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**Section III – Sports Training**

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# Technical Performance and Perceived Exertion Variations Between Small-Sided Basketball Games in Under-14 and Under-16 Competitive Levels

*by*

*Filipe Manuel Clemente[1,2], Rita Sanches[1], Carlos Filipe Moleiro[1], Mónica Gomes[1], Ricardo Lima[1]*

*The aim of this study was twofold: i) to compare the rate of perceived exertion (RPE) and the frequencies of technical actions per minute in different small-sided games (SSGs) between under-14 and under-16 age groups, and ii) to compare the RPE and the frequencies of technical actions per minute between 1 x 1, 2 x 2, 3 x 3, 4 x 4 and 5 x 5 formats within age groups. Twenty young male basketball players from the same club (N = 10, from under-14; N = 10, from under-16) competing at the national level voluntarily participated in this study. Five different SSGs (1 x 1, 2 x 2, 3 x 3, 4 x 4 and 5 x 5) were played twice on courts of the same relative area and were compared in terms of the RPE and technical actions. The number of technical-tactical actions per minute, i.e. conquered balls (CB), received balls (RB), lost balls (LB), attacking balls/passes (AB), shots (S), rebounds (R), and the RPE were collected for each player for each SSG session. The results revealed that most of the differences between age groups were considered trivial/small and/or unclear for all SSG formats, though likely moderate differences between age groups were found in 1 x 1 and 2 x 2 SSGs, revealing that young players had greater frequencies of received, conquered, and lost balls. Within-age-group comparisons also showed moderate-to-large increases in technical actions during smaller formats than during larger ones. The main evidence of this study revealed that age group seemed not to largely influence the RPE or technical actions during different SSGs. However, smaller formats moderately-to-largely increased the number of technical actions. Interestingly, the biggest format (5 x 5) largely increased the RPE in comparison to the remaining formats. As a conclusion, technical actions and the RPE were influenced more by the format of play than by the age group.*

***Key words**: basketball, SSG, drill-based games, youth, performance, technique, notational analysis, perceived exertion.*

## Introduction

Small-sided games (SSGs) are very popular drills used in the training context of team sports and are used to adjust the regular format of play into smaller and modified versions (Clemente, 2016; Halouani et al., 2014). The main purposes of these games are to increase the players' activity during the drills and to specify the physical demands, ensuring the dynamics of a regular game (Hill-Haas et al., 2011). Usually, SSGs use fewer players and smaller courts than official games, and the rules are adjusted to meet the tactical and physical purposes of the coach (Bredt et al., 2018; Clemente, 2016).

Changing the format of play is one of the most typical design studies conducted in basketball (Castagna et al., 2011; Klusemann et al., 2012; Sampaio et al., 2009). The majority of previous studies have revealed that smaller formats elicit a greater heart rate, blood lactate concentrations, and the rate of perceived exertion (RPE) (Castagna et al., 2011; Delextrat and Kraiem, 2013). In studies conducted on basketball

[1] - *Instituto Politécnico de Viana do Castelo, Escola Superior de Desporto e Lazer, Melgaço, Portugal.*
[2] - *Instituto de Telecomunicações, Delegação da Covilhã, Portugal.*

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players comparing 2 x 2, 3 x 3, and 4 x 4 formats, it has been found that the maximal heart rate varied between 86 and 90% in the 2 x 2 format, between 86 and 87% in the 3 x 3 format, and between 83 and 87% in the 4 x 4 format (Castagna et al., 2011; Delextrat and Kraiem, 2013; Klusemann et al., 2012). Moreover, different formats contributed to changes in the physical demands of the drill. A comparison between 2 x 2 and 4 x 4 formats played revealed that the 2 x 2 format imposed higher frequencies of sprints, high-intensity shuffling movements, and jumps, whereas the 4 x 4 format contributed to higher frequencies of standing or walking, jogging, and low-shuffle movements (Klusemann et al., 2012). Based on these results, it is possible to conclude that smaller formats (i.e., formats involving fewer players) contribute to increasing the demand of participation in the game, thus increasing players' acute physiological responses and physical demands. Such evidence seems to be valid for specialized young players, as the majority of the studies conducted have involved players from age groups between under-16 and under-19.

The use of different formats also influences the technical actions made by players during practice. Comparisons between 2 x 2 and 4 x 4 formats revealed that the smaller format increased the frequency of dribbling, passing, close-range shots, mid-range jump shots, and ball screens (Conte et al., 2016; Klusemann et al., 2012). Similar evidence was found in the comparisons between 3 x 3 and 5 x 5 formats, revealing that players participated more often per attack during the smaller format, thus increasing the volume of play (McCormick et al., 2012; Piñar et al., 2009).

