرة - العاب عادية - معدل ضربات القلب – حمض اللبن- كرة طائرة.

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1. Introduction:

Small-sided games (SSGs) are widely used as part of training (Aguiar et al., 2012) in several sports such as soccer (Hill-Haas et al., 2011; Koklu et al., 2011)or rugby (Gabbett et al., 2012; Kennett et al., 2012).They enable coaches to address various objectives simultaneously, for example, technical skills (Jones et al., 2007), conditioning (Hill-Haas et al., 2009), tactical behavior (Almeida et al., 2013), or psychological aspects (Flanagan et al., 2002).

SSGs offer multiple possibilities of factors variations. In this context, several studies have analyzed the effect of modifying the number of players (Dellal et al., 2011; Halouani et al., 2017; Hill-Haas et al., 2009; Little et al., 2007), pitch size (Halouani et al., 2017; Kelly et al., 2009; Tessitore et al., 2006), area per player (Martone et al., 2016), exercise duration (Casamichana et al., 2012; Fanchini et al., 2011; Hill-Haas et al., 2009), coach encouragements(Rowsell et al., 2009), rule changes (Halouani et al., 2017; Halouani et al., 2017; Hill-Haas et al., 2010), ball contacts (Dellal et al., 2011) and differentperiods of play(Dellal et al., 2012) on the physiological demands of soccer. SSGs are viewed as a safe and effective method replicating the physiological demands of competition and providing an opportunity to transfer skills to a competitive environmen(Gabbett et al., 2009).Moreover, volleyball strategy implies a special consideration on game skills efficiency aspects where players must acquire all specific motions: serve, receive, set, attack, block, and dig (Croitoru et al., 2013).Volleyball is an intermittent court sport, with multiple jumps and lateral movements performed throughout a match (Polglaze et al., 1992). It requires well-developed speed, agility, upper- and lower-body muscular power, and maximal aerobic power (VO2max) (Hakkinen 1993). Smith, (1992) suggested that physiological capacities play an important role in the preparation and selection of elite volleyball players (Smith et al., 1992). Furthermore, in volleyball, skill-based conditioning games offer a specific training stimulus to simulate the physiological demands of competition in youth volleyball players (Gabbett 2008). In addition, in the physiological capacities improvements in volleyball players were greater with the use of skill-based conditioning games than with instructional training (Gabbett 2008). This author suggest that conditioning coaches may use skill-based conditioning games during game-specific phases of training to elicit improvements in muscular power, speed, agility, and maximal aerobic power in order to promote the development of game- specific skills under fatigue. Thereby, the use of skill-based conditioning games as training drills allows the movement patterns simulation of team sports, while maintaining a competitive environment in which athletes must perform under pressure and fatigue (Gabbett 2002) .

Nevertheless, it should be stated that most of studies focused on SSG effects have been conducted in a limited number of team sports i.e. soccer, rugby, handball and basketball(Atli et al., 2013; Buchheit et al., 2009; Gabbett et al., 2011; Halouani et al., 2017; Halouani et al., 2017; Halouani et al., 2014).To our best knowledge, no study has attempted to evaluate the physiological impact (i.e., HR and La) of SSGs in volleyball .

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Knowing that the task constraints manipulation could affect the physiological responses and, therefore, the potential beneficial effect for performance improvement, SSGs can offer an additional challenge to volleyball players that would not normally be present in non– skill-related conditioning activities. In addition, it seems to be important to determine which format of SSGs would promote better physiological responses in volleyball. Therefore, the aim of the present study was to compare the effects of two formats of SSGs (SSG2: 2 vs. 2 and SSG3: 3 vs. 3) with regular game (RG: 6 vs. 6) on exercise intensity in volleyball youth players.

1. 2. Methods

1.1 Participants

Twelve young volleyball players (age: 17.2 ± 7.44 years; height: 189.03 ±5.57 cm; body mass: 72.83 ± 8.57 kg) voluntarily participated in this study. All players were members of the same youth team and played in professional league. They had an experience at least of 6 years of volleyball training. All the players and their parents or legal guardians were notified about the research design and its requirements, as well as the potential benefits and risks. Each participant gave written informed consent prior to the start. The study was approved by the local Ethics Committee, and was conducted in a manner consistent with the institutional ethical requirements for human experimentation in accordance with the Declaration of Helsinki 1964 and its further amendments.

