# Are there differences in elite youth soccer player work rate profiles in congested versus regular match schedules?

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Running head: Congested versus regular soccer match schedules

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**Abstract**

Official international tournaments in which youth soccer players participate can involve very congested schedules. Yet no information regarding physical and technical match performance during congested versus regular (non-congested) cycles is available. In this study, accelerations, decelerations, mean metabolic power, and technical performance (offensive and defensive variables) were compared across very congested (VCM; 10 international matches played over 3 successive days, including 2 days with 2 consecutive matches separated by a 4-5 hr interval) and 10 regular (non-congested) match periods (NCM) in elite male Under 15 (U15, n=11) and Under 17 (U17, n=13) soccer players. Players wore a 15-Hz GPS unit with a 100-Hz tri-axial accelerometer. The session-RPE was assessed 30 min post-match. Results showed a higher number of accelerations/min observed in VCM vs NCM (U15; 2.27±0.35 vs 2.12±0.23; effect size [ES]=0.49; U17; 2.27±0.41 vs 2.01±0.31; ES=0.69). Decelerations/min were higher during VCM (U15; 1.99±0.27 vs 1.84±0.25; ES=0.55; and U17; 1.98±0.35 vs 1.80±0.27; ES=0.56). Mean metabolic power was higher in the VCM (U15; 0.42±0.06 vs 0.37±0.02; ES=1.08; U17; 0.46±0.03 vs 0.30±0.03; ES=1.94). Technical actions/min were higher in the VCM for U17 (ES=1.60 and 1.37, for offensive and defensive performance, respectively); but lower (during VCM) for U15 (ES=3.59 and 0.28, for offensive and defensive performance). U15 reported a higher session-RPE in the VCM (7.9±0.5 AU vs 6.9±0.5 AU). The findings suggest that running activity in these youth players was unaffected overall in tournaments with congested schedules and that the intensity of match-play was actually greater than in regular match schedules.

Key Words: match congestion, football, analysis, performance, accelerations.

## Introduction

Congested match schedules frequently occur in elite-standard senior soccer (8, 17). Research in a professional team has shown that players were potentially exposed to 3 successive matches played within a 4-day period on up to 13 occasions across any one season (9). Official international tournaments in which youth players (Under 15 [U15] and Under 17 [U17]) participate can also involve very congested schedules. Players are potentially exposed to 2 matches per day (e.g. 25x25min; 10min half-time interval) and 5 or 6 matches within a 3 day-time period (2, 21).

Despite these intensive schedules, analyses of technical and physical performance, with the latter represented by total distance and that covered at a range of running speeds in several matches played successively over a short period, show that performance was generally unaffected in elite-standard senior players (10, 11, 14, 16, 23). In elite youth peers, limited yet contrasting information exists on the effects of congested fixture schedules on technical and physical match performance (2, 7, 29, 30). A recurring issue across all studies in youth players is that none directly compared performance in congested versus regular competitive schedules. This is necessary to account for the potential confounding effects of match context when interpreting changes in performance and the impact of short recovery intervals between matches (e.g., variations in match result, time in possession, home/away fixtures).

Research has nonetheless shown that the total distance covered and that run at high-speeds remained unchanged match-to-match over a congested competition in U15 Brazilian players (2). In contrast, decrements in these variables were reported in youth Australian players (29). Interestingly, players in the former investigation reported a progressive decrease in the frequency of acceleration actions performed across matches. The authors suggested that these actions potentially provide a more valid representation

of changes in external load over a congested match schedule compared to traditional metrics such as distances covered.

These discrepancies across study findings suggest a need for additional research notably regarding the choice of running performance-related variables. Comparisons of changes in the frequency of acceleration and deceleration actions during congested competitive schedules are necessary (8). Similarly, analysis of alterations in metabolic power (MP) would also be pertinent. MP is used to adjust time motion analysis data to account for the additional energy cost of acceleration and deceleration activities (8). Furthermore, there is a need to determine whether match-related fatigue, quantified using decrements in these variables across match halves for example, evolves across intensified competition periods. Finally, to our knowledge, comparisons of acceleration and deceleration actions, MP and technical performance in elite youth players during congested versus regular match schedules have not been conducted. Collectively, these proposals would provide additional evidence on the effects of fixture congestion on match performance in elite youth soccer players' and can help inform training and recovery prescription and player rotation strategies to optimize performance during such schedules.

The aim of this study was to compare physical and technical match performance and subjective perceptions of exercise intensity in elite youth male players during very congested versus regular match schedules. It was hypothesized that during the former, lower values for accelerations, decelerations, MP, and technical actions, and a higher perceived intensity would be observed.

## Methods

*Experimental approach to the problem*

Two elite male youth soccer teams were assessed during international tournaments. The tournaments required each team to play 5 matches over 3 successive days. During these very congested match schedules (VCM), time motion analyses of competitive running activity derived using Global Positioning Systems (GPS), session ratings of perceived exertion (S-RPE) and match analyses of technical performance were collected. Five matches were also played as part of the regular non-congested match schedules (NCM) for each team (U15 and U17). Comparisons between the same performance measures in the very congested versus non-congested schedules were then conducted.

