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ORIGINAL RESEARCH

How different are soccer training sessions based on small-sided games? A cluster analysis to explore perceived exertion and training load

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Abstract

Background: Soccer coaching staffs may have difficulties in classifying properly the load accomplished during training sessions and understanding how players rate the effort and the training load during the micro-cycles. **Objective:** The aims of this study were to investigate if the features and duration of training tasks can automatically classify the different weekly training sessions into different clusters, and to describe and compare the features and duration of training tasks, rating of perceived exertion and training load from the different training sessions across both classifications (prescribed by staff per day vs. automatically per cluster). **Methods:** Eighteen elite youth male soccer players reported their rating of perceived exertion 10 min after each practice during twelve micro-cycles. In each micro-cycle, differentiated management of the task characteristics for each training day was implemented. A Random Forest Clustering was used to automatically assign each training session to one cluster and allowed to create similar groups and contrast them with the sessions prescribed by the coaching staff. **Results:** Proper manipulation of different variables of small-sided games (number of players, relative playing area per player, game orientation, training regimen) can automatically differentiate training sessions. Youth soccer players can also perceive each training session differently ($p < .05$). **Conclusions:** Using different formats of small-sided games in each training session may be interesting to modulate the player's perceived load during the micro-cycle. However, results should be interpreted with caution, due to representing a single team and coaching staff.

Keywords: periodization, RPE, small-sided games, soccer, young

Introduction

Periodization for soccer entails organizing the season to ensure performance improvements and keep it as high as possible throughout the season (van Winckel et al., 2014). Consequently, proper manipulation of the training stress both over the season and within short-term training cycles is necessary for success (Mujika et al., 2018). A short-term training cycle is often termed a micro-cycle and in soccer usually lasts a week and is entirely focused on preparing for the next match.

Within each micro-cycle, periods of recovery, loading and tapering have to be sensibly arranged (Anderson et al., 2016; Impellizzeri et al., 2004; van Winckel et al., 2014). At the beginning of each week, the emphasis should be placed on recovering from the fatigue accumulated during the previous match. The highest training load (TL) should be condensed to the middle of the micro-cycle. At the end of the micro-cycle, different tapering strategies should be carefully scheduled to optimally prepare players for their next match. This TL variation is crucial to the effective delivery of the training stimulus for both individual players and the team (Morgans et al., 2014), so may be applied to both professional (Martín-García et al., 2018; Rago et al., 2019) and youth soccer players (Coutinho et al., 2015; Wrigley et al., 2012). In this context, monitoring TL may help coaches and sports scientists to maximize the adaptive response of players, optimizing therefore the training program (Impellizzeri et al., 2019).

There are several ways in which soccer coaches can develop, plan and implement training programs. In an attempt to improve youth soccer science knowledge, previous studies have explored how coaching staffs structure and sequence training tasks during training sessions (O'Connor et al., 2018; Partington & Cushion, 2013; Roca & Ford, 2020). Recent findings indicate that practice structures in youth soccer are changing, with more time spent in small-sided games (SSGs) compared to unopposed technical or tactical skills practices and fitness training (Roca & Ford,

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2020). One factor that could explain this tendency is the simultaneous effect of SSGs on physical and physiological responses and tactical and technical abilities (Aguiar et al., 2012; Arslan et al., 2020).

In this scenario, a recent study has described a weekly pattern with different formats of SSGs in each training session, which can serve to maintain and optimize players' physical performance during the season and modulate TL during the typical training micro-cycle (Guridi Lopategui et al., 2021). However, there is no evidence regarding how different these soccer training sessions are. Information about agreements between players' perceived TL and coaches intended TL variation is also lacking. This information seems relevant because coaches intended TL and athletes perceived TL may not always have full agreement (Paul et al., 2021). Specifically, in soccer, young elite players may perceive training as harder than what was intended by the coach, which could lead to maladaptation to training (Brink et al., 2014). Therefore, the main purposes of this study were to investigate if the features and duration of training tasks can automatically classify the different weekly training sessions into different clusters and to describe and compare the features and duration of training tasks, rating of perceived exertion (RPE) and TL from the different training sessions across both classifications (prescribed by staff per day vs. automatically per cluster).