2.2 Measures

Heart rate (HR) was continuously monitored throughout the SSGs and the RG by HR monitors (Polar Team Sport System, Polar-Electro OY, Kempele, Finland) and recorded at 5-s intervals. Individual mean HR during RG and SSGs were determined to indicate the overall intensity. HR data were therefore expressed as percentage of HRmax (%HR max). Capillary blood samples were taken from an earlobe within a minute of the end of the last bout of SSG and RG (Pyne et al., 2000); and immediately analyzed for lactate using a portable amperometricmicrovolume lactate analyzer (LactatePro, Arkray, Japan). SSGs and RG were performed at the same time-of-day (from 16 to 18 h) in order to limit the effects of the circadian variations on the measured variables, particularly on HR measures (Chtourou et al., 2012).

2.3 Design and procedures

We comparing 2 SSGs formats (i.e., SSG2:2 vs.2 and SSG3:3 vs.3) with RG (i.e., 6 vs. 6) in the same volley-ball players, we sought to investigate the importance of volley-ball SSG on physiological responses. To achieve this, 2 pitch dimensions and 3 formats of volley-ball players' numbers were employed (i.e., 2 vs.2 and 3 vs.3 on18 × 4.5 m; 6 vs. 6 on 18 × 9 m).Each player performed 4 × 5 min SSG with a recovery period of 1 min between bouts. Participants usually trained using the SSGs with varying numbers of players; but they have been further familiarized with the specific SSG formats (i.e., 2 vs.2; 3 vs.3 and 6 vs. 6) during 3 weeks before the experiment.

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The SSGs consisted of teams of 2 or 3 outfield players being played on 18 × 4.5 m pitch. Whereas the RG consisted of 6 players a-side played on 18 × 9m pitch. Both SSGs had the same duration and lasted for 4 × 5 min with 1 min of passive recovery between games, while the RG consisted of a set of 25 points with 2 technical time-out of 1min and 2 voluntary time-out. Moreover, both SSGs and RG involved normal match rules with no other added conditions. No specific tactical instructions were imposed to players within the games. A large number of balls were placed near to the net ensure continued play (figure 1). Each game was preceded by a 20-min standardized warm-up consisting of low-intensity running, striding, and dynamic stretching with a final part of 5 min of passing ball. All games were played at the beginning of the training sessions. Therefore, hydration status, nutrition, and activity profile were assumed to be consistent. The order of RG on Monday in the third week, SSG3 on Monday in the fourth week, and SSG2 on Monday in the fifth week of the investigation. As requested by the coach, SSGs were not scheduled the day before a competitive game.

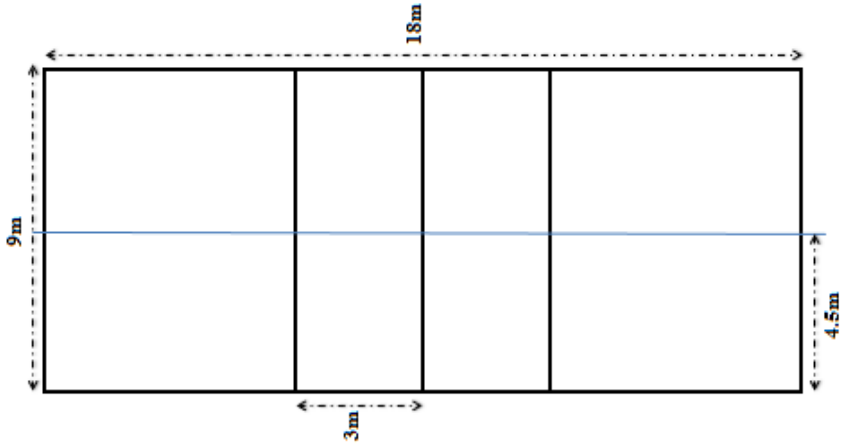

Figure 1: Volleyball court for SSGs

2.4 Statistical analysis

Data are presented as means and standard deviations (means ± SD). Before using parametric statistical test procedures, the normality distribution of data was verified. A two-way analysis of variance (ANOVA) (2×periods; 3×games) with repeated measures was used to test for differences in performance measures (dependent variable) between the different periods within each SSGs (SSG2, SSG3) or the RG, independent variable. When the ANOVA revealed significant factors or interactions

effects, a Bonferroni post hoc test was applied to test the discrimination between means. All statistical analyses were performed using the software package STATISTICA (StatSoft®, Maisons-Alfort, France) and significance was set at P< 0.05.