*Subjects*

All participating players belonged to U15 and U17 teams from a single elite soccer club. These teams participate regularly in national and international competitions and have reached top-ranked positions such as the semi-finals of the main National State Championships for their respective age-categories (2016-17). They also were winners of International Tournaments such as Next Generation Trophy (Austria, 2017) for the U15 and Amtzell Cup (Germany, 2017) for the U17 team.

Forty-four (20 U15 and 22 U17) elite male Brazilian soccer players, initially volunteered to participate in this study. Only data for players participating in at least 3 out of 5 VCM and 3 out of 5 NCM (completion of minimum 75% of total match time in every match) were considered for analysis. Consequently, 24 outfield players, 11 from the U15 (14.9 ± 0.4 yrs; 173.2 ± 7.6 cm; 61.6 ± 8.8 kg; 1.0 ± 0.6 yrs from peak height velocity) and 13 from the U17 (16.6 ± 0.4 yrs; 177.5 ± 6.0 cm; 68.3 ± 6.8 kg; 2.4 ± 0.5 yrs from peak height velocity) were included. Despite not maintaining rigid playing

positions, as can be expected in U15 and U17 match-play, of the 24 players, position-specific data for 5 full backs, 7 central defenders, 6 midfielders, and 6 forwards were analyzed.

All the U15 and U17 players typically participated in 5-8 soccer training sessions per week (strength and conditioning and technical-tactical sessions) and competed in a weekly single match. The U15 and U17 players habitually performed 2 strength training sessions in the gym per week. The main differences between teams regarding the strength training sessions was that the U15 habitually participated in a hybrid training session, which consisted of weight training during the first part of the session followed by specific-soccer technical exercises, while the U17 performed the weight training sessions as an isolated session (separated from the technical/tactical training sessions). The specific conditioning training sessions were composed of high-intensity short running bouts (HIB) and small-sided-games (SSG). Usually, players performed HIB or technical exercises prior to SSG.

Written informed assent and consent were obtained from each player and their parents or guardians, respectively, and the study was approved by the local University Ethics Committee. All players underwent a thorough medical assessment to verify their health status prior to participation and were free from illness or injury at the time of this study.

*Procedures*

Competitive schedules

The team's competitive schedules are presented in Table 1. The U15 male youth team played 5 matches over 3 successive days during an international competition (The Next Generation Trophy, Salzburg, Austria, 2016). Running and technical performance

and the session rating of perceived exertion (S-RPE) were assessed in 2 matches played on the 1st day of the competition; in 2 on the 2nd day, and in 1 on the 3rd day (25x25 min; 10-min-half-time interval; Table 1). Performance in an U17 male youth team were also assessed over an international competition (Varsseveld Tournament, Varsseveld, Holland, 2016) during which 5 matches were played over 3 successive days. The 1st match was played on the 1st day of the competition, the 2nd and 3rd matches were played on the 2nd day, and the 4th and 5th matches on the 3rd day (25x25 min; 10-min half-time interval) (Table 1). Five matches played as part of regular match schedules (NCM) schedule for each team (U15 and U17) were evaluated to compare performance measures between congested versus non-congested schedules. The assessed matches were from the State Championship of each age-category (35x35 min, with a 10-min half-time interval) and occurred within a 2-month period, during the mid-season.

All matches were played on natural grass, and under temperate conditions (mild temperatures). Precise measures of temperature and humidity were not collected. The maximum of 3 substitutions were conducted by coaches in both VCM and NCM matches. No systematic post-match recovery regimen was implemented between the assessed matches during either the VCM or NCM.

**Table 1 HERE**

*Physical Performance Parameters*

Each player wore a 15-Hz GPS unit coupled with a 100 Hz tri-axial accelerometer (SPI Elite, GPSports, Canberra, Australia). Each unit was harnessed between the shoulder blades and anchored using an undergarment to minimize

193 movement. These provide more valid and reliable measures of total and high-intensity
194 distance compared to 1- and 5-Hz units (20).

195 Physical performance parameters included accelerations and decelerations (>1.8
196 $m \cdot s^{-2}$ and -1.8 $m \cdot s^{-2}$, respectively) and average metabolic power (MP) ($W \cdot kg^{-1}$)
197 calculations, derived by the manufacturer's software. The threshold adopted for
198 determining accelerations and deceleration actions allowed assessment of light-,
199 moderate-, and high- acceleration and deceleration actions. This threshold has
200 previously been used in youth soccer players to study the effects of congested match
201 schedules (2). MP has been suggested as a reliable marker of locomotor load where
202 acceleration- and velocity-based running are accounted for (coefficient of variation
203 [CV%] = 4.5%) (2). All variables were normalized per min of on-field playing time.