Methods

Participants

A total of 18 elite youth male soccer players (age 14.61 ± 0.5 years, height 172.21 ± 5.68 cm, body mass 62.61 ± 5.17 kg) who belonged to the same team of a professional club (U-15) participated in this study. All outfield players were included in the study, but goalkeepers were excluded due to the different nature of their training. All participants were healthy.

This study was conducted in accordance with the Declaration of Helsinki (1964) and was approved by the Ethics Committee of the University of the Basque Country (UPV/EHU): M10_2021_004_CALLEJA GONZÁLEZ. Prior to the start, parental written informed consent was obtained and all participants volunteered to participate.

Procedures

The present research was conducted in nonexperimental conditions (ecological validity). The coaching staff and participants did not receive any input from the research team and training data were supplied by the coaching staff. Accordingly, this section describes the guidelines of the training methodology that the coaching staff followed to prescribe training sessions and monitor the TL. These guidelines have also been followed in a previous study with adult players (Guridi Lopategui et al., 2021).

In order to reduce bias, training data of 12 micro-cycles were selected for data analysis because followed a similar pattern during the competitive season: Monday rest; Tuesday match day minus 4 (MD-4) training; Wednesday MD-3 training; Thursday rest; Friday MD-1 training; Saturday competitive match. During selected micro-cycles, players trained 3 times a week (36 training sessions in total, N = 609 cases).

The coaching staff classified training tasks as follows: tasks without the ball (fitness tasks), tasks with the ball and without opponents (technical tasks), and tasks with the ball and opponents (technical-tactical tasks). Technical-tactical tasks include small-SSGs, medium-SSGs and large-SSGs, depending on the following variables: number of players per team (small: 1–3 players per team, medium: 4–6 players per team, large: 7 or more players per team), relative playing area per player (small: < 100 m^2 per player, medium: 100–199 m^2 per player; large: ≥ 200 m^2 per player), and game orientation (no oriented: game without goals or scoring zones, oriented: a game with multi-goals or different scoring zones, polarized: a game with goals facing each other). Relative playing area per player was calculated by dividing the total play surface of each SSG among all players (Parlebas, 1988).

Training days were prescribed by coaching staff as follows (Guridi Lopategui et al., 2021): MD-4 (first day, when training tasks should overload the musculoskeletal system at the highest level) were designed using a small/medium number of players per team (1–3, 4–6), in a small relative playing area per player (smaller than 100 m^2) with free game orientation (no oriented, oriented or polarized); MD-3 (second day, when training tasks should reflect typical match demands, stimulating metabolic responses to endurance training and enabling high speeds) were implemented using a large number of players per team (7–10), in a medium/large relative playing area per player (from 100 to ≥ 200 m^2) with polarized game orientation; MD-1 (third day, when training tasks should have an impact on the metabolic and neuromuscular demands of sprinting) were designed using a variable number of players per team playing in a medium/large relative playing area per player (from 100 to ≥ 200 m^2) and with polarized game orientation.

Daily manipulation of training volume was also implemented by the coaching staff. Small-SSGs involve a large number of bouts and a shorter time per bout (3–6 bouts of 2–5 min with 2–4 min rest), whereas large-SSGs were longer but with a reduced number of bouts (2–4 bouts of 7–10 min with 2 min rest). Medium-SSGs were prescribed with a different number of bouts and duration per bout, depending on the day they were implemented. As a result, SSGs programming during each day can be considered as intermittent (MD-4 and MD-1) or continuous (MD-3) training regimen (Casamichana et al., 2013; Köklü, 2012). Rule modifications, task constraints or coach encouragement of each task implemented in each training session depend on the coaching staff objectives.

Small-SSGs, medium-SSGs and large-SSGs were the most important part of the training sessions (50% of effective training time), but players also undertook 15 min of fitness tasks (strength training, aerobic fitness or injury prevention exercises) before soccer-specific activities during MD-4 and MD-3 training days.

Ten minutes after each practice (Los Arcos et al., 2015) and using a modified Borg CR-10 scale (G. Borg, 1982, 1998) soccer players were asked to rate their RPE (in arbitrary units; AU). The players were allowed to mark a plus sign (0.5 points) alongside the integer value (Los Arcos et al., 2015). Players reported RPE together during pre-season training sessions so were familiarized with this scale according to standard procedures before the 12 micro-cycles included in the study (G. Borg, 1998). TL was calculated using the session-rating of perceived exertion (sRPE) method, which consists in multiplying the session perceived effort by the duration (Foster et al., 2001).