2. Results

3.1 HR responses

The one-way ANOVA showed a significant effect of game format factor (F[2,2]=37.64 ,P< 0.001) on the % HRmax. Post-hoc analysis reported that the %HRmax was significantly higher during SSG2 compared to the SSG3 (83.45 ± 4.06% vs.77.12 ± 2.51%; P< 0.001) and to the RG (83.45 ± 4.06% vs.71.67 ± 4.55%). Moreover, %HR max was significantly higher during SSG3 compared to RG (77.12 ± 2.51% vs.71.67 ± 4.55%; P< 0.001) (Figure 2).

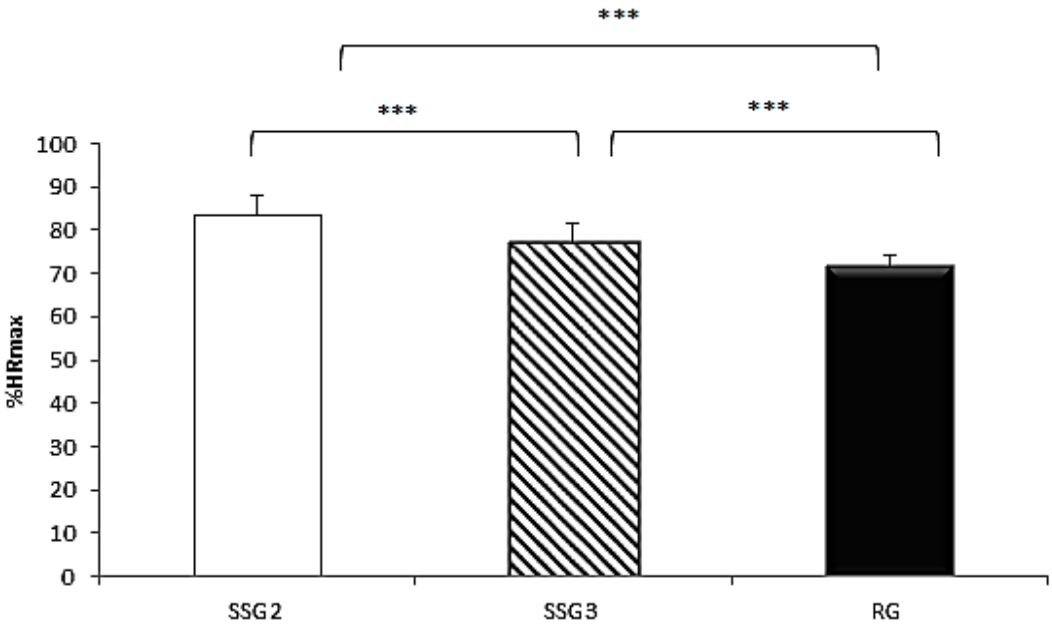

Figure 2.HR values during SSG2, SSG3 and RG *** significant differences at *P*<0.001

3.2 Blood lactate concentration

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The one-way ANOVA showed a significant effect of game format factor ($F[2,2]=4.80$, $P< 0.05$) on the blood lactate concentration. Post-hoc analysis results of the [La−] reported that there was not a significant difference between SSG2 and SSG3 (9.54 ± 5.3 vs. 8.82 ± 3.18 mmol/l; $P =0.65$). However, the [La−] was significantly higher (9.54 ± 5.3 vs.4.99 ± 2.57 mmol/l; $P<0.05$) in SSG2 and SSG3 compared to RG (8.82 ± 3.18 vs. 4.99 ± 2.57 mmol/l; $P< 0.05$)(Figure 4).