Despite the aforementioned studies comparing different acute physiological responses, physical demands, and technical actions between formats of play, relatively little is known about the effects of such formats for different age groups. To the best of our knowledge, there are no studies that have analyzed the effects of different SSGs between age groups. Such information may determine the real impact of these games and whether their effects can vary between ages or competitive levels. This should be carefully analyzed based on the fact that SSGs elicit different technical actions and require more involvement from players than official games, making it essential that the right games are employed at the youth competitive level. Moreover, we have not found any comparisons between all possible balanced SSGs (1 x 1, 2 x 2, 3 x 3, and 4 x 4) that inspected young male players of the under-14 and under-16 age groups. Such analyses may help understand the group of games that are similar in terms of response and the thresholds between them considering the impact on technical actions and perceived exertion. Finally, a comparison between all smaller formats of play with the real format (5 x 5) may help understand the potential differences between SSGs and real game scenarios in terms of technical actions and perceived effort.

Based on previous issues, this study aimed to i) compare the RPE and the frequencies of technical actions per minute in different SSGs between under-14 and under-16 age groups considering different SSGs and real game scenarios, and ii) to compare the RPE and the frequencies of technical actions per minute between 1 x 1, 2 x 2, 3 x 3, 4 x 4, and 5 x 5 (real game) formats within age groups. It was hypothesized that older-players would increase the individual frequencies of technical actions and perception of effort and that smaller formats of play would enhance the individual frequencies of technical actions and increase the overall effort of exercise.

## Methods

### *Participants*

Twenty young male basketball players competing at the national level voluntarily participated in this study (Table 1). These players usually trained three times a week and competed in an official match on weekends. Under-14 players trained, on average, 240 min/week (~80 min/training session) and under-16 players trained, on average, 300 min/week (~100 min/training session). The exclusion criteria were: i) being injured in the last 30 days; ii) competitive experience of less than 2 years; iii) not participating in all experimental sessions. Participants and their parents were informed about the study protocol as well as potential risks and benefits, and after that, the parents signed an informed consent form. The experiment was conducted following the ethical standards for the study in humans as suggested by Declaration of Helsinki.

***Design and Procedures***

A cross-sectional study was conducted to analyze the variations of technical performance and perceived exertion during different SSGs between under-14 and under-16 players. Comparisons between SSG formats within age groups were also executed. The study was conducted 14 weeks after the beginning of the basketball season (i.e., during the midseason). The most of training sessions of these players (before study intervention), independently of the age-group, consisted of a standardized warm-up protocol, followed by a physical conditioning period (strength and power, aerobic capacity or speed/agility), small-sided and conditioned games/analytical drills/position games and formal game.

The 1 x 1, 2 x 2, 3 x 3, 4 x 4 and 5 x 5 formats of play were implemented at a basketball court in an indoor facility during a 5-week period. Participants were familiarized with the rules and dynamics of the matches before the study began. On the first week of data collection, the 3 x 3 and 1 x 1 formats were implemented. On the second week, the 5 x 5 and 2 x 2 formats were used. On the third week, the 4 x 4 and 1 x 1 formats were applied. On the fourth week, the 3 x 3 and 2 x 2 formats were implemented, while on the fifth week, the 5 x 5 and 4 x 4 formats were used. In each session, only one format was tested during two bouts. There was a 48-hour rest interval between data collection sessions. The SSGs were played immediately after a 15-min standardized warm-up consisting of 5 min of moderate running, 5 min of dynamic stretching, mobility and accelerations/decelerations, and 5 min of a ball-possession game. Players were allowed to drink water between exercises ad libitum. The sessions were carried out at 6.30 pm at an average temperature of 16.4ºC on an indoor court.

***Small-sided games***

The teams were chosen by the head coach, considering the player's level and the playing position, trying to balance the teams in terms of the skill level and positions (e.g., 1 guard + 1 center vs. 1 guard + 1 center). In the situation of the 1 vs. 1 format the pairs were chosen by a playing position (e.g., 1 guard vs. 1 guard).

No strategic or tactical instructions were conceded to players before, during or after the SSGs. Only verbal encouragement was provided to maintain the players' commitment. Five basketballs were distributed around the court to avoid wasting time whenever a ball went out of bounds. All FIBA rules were implemented with the exceptions of those regarding time-offs and free-throws. Personal fouls led to the loss of ball possession by the team that committed the foul, and the team that suffered the foul regained ball possession by throwing the ball in from the sideline. The coaches acted as referees during the matches. The specificities of the SSGs, court dimensions, and exercise regimens are presented in Table 2. All the matches occurred with baskets and balls normalized to the age group. The individual playing area per player and the width: length ratio were kept as similar as possible to the official format to minimize the effect of changing the court dimensions during the analyses of variations of technical actions and perceived effort between formats.