Statistical analysis

Descriptive statistics are reported as means and standard deviations. The Kolmogorov-Smirnov was applied to the verification of normal data distribution and the Levene test was used to verify the homogeneity of the variances.

A Random Forest Clustering (RFC) was used to automatically assign each training session to one cluster based on similarity measures (Euclidean distance) and allowed to create similar groups and contrast them with the weekly training sessions prescribed by the coaching staff. The Gini impurity index was computed to identify the most important variables to distinguish the sessions/clusters. All features of the tasks (except total and effective training time) and RPE values of each training session were included in the RFC, identifying different clusters composed of similarly perceived training sessions. Afterwards, the team total training volume of each feature of the tasks, RPE and sRPE were compared between clusters, between training sessions and between both classifications (prescribed by staff per day vs. automatically per cluster) using non-parametric Kruskal-Wallis and Mann-Whitney *U* test. Differences in RPE and sRPE were also compared between clusters, between training sessions and between both classifications using standardized differences based on Cohen's effect size principle. Threshold values for standardized differences were < 0.2 (trivial), 0.2–0.5 (small), 0.5–0.8 (moderate), and > 0.8 (large; Cohen, 1988). A qualitative probabilistic mechanistic inference (90% confidence intervals) was applied, with inferences based on standardized thresholds for the smallest worthwhile change (SWC), which was set as 0.2 of session standard deviation (Hopkins et al., 2009). The qualitative probabilistic terms were assigned using the following scale: < 0.5%, most unlikely or almost certainly not; 0.5–5%, very unlikely; 5–25%, unlikely or probably not; 25–75%, possibly; 75–95%, likely or probably; 95–99.5%, very likely; >99.5%, most likely or almost certainly (Hopkins, 2007).

Statistical significance was inferred at $p < .05$. RFC were carried out by JASP (Version 0.12.2; https://jasp-stats.org) and statistical analyses were carried out by IBM SPSS Statistics for Windows (Version 20; IBM, Armonk, NY, USA).

Results

Table 1 shows that RFC classifies the different weekly training sessions into 3 different clusters. The features and duration of training tasks discriminated perfectly MD-4; perfectly MD-3; not so on MD-1. The training sessions from MD-4 and MD-3 were entirely assigned to clusters -4 (CL-4) and -3 (CL-3), respectively, but MD-1 training sessions were assigned to different clusters (CL-1 and CL-3). Clusters are graphically presented in Figure 1.

Based on the mean decrease in Gini coefficient (Table 2), the most important variables to distinguish the sessions/clusters were time playing in a polarized game orientation,

Table 1 Contingency table of the interaction between training sessions and clusters identified by Random Forest Clustering. Numbers represents individual cases.

	CL-4	CL-3	CL-1	Total
MD-4	202	0	0	202
MD-3	0	199	0	199
MD-1	0	17	191	208
Total	202	216	191	609

Note. CL-4 = cluster -4; CL-3 = cluster -3; CL-1 = cluster -1; MD-4 = match day minus 4; MD-3 = match day minus 3; MD-1 = match day minus 1.

Figure 1 Depiction from the *t*-distributed stochastic neighbour embedding cluster plot for the Random Forest Clustering. Each training session of each player is assigned to one cluster (CL-4, CL-3, CL-1) based on similarity measures (Euclidean distance).

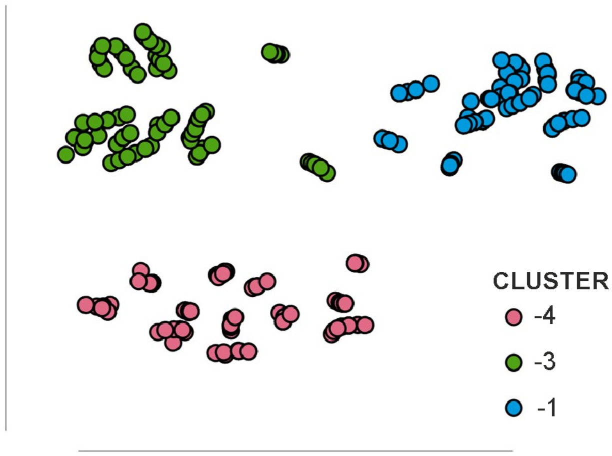


Table 2 Variable importance of features of the tasks implemented based on the Gini impurity index