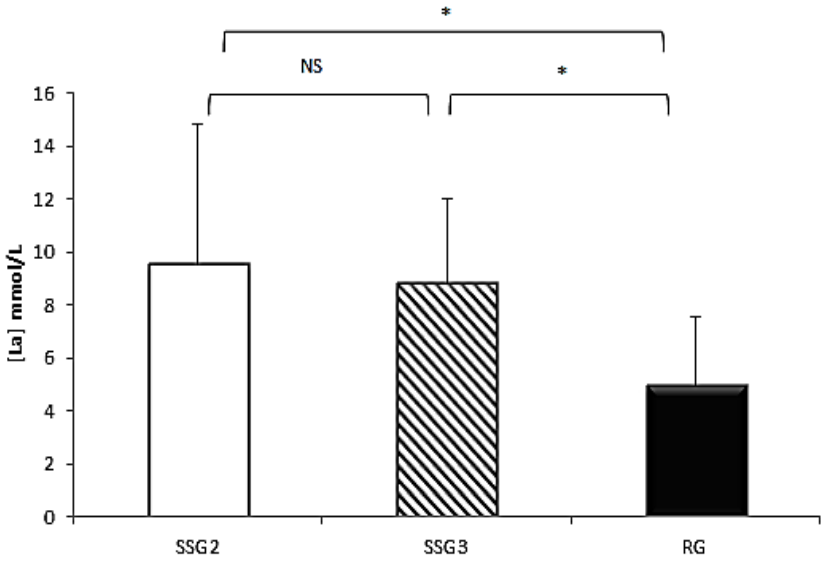

Figure 3.[La−] during SSG2, SSG3 and RG * significant differences at *P*<0.05 and NS no significant difference.

3. Discussion

The purpose of this study was to investigate the physiological responses (HR and [La−]) of SSGs and RG in youth volleyball players. Given the absence of work on volleyball SSGs, we will compare our res1ults with (i) those of team sports and (ii) the specificities and requirements of volleyball.

The results of this study demonstrate that SSGs provide greater physiological responses than RG. Concerning HR results, SSG2 and SSG3 were significantly higher than RG (83.45% vs. 77.12% vs. 71.67%, respectively). These results are further supported in football by the studies of (Dellal et al., 2012; Jones et al., 2007), who showed that players presented higher HR responses during SSGs than RG. This increase in SSGs could be explained by the fact that SSGs induce a greater technical, physical and tactical implication of all players both in offensive and defensive phases. These results are probably due to the increase of shifting distance, the reduction of recovery period and a higher incentive for players in SSGs compared to RG.

Interestingly, in spite of greater number high-intensity actions of play observed during SSGs of the present study, [La−] was higher during the SSGs than during RG (9.54 vs. 8.82 vs. 4.99mmol/l, respectively to SSG2, SSG3 and RG).In football, Dellal et al. (2012) found a higher [La−] within RG than SSGs (Dellal et al., 2012), which is inconsistent with the results of this study, these authors explained the lower [La−] in soccer SSGs by the fact that the high-intensity running bouts were shorter in duration in the SSGs causing a higher reliance on ATP and CP breakdown rather than anaerobic glycolysis. In general, in a volleyball game low concentrations of [La−] (2.54 ± 1.21 mmol/l) during and after matches and increase of free fatty acids indicate that energy during the short exercise periods is mainly supplied by a breakdown of creatine phosphate, while aerobic pathways restore the energy sources during rest periods (Kunstlinger et al., 1987). Due the more high-intensity performed during the SSGs, the anaerobic energy turnover would be expected to contribute more to the muscle metabolism in SSGs as compared to RG.

SSGs are often used as part of regular training programs in various forms, depending on the aim and the philosophy of the coach. Moreover, it allows more time spent managing the ball under game-like conditions compared with generic training. Thus, most exercise sessions in team sports have SSG played with a reduced number of players on a smaller area than the regular official game pitch size (Rampinini et al., 2007).

Since it has been found that the physiological responses during SSGs are higher than within RG, it can be seen that SSGs can be used as a physical training modality for volleyball. All these physiological responses provided some interesting elements but it is important to study these physiological results within different SSG formats and pitch dimensions.

This study extends the findings of others demonstrating that increasing the number of players can significantly alter the physiological responses during SSGs (Foster et al., 2010; Kelly et al., 2009; Rampinini et al., 2007).