***Measures***

*The Rate of Perceived Exertion (RPE)*

The effort during each match was monitored with the CR-10 Borg scale (Borg, 1998). On this 10-point perceptive scale, a rating of 1 means very light activity and a rating of 10 means maximal exertion. Players were asked to score the exertion level immediately after each match. Players were previously familiarized with the scale to ensure their comprehension and accurate scoring. The RPE score was standardized based on the time of play. The answers were provided privately to avoid players hearing the ratings of other players and to otherwise minimize external factors, thus increasing the reliability and validity of the scores.

*Technical performance*

Three digital cameras (Go Pro Hero 2, 1280 x 960, 25 Hz) recorded all the matches during the experiments. Two cameras were positioned at an open angle, and one was used to focus on the player with possession of the ball. The following technical actions were coded: conquered balls (CB), received balls (RB), lost balls (LB), attacking balls/passes (AB), shots (S), and rebounds (R). These categories were chosen based on the Performance Assessment in Team Sports instrument (Gréhaigne et al., 1997). CB were considered every time a player stole the ball from an opponent. RB were coded in situations when a player received a ball (pass) from a teammate and

did not lose control of it. LB were considered in cases when a player lost ball possession to an opponent or by going out of bounds. AB were considered every time a player executed a pass to a teammate which moved the ball forward from the passer's position (backward passes were not included). S were considered when a player tried to score by means of a throw. R were coded when a player gained ball possession after a missed throw attempt in both offensive and defensive situations.

To compare the technical actions between formats, the number of actions was relativized by minutes (number of actions per minute). The observational process was carried out by one experienced observer who had more than three years of experience in basketball match analysis. The observer's reliability was tested, basically comparing the total frequencies per player in the test and re-test. A within-observer test was conducted with 10% of the data. The observer coded the same data twice with a 20-day interval. The intraclass correlation coefficient revealed a value of 0.93 (excellent reliability).

***Statistical analysis***

Results are presented as either means and standard deviations (SD) or percentage differences and 90% confidence intervals (90% CI). Between-age groups and within-age groups differences were analyzed using the standardized differences of the effect size (ES), with a 90% CI (Cohen, 1988). ES was classified as trivial (<0.2), small (0.2-0.6), moderate (0.6-1.2), or large (>1.2) (Batterham and Hopkins, 2006). Probabilities were calculated considering the smallest worthwhile changes (SWC, 0.2 × between-subjects SD) (Hopkins et al., 2009). Qualitative probabilistic mechanistic inferences of the true effects were made using these probabilities (Hopkins et al., 2009). The scale for qualitative probabilities was as follows: 25-75% = possible; 75-95% = likely; 95-99% = very likely; >99% = most likely (Hopkins et al., 2009).

## Results

Table 3 presents the RPE and the number of each technical-tactical action performed by each player per minute between-age groups in the five formats of play. Most of the differences between-age groups were considered trivial/small and/or unclear among SSG formats. The exceptions are highlighted in Table 3.

Standardized differences of conquered and lost balls between formats within age groups can be found in Figure 1. Very likely large decreases of conquered balls were found in 2 x 2 (-65.3%, [-82.6;-30.8]), 3 x 3 (-74.2%, [84.0;-58.5]), 4 x 4 (-67.1%, [89.4;1.7]) and 5 x 5 (-85.9%, [-93.7;-68.0]) formats in comparison to the 1 x 1 format in under-14 players. Additionally, very likely large decreases of conquered balls were found in the 5 x 5 compared to the 2 x 2 format (-59.2%, [-80.2;-16.0]) in under-14. Considering the under-16 age group, very likely large decreases of conquered balls were observed in the 3 x 3 (-42.3%, [-98.2;1752.0]) and 4 x 4 (-29.3%, [-92.1;530.7]) formats in comparison to the 1 x 1 format. Moreover, there were likely large decreases of conquered balls in under-16 in the 5 x 5 compared to the 4 x 4 format (-49.6%, [-74.3;-1.1]).

We found very likely decreases of lost balls in the 2 x 2 (-62.9%, [-80.4;-29.8]), 3 x 3 (-68.8, [-86.8;-26.6]), 4 x 4 (-72.9%, [-89.0;-33.2]) and 5 x 5 (-77.4, [-88.5;-55.6]) formats in comparison to the 1 x 1 format in the under-14 age group. Moreover, in the same group, a very likely large decrease of lost balls in the 5 x 5 was noted in comparison to the 2 x 2 format (-57.6%, [-69.1;-41.9]). In the case of the under-16 group, all large differences were unclear.

Standardized differences of rebounds and shots between formats within age groups are presented in Figure 2. Very likely large decreases of rebounds were found in the 5 x 5 format in comparison to the 1 x 1 format (-60.9%, [-79.7;-24.4]) and likely large decreases were found in the 4 x 4 format in comparison to the 1 x 1 format (-58.3%, [-81.0;-8.3]) in under-14. With regard to the under-16 players, very likely decreases of rebounds were observed in the 2 x 2 (-52.3%, [-64.4;-36.2]), 3 x 3 (-55.8%, [-65.5;-43.3]), 4 x 4 (-55.2%, [-63.9;-44.4]) and 5 x 5 (-55.8%, [-62.4;-48.0]) format in comparison to the 1 x 1 format.