Variable	Mean decrease in Gini index
Polarized	62.5
Fitness tasks	56.9
Technical-tactical tasks	55.2
7–10 players	52.8
Relative area per player < 100 m^2	51.6
Task with ball	48.6
Technical tasks	47.2
Relative area per player 100–199 m^2	43.4
1–3 players	39.7
No oriented	38.6
Pause time	35.7
4–6 players	35.6
Oriented	18.6
Relative area per player ≥ 200 m^2	15.8
Rating of perceived exertion	5.3

duration of fitness tasks, duration of technical-tactical tasks, time playing with 7–10 players per team and time playing in a smaller relative area than 100 m^2 per player. However, RPE was the variable with higher homogeneity and lower ability to discriminate the days/clusters.

Table 3 shows differences between clusters, between training sessions and between both classifications (prescribed by staff per day vs. automatically per cluster) and confirms that each training session and each cluster are different from the other. However, the MD-1 session can have different solicitations (when CL-1 is analysed, the duration of tasks performed in a relative area per player ≥ 200 m^2 or no oriented were maintained to 0 minutes).

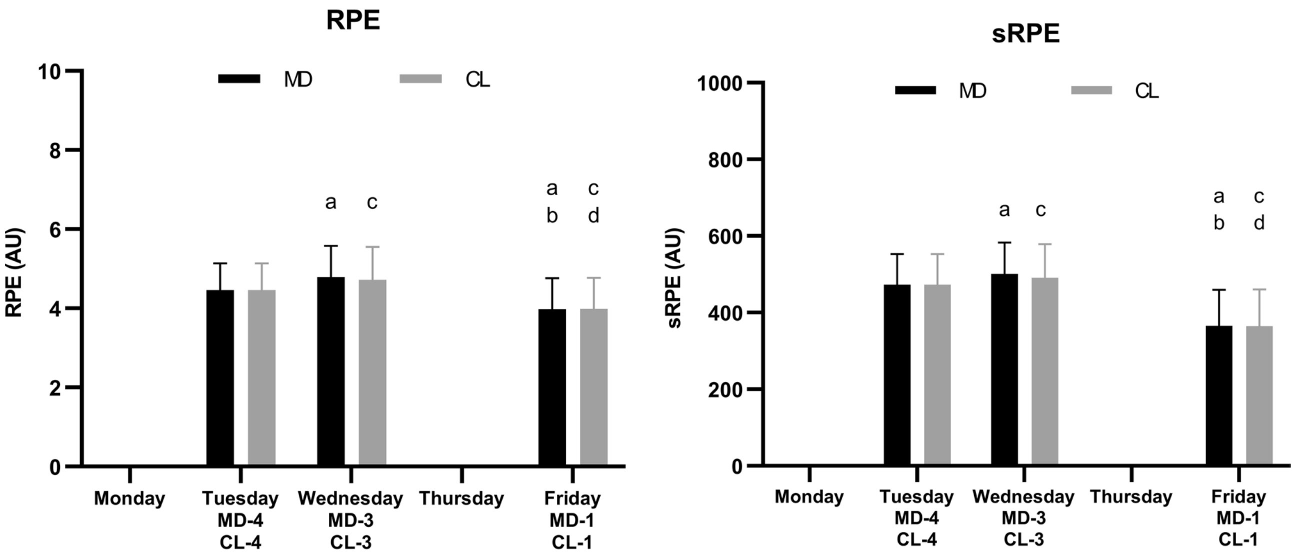
Figure 2 represents the descriptive statistics of the RPE and sRPE during the micro-cycle. RPE for MD-4 training sessions and CL-4 were significantly lower than RPE for MD-3 training sessions and CL-3 (4.46 ± 0.68 vs. 4.79 ± 0.79, 4.46 ± 0.68 vs. 4.72 ± 0.83, p <.05,

Table 3 Description of the three training days and clusters identified according to the features of the tasks implemented (values represent minutes of tasks and are presented as M ± SD)