In this study, SSG2 had the highest %HR max (83.45%) compared with SSG3 (77.12%). In this context, Dellal et al., (2011) and Rampinini et al., (2007) investigated the effect of changing number of players in football on HR responses in different conditions (Dellal et al., 2011; Rampinini et al., 2007). Those authors observed a higher % HR max and greater HR reserve with reduced number of players. These findings are similar to the results of Casamichana and Castellano (2012) (Casamichana et al., 2012). They revealed that a larger area per player determines a higher effective playing time, %HR max, time spent above 90% HR max and RPE. In rugby, Foster et al. (2010) found that an increase in number of players resulted in a reduced %HRmax(Foster et al., 2010). The highest %HR max revealed in our study can be explained by the recovery for the inactive player during SSG3 were more tactical combinations can be performed. This may increase the active recovery, and thus prepare the players for high intensities

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and to restarts in the following offensive or defensive process. These results can be explained by the greater number of opponents in SSG3 that increase the uncertainty of the player about the actions.

Unlike the previous studies (Dellal et al., 2012; Halouani et al., 2014; Little et al., 2007), we found showed no significant differences in [La−]between SSG2 and SSG3 (9.54 vs. 8.82 mmol/l, respectively). This may have been due to the characteristics of the volleyball game; in both SSG2 and SSG3 format, players are quite free to move and change their position. Furthermore, since the specificity of volleyball requires much more placement than movement, the two forms of SSGs require the same time motion where the players must imperatively participate in each action on volleyball SSG, 0, 1or 2 players are on block and 1, 2 or 3 in the back defense. The specificity of this sport obliges the defender to cover a wider space (forward and backward movement) for the game 1vs.1 as it also forces the blocker to block 2 spikers throughout the net (lateral or cross movement). The finding is useful in coaching and developing the technical skills of novice players because it can promote a higher individual participation and stimulate the technical and physiological aspects.

Hence the absence of any significant difference in this parameter, a time-motion analysis and distance traveled is essential to more clarify and justify our results. Concerning the small number of players participating in this study (n: 12), most studies in SSG have used a small number of subjects participating in their research, and some of them have used the same number of our sample size (Gabbett 2008). Moreover, in our study (RG, SSG2 and SSG3) 12 players fulfilled the inclusion criteria for participating in the research, In order to ensure the smooth running of RG and to guarantee for all players to play within the different game formats.

This study has some limitations. First, the results cannot be generalized for all volleyball training and can only be applied to youth players and not to adults' players. Nonetheless, the study proves that SSG can change players' performance (physiological responses). Future studies can compare the effects of RG with those of SSGs, mainly comparing the physical and tactical learning of players and the collective organization of teammates. The lack of the use of video and GPS does not allow us to provide more accurate data on the players' motion. Further studies with RG and SSG might investigate some comparisons made using GPS and video analysis.

The main limitation of this study are numerous, first, the results cannot be generalized for all volleyball training and can only be applied to youth players. Second, more accurate data in terms of time players' motion and distance traveled using video and GPS analyses could be interesting to more clarify and justify our results. In conclusion, the main findings of the present study reveal that SSGs have higher physiological responses than those during RG. In this context, it appears that the higher physiological responses of youth volleyball players during SSGs are linked with the involvement of each player in the game. On the contrary, a partial commitment of every player is noticed within RG. Within SSGs, changing the number of player has shown to

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significantly influence HR while there was no significantly difference in [La−]. Specifically, the high intensity of SSG2 compared with SSG3 probably due to the pitch area per player. Finally, all these elements could help in planning of seasonal programs and multifunctional aspects of specific training sessions in youth volleyball players. The results of the present study could be used by coaches in order to improve the physiological and/or technical training.

4. Conclusion

The main findings of the present study reveal that SSGs have higher physiological responses than those during RG. In this context, it appears that the higher physiological responses of youth volleyball players during SSGs are linked with the involvement of each player in the game. On the contrary, a partial commitment of every player is noticed within RG. Within SSGs, changing the number of player has shown to significantly influence HR while there was no significantly difference in [La−]. Specifically, the high intensity of SSG2 compared with SSG3 probably due to the pitch area per player. Finally, all these elements could help in planning of seasonal programs and multifunctional aspects of specific training sessions in youth volleyball players.The results of the present study could be used by coachesin order to improve the physiological and/or technical training.

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