Very likely large decreases of shots were noticed in the 4 x 4 (-70.5%, [-80.1;-56.1]) and 5 x 5 (-75.0, [-81.7;-65.7]) format compared to the 2 x 2 format in under-14 players. Additionally, very likely decreases in the 4 x 4 (-55.8%, [-67.3;-40.4]) and 5 x 5 (-55.8%, [-71.2;-32.3]) formats were found in comparison to the 3 x 3 format. With regard to the under-16 age group, we found very likely large decreases of shots in the 2 x 2 (-43.0%,

[-50.7;-34.2]), 3 x 3 (-46.1%, [-50.7;-41.1]), 4 x 4 (-45.5%, [-51.2;-39.2]) and 5 x 5 (-42.3%, [-50.1;-33.2]) formats in comparison to the 1 x 1 format. Very likely large decreases of shots in the 4 x 4 (-54.5%, [-75.0;-17.2]) and 5 x 5 (-60.0%, [-74.3;-37.7]) format compared to the 2 x 2 format were found in under-16 players. Finally, in the same age group (under-16) very likely decreases in the 4 x 4 (-32.5%, [-58.6;9.9]) and 5 x 5 (-40.6%, [-59.7;-12.4]) format in comparison to the 3 x 3 format were observed.

Standardized differences of attacking balls and received balls between formats within age groups can be found in Figure 3. Very likely large decreases of attacking balls in the 4 x 4 (-48.0%, [-65.4;-21.7]) and 5 x 5 (-48.9%, [-63.3;-28.7]) formats compared to the 2 x 2 format were found in under-14. We also found very likely decreases of received balls in the 4 x 4 (-19.7%, [-31.6;-5.6]) and 5 x 5 (-24.7%, [-35.1;-12.5]) format in comparison to the 3 x 3 format in under-16 players.

Standardized differences of the RPE between formats within age groups are presented in Figure 4. Very large increases of the RPE were found in the 5 x 5 compared to the 1 x 1 (66.4%, [34.3;106.2]), 2 x 2 (62.6%, [37.9;91.7]), 3 x 3 (49.6%, [32.5;68.8]) and 4 x 4 (53.2%, [35.8;72.8]) format in under-14. Similarly, in under-16, we observed very likely large increases of the RPE in the 5 x 5 format in comparison to the 1 x 1 (64.6%, [47.2;84.0]), 2 x 2 (77.0%, [58.1;98.2]), 3 x 3 (65.5%, [56.6;74.9]) and 4 x 4 (60.1%, [48.7;72.3]) format.

**Table 1**

*Descriptive statistics (mean and SD) of the participants*

| | Under-14 (N = 10) | Under-16 (N = 10) |
|---|---|---|
| Age (years old) | 12.0 (0.8) | 14.3 (0.5) |
| Body height (cm) | 161.0 (7.2) | 170.7 (9.8) |
| Body mass (kg) | 57.4 (15.3) | 67.2 (17.7) |
| Experience (years) | 3.1 (0.4) | 4.6 (0.7) |

**Table 2**

Specificities of the SSG formats.

| | **1x1** | **2x2** | **3x3** | **4x4** | **5x5** |
|---|---|---|---|---|---|
| Court dimensions* | 15 x 6 m | 22 x 8 m | 24 x 11 m | 26 x 13 m | 28 x 15 m |
| Area per player | 45 $m^2$ | 44 $m^2$ | 44 $m^2$ | ~42 $m^2$ | 42 $m^2$ |
| Regimen | 2x1′/2′ rest | 2x2′/2′ rest | 2x3′/2′ rest | 2x4′/2′ rest | 2x5′/2′ rest |

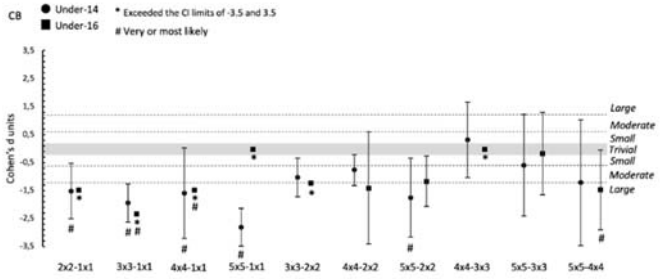
**The baskets were separated by the length of the court in each SSG format.*