	Tuesday	Wednesday		Friday	
	MD-4 or CL-4	MD-3	CL-3	MD-1	CL-1
Total training time	106.0 ± 7.5	105.0 ± 7.3	104.4 ± 7.3^{c}	91.5 ± 11.4^{ab}	90.9 ± 11.8^{cd}
Pause time	16.1 ± 3.9	13.5 ± 2.5^{a}	13.5 ± 2.4^{c}	18.7 ± 15.0^{ab}	19.2 ± 15.6^{cd}
Effective training time	89.9 ± 7.2	91.5 ± 6.1	90.9 ± 6.1	72.8 ± 6.3^{ab}	71.8 ± 5.4^{cd}
Fitness tasks	27.2 ± 5.8	20.3 ± 4.7^{a}	19.5 ± 5.3^{c}	9.5 ± 1.5^{ab}	9.4 ± 1.5^{cd}
Task with ball	62.7 ± 4.4	71.2 ± 7.3^{a}	71.5 ± 7.0^{c}	62.5 ± 6.6^{b}	61.4 ± 5.7^{d}
Technical tasks	0 ± 0	9.5 ± 3.5^{a}	9.6 ± 3.4^{c}	16.5 ± 12.1^{ab}	17.1 ± 12.5^{cd}
Technical-tactical tasks	62.7 ± 4.4	61.6 ± 7.0	61.4 ± 6.8^{c}	42.5 ± 12.2^{ab}	41.1 ± 11.8^{cd}
Players involved					
1–3	27.2 ± 18.2	5.9 ± 9.1^{a}	6.7 ± 9.2^{c}	2.5 ± 5.7^{ab}	1.3 ± 4.3$^{cd\#}$
4–6	28.0 ± 19.2	3.6 ± 7.9^{a}	4.9 ± 8.2^{c}	6.9 ± 8.3^{ab}	6.2 ± 8.3^{cd}
7–10	4.7 ± 8.1	49.5 ± 8.2^{a}	46.9 ± 11.8^{c}	9.6 ± 9.2^{ab}	8.9 ± 9.3^{cd}
Relative area per player					
< 100 m^2	47.1 ± 12.8	4.1 ± 7.9^{a}	5.0 ± 8.2^{c}	2.6 ± 5.9^{ab}	1.4 ± 4.6$^{cd\#}$
100–199 m^2	12.7 ± 9.4	37.7 ± 23.3^{a}	35.9 ± 23.2^{c}	15.2 ± 13.6^{b}	15.1 ± 14.2^{d}
≥ 200 m^2	0 ± 0	17.1 ± 20.8^{a}	17.1 ± 19.9^{c}	1.4 ± 4.7^{ab}	0 ± 0$^{d\#}$
Game orientation					
No oriented	21.4 ± 12.2	0.9 ± 2.8^{a}	2.0 ± 4.9^{c}*	1.3 ± 4.3^{a}	0 ± 0$^{cd\#}$
Oriented	14.1 ± 13.8	0 ± 0^{a}	0 ± 0^{c}	0 ± 0^{a}	0 ± 0^{c}
Polarized	24.3 ± 14.9	58.1 ± 7.0^{a}	56.0 ± 9.7^{c}	17.8 ± 13.6^{ab}	16.5 ± 13.4^{cd}

Note. MD-4 = match day minus 4; MD-3 = match day minus 3; MD-1 = match day minus 1; CL-4 = cluster -4; CL-3 = cluster -3; CL-1 = cluster -1. ^{a}significant differences with respect to MD-4. ^{b}significant differences with respect to MD-3. ^{c}significant differences with respect to CL-4. ^{d} significant differences with respect to CL-3. *significant differences between MD-3 and CL-3. $^{\#}$significant differences between MD-1 and CL-1.

Figure 2 Mean differences in RPE and sRPE

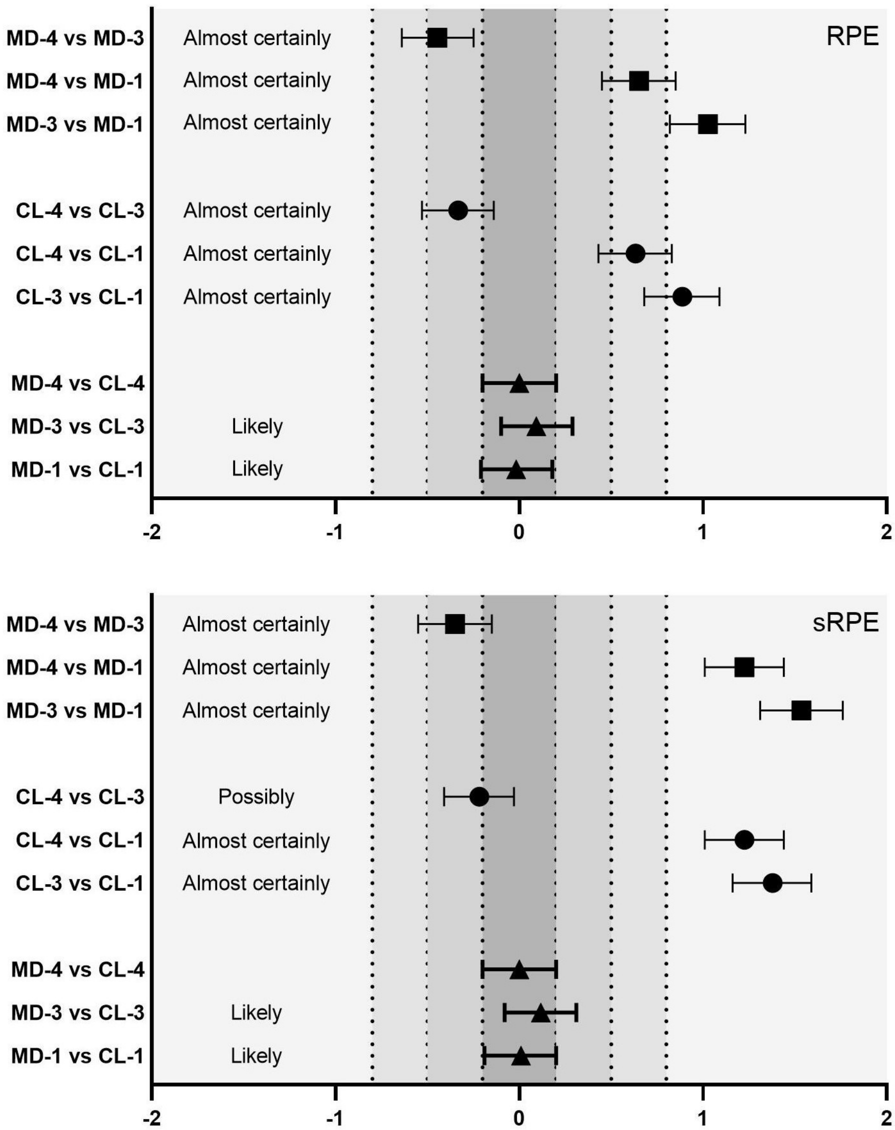


Note. RPE = rating of perceived exertion; sRPE = session-rating of RPE; AU = arbitrary units; MD = match day; MD-4 = match day minus 4; MD-3 = match day minus 3; MD-1 = match day minus 1; CL = cluster. ^{a}significant differences with respect to MD-4, ^{b}significant differences with respect to MD-3, ^{c}significant differences with respect to CL-4, ^{d}significant differences with respect to CL-3.

respectively) but higher than MD-1 training sessions and CL-1 (4.46 ± 0.68 vs. 3.98 ± 0.78, 4.46 ± 0.68 vs 3.99 ± 0.78, $p < .05$, respectively). The RPE for MD-3 training sessions and CL-3 were also significantly higher than MD-1 training sessions and CL-1 (4.79 ± 0.79 vs. 3.98 ± 0.78, 4.72 ± 0.83 vs 3.99 ± 0.78, $p < .05$, respectively). Similar results were found when sRPE was compared. The sRPE for MD-4 training sessions and CL-4 were significantly lower than during MD-3 training sessions and CL-3 (472.99 ± 80.05 vs. 501.29 ± 81.46, 472.99 ± 80.05 vs. 491.33 ± 87.63, $p < .05$, respectively) but higher than MD-1 training sessions and CL-1 (472.99 ± 80.05 vs. 365.59 ± 94.23, 472.99 ± 80.05 vs. 364.78 ± 95.98, $p < .05$, respectively), whereas sRPE for MD-3 training sessions and CL-3 were also significantly higher than MD-1 training sessions and CL-1 (501.29 ± 81.46 vs. 365.59 ± 94.23, 491.33 ± 87.63 vs. 364.78 ± 95.98, $p < .05$, respectively). No significant differences were obtained comparing RPE and sRPE across both classifications (MD-4 training sessions vs. CL-4, MD-3 training sessions vs. CL-3, MD-1 training sessions vs. CL-1).