**Table 3**

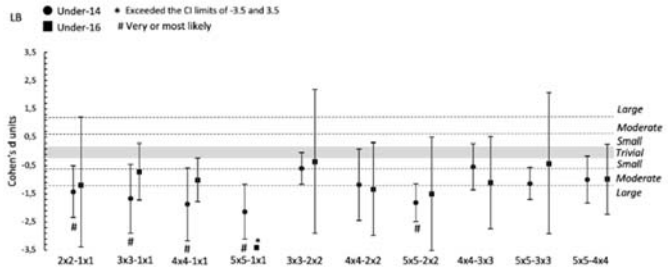
*The RPE and the number of technical-tactical actions performed per player per minute in each age-group, percentage and standardized differences between age-groups for all technical-tactical actions and the RPE, and the probabilities of each standardized difference.*

| Format | Variable | M(SD) Under-14 | M(SD) Under-16 | % difference (U16-U14) | | Standardized difference (U16-U14) | | % greater/similar/lower values for U16 vs. U14 |
|---|---|---|---|---|---|---|---|---|
| | | | | Value | [90%CI] | Value (*Magnitude*) | 90%CI | |
| 1 x 1 | CB (n/min) | 0.75(0.72) | 0.25(0.35) | -35.4 | [-62.2;10.1] | **-0.63 *moderate*** | [-1.39;0.14] | 4/12/84 *likely* |
| | LB (n/min) | 0.80(0.67) | 0.30(0.42) | -17.1 | [-51.8;42.6] | -0.28 *small* | [-1.08;0.52] | 15/28/57 *unclear* |
| | R (n/min) | 0.60(0.61) | 1.40(0.39) | 81.8 | [19.8;176.1] | **0.95 *moderate*** | [0.29;1.62] | 97/3/1 *very likely* |
| | S (n/min) | 0.75(0.72) | 2.35(0.41) | 151.2 | [58.5;298.1] | **1.32 *large*** | [0.66;1.98] | 99/1/0 *very likely* |
| | RPE (A.U.) | 3.65(1.53) | 3.65(0.97) | 3.3 | [-20.1;33.5] | 0.08 *trivial* | [-0.56;0.72] | 37/40/23 *unclear* |
| 2 x 2 | RB (n/min) | 1.83(0.74) | 1.43(0.59) | -23.3 | [-45.7;8.2] | **-0.60 *moderate*** | [-1.38;0.18] | 5/15/81 *likely* |
| | CB (n/min) | 0.43(0.26) | 0.18(0.17) | -34.5 | [-53.5;-7.7] | **-0.83 *moderate*** | [-1.50;0.16] | 1/5/94 *likely* |
| | LB (n/min) | 0.38(0.21) | 0.28(0.25) | -7.2 | [-38.0;38.7] | -0.16 *trivial* | [-1.01;0.69] | 23/30/47 *unclear* |
| | AB (n/min) | 1.03(0.34) | 0.75(0.41) | -19.8 | [-40.6;8.3] | -0.56 *small* | [-1.33;0.21] | 5/16/79 *unclear* |
| | R (n/min) | 0.63(0.54) | 0.58(0.39) | -14.9 | [-52.2;51.7] | -0.20 *small* | [-0.92;0.52] | 17/33/50 *unclear* |
| | S (n/min) | 1.40(0.61) | 1.10(0.60) | -22.9 | [-48.4;15.3] | -0.46 *small* | [-1.18;0.25] | 6/20/73 *unclear* |
| | RPE (A.U.) | 3.60(0.94) | 3.40(0.99) | -6.2 | [-24.0;15.8] | -0.23 *small* | [-0.98;0.52] | 17/31/53 *unclear* |
| 3 x 3 | RB (n/min) | 1.55(0.57) | 1.28(0.16) | -11.9 | [-30.9;12.3] | -0.29 *small* | [-0.84;0.26] | 7/32/61 *unclear* |
| | CB (n/min) | 0.23(0.14) | 0.05(0.11) | -0.7 | [-90.7;966.4] | -0.01 *trivial* | [-4.92;4.89] | 41/16/43 *unclear* |
| | LB (n/min) | 0.30(0.20) | 0.10(0.14) | -18.6 | [-51.2;35.7] | -0.33 *small* | [-1.15;0.49] | 13/26/61 *unclear* |
| | AB (n/min) | 0.83(0.38) | 0.73(0.34) | -13.1 | [-40.7;27.5] | -0.27 *small* | [-1.01;0.47] | 14/29/57 *unclear* |
| | R (n/min) | 0.52(0.41) | 0.40(0.27) | 15.0 | [-31.3;92.4] | 0.17 *trivial* | [-0.46;0.79] | 47/38/16 *unclear* |
| | S (n/min) | 0.83(0.41) | 0.72(0.32) | -25.7 | [-46.2;2.8] | **-0.77 *moderate*** | [-1.60;0.07] | 3/10/87 *likely* |
| | RPE (A.U.) | 3.85(0.67) | 3.55(0.60) | -7.7 | [-19.0;5.2] | -0.42 *small* | [-1.11;0.27] | 7/22/71 *unclear* |
| 4 x 4 | RB (n/min) | 1.01(0.42) | 0.99(0.41) | -5.4 | [-30.6;29.1] | -0.15 *trivial* | [-1.01;0.71] | 24/30/46 *unclear* |
| | CB (n/min) | 0.14(0.16) | 0.10(0.11) | -26.0 | [-55.0;21.8] | -0.54 *small* | [-1.42;0.35] | 8/17/75 *unclear* |
| | LB (n/min) | 0.16(0.14) | 0.13(0.12) | -22.6 | [-51.2;22.8] | -0.44 *small* | [-1.23;0.35] | 9/21/70 *unclear* |
| | AB (n/min) | 0.66(0.50) | 0.59(0.43) | 6.8 | [-41.1;93.5] | 0.07 *trivial* | [-0.60;0.75] | 37/38/24 *unclear* |
| | R (n/min) | 0.33(0.31) | 0.29(0.13) | 28.5 | [-21.8;111.1] | 0.29 *small* | [-0.28;0.86] | 61/32/8 *unclear* |
| | S (n/min) | 0.44(0.25) | 0.51(0.22) | 18.8 | [-28.3;96.8] | 0.25 *small* | [-0.49;0.99] | 55/30/15 *unclear* |
| | RPE (A.U.) | 3.80(0.95) | 3.70(0.82) | -2.2 | [-17.4;15.7] | -0.09 *trivial* | [-0.78;0.59] | 23/37/39 *unclear* |
| 5 x 5 | RB (n/min) | 1.10(0.41) | 0.93(0.35) | -15.4 | [-36.5;12.7] | -0.41 *small* | [-1.12;0.29] | 7/23/70 *unclear* |
| | CB (n/min) | 0.11(0.12) | 0.04(0.05) | -38.2 | [-60.6;-3.0] | **-0.74 *moderate*** | [-1.43;-0.05] | 2/7/91 *likely* |
| | LB (n/min) | 0.11(0.10) | 0.05(0.07) | -16.6 | [-47.3;31.8] | -0.34 *small* | [-1.20;0.52] | 14/25/62 *unclear* |
| | AB (n/min) | 0.54(0.22) | 0.55(0.25) | -1.9 | [-34.1;45.8] | -0.04 *trivial* | [-0.84;0.76] | 30/33/37 *unclear* |
| | R (n/min) | 0.25(0.18) | 0.25(0.18) | 21.0 | [-28.6;105.0] | 0.25 *small* | [-0.44;0.95] | 55/31/14 *unclear* |
| | S (n/min) | 0.36(0.17) | 0.43(0.16) | 23.3 | [-20.7;91.5] | 0.33 *small* | [-0.36;1.01] | 62/28/10 *unclear* |
| | RPE (A.U.) | 5.70(0.48) | 5.85(0.78) | 2.2 | [-6.4;11.5] | 0.23 *small* | [-0.71;1.16] | 52/26/22 *unclear* |