Standardized differences in RPE and sRPE are shown in Figure 3. Compared to MD-3, both RPE and sRPE in MD-4 training sessions were slightly lower, but compared to MD-1, RPE was moderately greater whereas sRPE was largely higher. Both RPE and sRPE in MD-3 training sessions were largely greater than in MD-1. Similar results were obtained when clusters were compared between them. Compared to CL-3, both RPE and sRPE in CL-4 were slightly

Figure 3 Standardized differences in RPE and sRPE and qualitative probabilistic mechanistic inference. RPE and sRPE are compared between cluster (CL-4, CL-3, CL-1), between training sessions (MD-4, MD-3, MD-1) and between both classifications (prescribed by staff per day vs. automatically per cluster).



Note. RPE = rating of perceived exertion; sRPE = session-rating of RPE; MD-4 = match day minus 4; MD-3 = match day minus 3; MD-1 = match day minus 1.

lower, but compared to CL-1, RPE was moderately greater whereas sRPE was largely higher. Both RPE and sRPE in CL-3 were largely greater than in CL-1. When training sessions were compared to similar clusters, standardized differences between RPE and sRPE were trivial.

Discussion

The main findings of the present study were: (1) the proper manipulation of different variables of SSGs (number of players, relative playing area per player, game orientation, training regimen) can automatically differentiate training sessions, but MD-1 is the most difficult session to classify due to its variability in SSGs formats; (2) RPE is the variable with the lowest ability to detect differences between training sessions or clusters; (3) youth soccer players can perceive each training session differently which indicates the weekly TL variation intended by the coaching staff.

How youth soccer coaches prescribe training plays a key role in helping players development for successful performance. The structure and sequencing of activities during youth soccer coaching sessions have been investigated, revealing that years ago coaches prescribed more work on fitness, technique and skills practices than SSGs (Partington & Cushion, 2013). However, recent research reveals that practice structures in youth soccer are changing, with more time spent in SSGs compared to unopposed technical or tactical skills practices and fitness training (Roca & Ford, 2020). This could be explained by the effects of SSGs on physiological responses, and tactical and technical skill requirements (Aguiar et al., 2012; Arslan et al., 2020). In this context, our results indicate that this periodization approach (Guridi Lopategui et al., 2021) may facilitate coaching staffs to prescribe automatically different training sessions based on different formats of SSGs. MD-4, when training tasks should overload the musculoskeletal system at the highest level, is absolutely different to other training sessions and is represented perfectly by CL-4. Nevertheless, MD-1 is the most difficult session to classify due to the variability in time spent in SSGs with 1–3 players per team, time spent in relative area per player < 100 m^2, but especially by the variability in time spent in relative area per player ≥ 200 m^2 and no oriented game (when analysing CL-1, these were maintained to 0). This may be related to the fact that coaching staffs may prescribe different formats of SSGs in MD-1 to optimize metabolic and neuromuscular demands of sprinting, but they may be relatively similar to those prescribed in MD-3.

The second finding of our study is that RPE is the variable with the lowest importance to detect differences between training sessions or clusters. RPE was different when training sessions and clusters were compared but was more homogeneous than the rest of the prescriptive variables controlled by the coaching staff. Our results may be influenced by a reduced sensitivity of the scale to account for the range of individual demands across training (McLaren et al., 2018) and could be different if a 100-point RPE category ratio scale (CR100) was used, due to its wider numerical range and a finer grading (E. Borg & Borg, 2002; Fanchini et al., 2016). This reduced sensitivity may also mask the inter-player variability with respect to RPE during SSGs (Köklü et al., 2015; Rampinini et al., 2007), and therefore, influence their ability to distinguish training sessions or clusters.

The last finding of this study indicates that youth soccer players were able to perceive each training session differently, as was intended by the coaching staff. The manipulation of different variables of SSGs (number of players, relative playing area per player, game orientation, training regimen) in each training session may influence the exercise intensity during SSGs and stimulate different players' perceptual responses.