*Legend: RB: received balls; CB: conquered balls; LB: lost balls; AB: attacking balls; R: rebounds; S: shots; RPE: rated of perceived exertion (10-points scale); U14: under-14 years old; U16: under-16 years old*




(a)

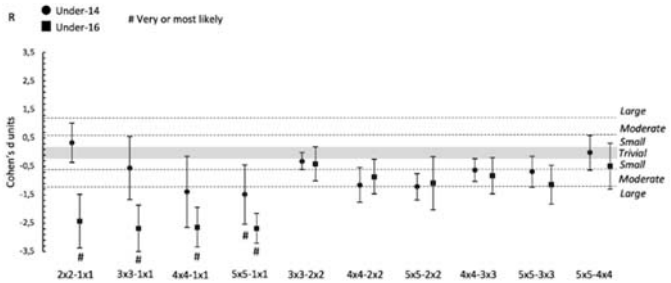



(b)

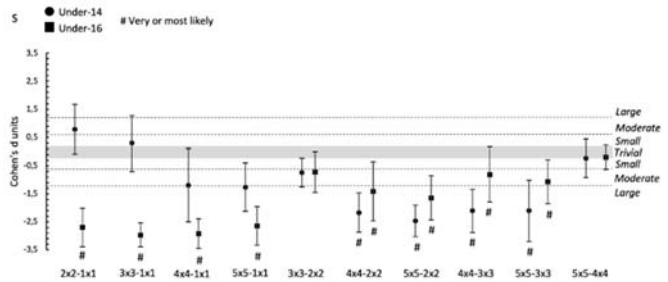
**Figure 1**

*Standardized differences (Cohen) between SSG formats for (a) conquered balls (n/min) and (b) lost balls (n/min).*

*Legend: grey area represents trivial magnitude. Standardized value direction depends on the A-B relationship. If the value of Cohen D is negative it means that B had greater values. On the other hand, if the values are positive it means that A had greater values.*




(a)

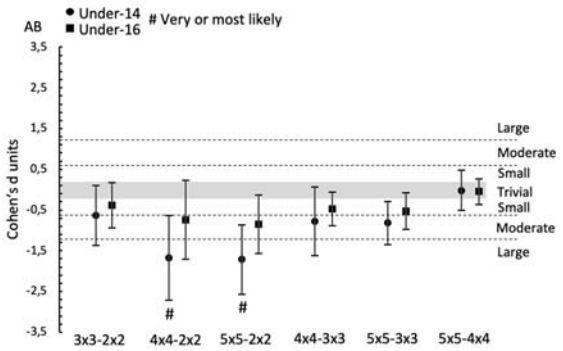



(b)

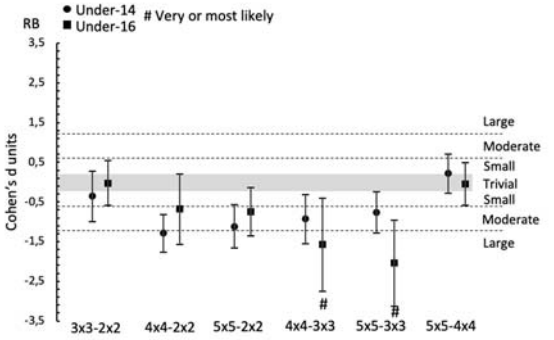
**Figure 2**

*Standardized differences (Cohen) between SSG formats for (a) rebounds (n/min) and (b) shots (n/min).*

*Legend: grey area represents trivial magnitude. Standardized value direction depends on the A-B relationship. If the value of Cohen D is negative it means that B had greater values. On the other hand, if the values are positive it means that A had greater values.*




(a)




(b)

**Figure 3**

*Standardized differences (Cohen) between SSG formats for (a) attacking balls (n/min) and (b) received balls (n/min).*

*Legend: grey area represents trivial magnitude. Standardized value direction depends on the A-B relationship. If the value of Cohen D is negative it means that B had greater values. On the other hand, if the values are positive it means that A had greater values.*

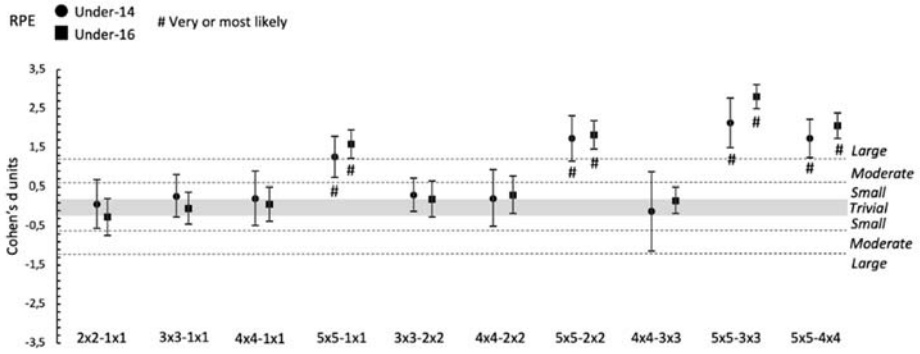



**Figure 4**

***S**tandardized differences (Cohen) between SSG formats for the RPE (n/min).*

*Legend: grey area represents trivial magnitude. Standardized value direction depends on the A-B relationship. If the value of Cohen D is negative it means that B had greater values. On the other hand, if the values are positive it means that A had greater values.*

## Discussion

Between-age-group differences were tested in this study. It was hypothesized that older-players would increase the individual frequencies of technical actions and perception of effort and that smaller formats of play would enhance the individual frequencies of technical actions and increase the overall effort of exercise. The main evidence revealed trivial-to-small differences in the technical actions and perceived exertion across formats. However, likely moderate decreases of conquered balls for the under-14 and under-16 age groups were found in the 1 x 1, 2 x 2 and 5 x 5 formats. Considering the frequency of shots, very likely large increases were found in the under-16 group during 1 x 1 SSGs; furthermore, likely moderate increases in the under-14 group in the 3 x 3 format were also observed. Received balls were likely moderately greater in the under-14 group in the 2 x 2 format. Finally, very likely large increases in rebounds were noticed in the under-16 group during the 1 x 1 format. The within-group differences revealed moderate-to-large increases in the 1 x 1 format in terms of the frequency of conquered balls, lost balls, shots, and rebounds in comparison to the other formats. It was also found that smaller formats (2 x 2 and 3 x 3) moderately-to-largely increased the frequency of received balls, attacking balls, and shots in comparison to larger formats. The 5 x 5 format largely increased the RPE for both age groups.