Despite some methodological concerns, most studies have shown that SSGs with fewer numbers of players elicit greater perceptual responses than larger formats, independent of age category (Aguiar et al., 2013; Hill-Haas et al., 2008; Hill-Haas et al., 2010; Hill-Haas, Dawson, et al., 2009; Impellizzeri et al., 2006; Rampinini et al., 2007). However, number of players per team could also affect perceptual responses when combine with pitch dimensions (Halouani et al., 2014). For a fixed pitch area, the lower is the number of players, the higher is the perceptual response (Hill-Haas, Dawson, et al., 2009; Hill-Haas, Rowsell, et al., 2009; Köklü et al., 2015). It also appears that, for a particular number of players, the increase in relative playing area per player led to higher perceived responses (Casamichana & Castellano, 2010; Rampinini et al., 2007). This could explain the differences in RPE for MD-4 training sessions and CL-4 when compared to MD-3 training sessions and CL-3, respectively. Anyway, RPE (and sRPE, therefore) probably would be higher during MD-3 training sessions if the team's mean total training volume in relative playing area per player ≥ 200 m^2 was higher.

Changing game orientation may also increase the perceived exertion in SSGs with no oriented area compared with the SSGs with the polarized area because SSGs with no oriented area encourage players to cover longer distances at higher running speeds whereas SSG with a polarized area increase the time the ball is out of play (Köklü et al., 2015). However, differences in RPE for MD-4 and CL-4 when compared to MD-3 and CL-3 suggest that this factor in isolation may have relatively less perceptual importance than the number of players or relative pitch area per player. Anyway, it should be confirmed by future studies.

Intermittent (MD-4 and MD-1) and continuous (MD-3) SSGs training regimes may result in different work:rest ratios among each SSG and training session. Unfortunately, work:rest ratios of each SSG were not controlled by the coaching staff, which makes the comparison between both regimens difficult. Moreover, previous studies have not used consistent work:rest ratios and there is a large variation in the length, duration, and the number of work bouts and rest intervals amongst studies (Hill-Haas et al., 2011). Thus, we cannot confirm the potential influence of training regimen on RPE. Nevertheless, the lower total and effective training time and the higher pause time during MD-1 training sessions and CL-1 may be responsible for the lowest RPE and perceived TL.

Our results show that the highest TL is perceived in the MD-3 training sessions and the lowest in the MD-1 training sessions. This represents the weekly TL variation intended by the coaching staff. It includes phases of recovery (Sunday and Monday rest), loading (Tuesday MD-4 training; Wednesday MD-3 training) and tapering (Thursday rest; Friday MD-1 training), as have been previously suggested (Anderson et al., 2016; Impellizzeri et al., 2004; van Winckel et al., 2014) and reported with a similar population (Coutinho et al., 2015). Thus, the coaching staffs can modulate some features and duration of training tasks to apply TL that exceed the individual capacity of a player and perturb a player's homeostasis adequately within a week (Brink et al., 2014).

The main limitations of this study were the following. First, we were unable to isolate the prescriptive variables which can contribute most to the players' perceptual response. Second, differences in fitness tasks between training sessions may also influence the players' perceptual response. Third, the low level of cognitive development and poor education have been recognized as limiting factors when using subjective load monitoring procedures with youth athletes, despite clear instructions and supervision (G. Borg, 1998; Brink et al., 2014). Consequently, we cannot exclude the possibility that some players may not be able to adequately rate their perceived exertion. Moreover, only perceived internal TL was monitored, so this may have constrained the real quantification of physiological and biomechanical stress of the training sessions. The generalisability (external validity) of our results is also limited because only one team was analysed, so our findings should be analysed with caution and avoid generalization, because each team and training environment may present its own idiosyncrasies.

From a practical point of view, our results show that coaching staffs may modulate the perceived TL of young soccer players using different SSGs formats in each training session. Consequently, this periodization approach may help coaches to promote positive adaptations and performance improvements (Windt & Gabbett, 2017). This is important because elite youth soccer academies stimulate long-term development throughout the seasons with a continuing build-up of TL over the different age categories (Vaeyens et al., 2008). However, more research is warranted to understand how players are coping with different micro-cycles based on SSGs. We recommend longitudinal designs with different levels or gender players and bigger samples. Further examination of different internal TL metrics and distance- and accelerometry-based parameters may also be useful.

Conclusions

The proper manipulation of different variables of SSGs (number of players, relative playing area per player, game orientation, training regimen) can automatically differentiate training sessions, but MD-1 is the most difficult session to classify due to its variability in SSGs formats. Youth soccer players can also perceive each training session differently, which indicates the weekly TL variation intended by the coaching staff. Consequently, this periodization approach may be an interesting option to modulate the player's TL during the micro-cycle, avoiding fatigue accumulation during subsequent training and matches in young talented soccer players.

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Conflict of interest

The authors report no conflict of interest.

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