The generalization of the use of SSGs in a training context has been observed, aiming to improve the specificity of drills to the format and demands of the game (Halouani et al., 2014; Vaquera et al., 2018). However, one of the main requirements is that SSGs fit the level of players to guarantee a proper level of exertion. In a previous study it was found that the skill level influenced performance in SSGs, and for that reason, it is important to adjust the usability of these games to the specificity of players (Clemente et al., 2017). Testing the aging effects on SSGs performance, it was found in our study that the majority of differences were trivial to small. The main differences (i.e., those with moderate effects) were the higher frequencies of conquered balls in under-14 during 1 x 1, 2 x 2, and 5 x 5 formats. As conquered balls are associated with the loss of the ball of the opponent, it is plausible that younger players tend to have a lower capacity to maintain the ball during SSGs, and this may cause an increase in their defensive capacity to recover the ball. Despite the different limbs used in the ball control, in a previous study (Almeida et al., 2013) that compared novice with expert young soccer players it was found that expert players tended to keep the ball for longer periods of time and were more involved in the attacking process, thus being in line with our possible explanation.

Differences between age groups were not conclusive in the case of shots. Very likely large increases of shots were found in the under-16 age group in the 1 x 1 format; however, likely moderate increases were observed in the under-14 age group in the 3 x 3 format. In a study conducted in soccer players, it was found that older players tended to increase their attacking capacity to explore the wings of the field, aiming to score (Olthof et al., 2015). However, in our study, the final outcome of shooting data revealed an unclear tendency across the formats, despite of older players achieving very likely larger shots than younger players during the 1 x 1 format. Probably, the technical improvement (based on experience) and the greater synchronization with the target helped explain this very clear evidence in older players.

The secondary purpose of this study was to analyze the within-age-group differences between SSG formats. The inferences about these comparisons were much clearer than the comparisons between age groups. The main evidence revealed that the 1 x 1 format very likely largely increased the individual frequencies of conquered balls in both age groups. Moreover, the 2 x 2 format induced large increases in the frequency of conquered balls in comparison to 5 x 5 (in under-14) and 4 x 4 (in under-16) formats. Lost balls were also largely greater in smaller formats in both age groups. Such evidence reveals that extreme (1 x 1) and smaller (2 x 2) formats tend to increase errors in terms of losing balls and the individual defensive actions regarding the frequencies of conquered balls.

Analyses of individual frequencies of shots and attacking balls revealed that the 2 x 2 format largely increased these performance indicators in comparison to larger formats. This is in line with studies that revealed that the particular format of 2 x 2 increased attacking

elements (dribbling, passing, shots, and ball screens) in comparison to the 4 x 4 format (Conte et al., 2016; Klusemann et al., 2012). Results seem to be very clear suggesting that smaller formats largely increase the individual participation of players, which is extremely helpful to enhance the potential time of learning and provide more learning opportunities for players (Tallir et al., 2012). Despite that, coaches should be aware that smaller formats also result in an increase in lost balls and that, for this reason, SSGs must be carefully applied in the sensitivity period of learning.

Finally, the effort exerted was very likely greater in the biggest format (5 x 5). This result was probably caused by the greater amount of time spent in this format in comparison to smaller ones. The greater activation of aerobic capacity (and acute physiological responses associated with an increase in the heart rate) may have caused the higher rates of effort of players. For this reason, the results are not in line with previous findings that showed that smaller formats elicited a greater heart rate, blood lactate, and the RPE when the time was the same across formats (Castagna et al., 2011; Delextrat and Kraiem, 2013; Klusemann et al., 2012).

This study had some limitations. Only two age groups were considered in the analysis. It would be interesting to increase the range of ages and to analyze whether greater differences in age result in significant differences in SSG performance. Moreover, this study did not split comparisons between skill levels. Considering the physical impact, the external load (namely, the number of jumps, height of jumps and acceleration/deceleration profile) measured by inertial measurement units was not assessed. This would have allowed to understand the effort in relation to physical demands of the game. Finally, the space creation dynamics and the tactical behavior were not measured and definitely this information would contribute to understand the outcomes obtained in terms of technical actions. All those methodological approaches/analyses should be used in future to increase the knowledge about SSGs.

This study was the first that tested SSG performance between two youth age groups. The results revealed that defensive variables (conquered balls) were largely greater in under-14 players, probably due to their lower capacity to maintain the ball against defensive pressure on a small court. Moreover, it was also clear with regard to within-age group differences that smaller formats moderately-to-largely increased the individual frequencies of attacking and defensive variables. In conclusion, this study confirms that smaller formats can be used to meaningfully increase the number of technical actions performed by each player and the larger format should be considered as the most fatiguing scenario for young players. This information may be used by coaches to choose the best format to fit the aim of SSG drills.

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**Corresponding author:**

**Filipe Manuel Clemente**,
Complexo Desportivo e Lazer de Melgaço – Monte de Prado,
4960-320, Melgaço, Portugal
E-mail: filipe.clemente5@gmail.com