204

205 *Technical Performance Parameters*

206 Video recordings were obtained using two digital cameras (Panasonic, 60Hz
207 frequency acquisition). One camera was located 15 m above and to one side of the long
208 axis of the pitch, and the other was placed 5 m to one side of the pitch to facilitate
209 player identification and coding. Dartfish 9 TeamPro software (Dartfish, Fribourg,
210 Switzerland) was used to code match performance.

211 The technical events were chosen to match those used in previous research (21, 27,
212 32). Definitions for variables were:

213 • Involvements with the ball: all situations where the player was in contact with
214 the ball.
215 • Goal attempts: number of attempts to score a goal.
216 • Total passes: number of short and long foot passes performed by a player.
217 • Total headers: number of times where a player played the ball with his head.

- Tackles and interceptions: number of situations where a player contested the ball with an opponent player irrespective of whether these situations involved or not clear physical contact between players.

To examine overall technical performance, two categories were used: offensive and defensive performance. Offensive performance was analysed using data on involvements with the ball, goal attempts, and total passes. Defensive performance was assessed using tackles and interceptions made. Heading actions were also included but not classified according to whether these were attacking or defending actions. This classification was adopted previously in a study on performance in youth players during a congested competitive schedule (21). The offensive and defensive variables were normalized per min of on-field playing time.

Results from tests of inter- and intra-reliability of technical performance were found to be excellent when analyzing two trials for each match using two experienced match analysts. The Kappa values for the analysed variables ranged between 0.90–0.95 (inter-observer) to 0.95–0.98 (intra-observer).

Due to the playing philosophy of their parent club a 4-4-2 team formation was preferentially adopted during all assessed matches by both the U15 and U17 teams.

*Match Intensity*

To subjectively quantify match intensity, S-RPE was assessed following each match. Each player rated the match intensity using the CR-10 sliding scale 30 min post-match (18). This method is shown to be a valid means for monitoring load in youth soccer players (19, 21).

*Statistical Analysis*

Values are presented as means and standard deviations for the ensemble of the matches. A magnitude-based inferential statistical approach was adopted for physical and technical data analyses based on previous recommendations for performance measures (33). Cohen's d effect sizes (ES) were calculated to determine the meaningfulness of the difference, corrected for bias using Hedges formula and presented with 90% Confidence Limits (CL) (3). The differences between match halves within each competition (VCM and NCM), and differences between competitions for the whole match were then examined, for physical and technical parameters, for each age-category, separately. ES with values of 0.2, 0.5, and 0.8 were considered small, medium, and large differences respectively (12). Data were analysed using Microsoft Excel (Microsoft™; USA). A two-way analysis of variance [condition (VCM vs NCM) and time-point assessments (match 1 to match 5)] with repeated measures in the second factor was used for S-RPE, after checking for data normality (Shapiro-Wilk's test) and homoscedasticity (Levene's test). The sphericity of data was assumed according to the Mauchly's test results. In the event of a significant difference, a Bonferroni post-hoc test was used to identify any localized effects. Statistical significance was set at $p < 0.05$. Data were analyzed using Statistica 13.0. (Dell™ Statistica™; EUA)

**Results**

*Physical Performance Parameters*

Figure 1 presents data (mean and SD) for accelerations (ACC) (Figure 1A), decelerations (DEC) (Figure 1B), and average metabolic power (MP) (Figure 1C) during the VCM and NCM schedules. In Figure 2 the magnitude of the differences in ACC, DEC, and MP, between the schedules is presented. A difference classified as

268 worthy of consideration (ES>0.20) was observed for the 3 physical performance
269 parameters, in both U15 and U17 players.

270 Figure 3 presents the ES for comparisons in measures across halves (for each
271 match schedule). A decrease in ACC and DEC, from the 1st to the 2nd half was observed
272 in U15 and U17 for both schedules. However, a large increase from the 1st to the 2nd
273 half was observed for MP; with a very large increase for both teams during the NCM. In
274 the VCM, the MP increased (1st to the 2nd half) for U17 but decreased for U15.

275

276 **Figure 1 HERE**

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278 **Figure 2 HERE**

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280 **Figure 3 HERE**

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282 *Technical Performance Parameters*

283 Offensive and defensive values are depicted in Figure 4. In U15, a large
284 difference was observed between the VCM and NCM in relative offensive performance
285 (ES=3.59), with lower values in the VCM. In contrast, the U17's offensive performance
286 was higher during the VCM vs NCM (ES=1.60). The same pattern was observed for
287 defensive performance, with a small difference (ES=0.28) for U15 (lower value during
288 the VCM) and a large difference (ES=1.37) for U17 (higher value during the VCM)
289 respectively. Regarding the change in technical performance from the 1st to the 2nd half,
290 an increase in offensive performance was observed for U15 and U17 during the NCM
291 (ES=0.91 and 0.32, respectively); with a small change during the VCM for U15 only
292 (ES= 0.20). The U15 demonstrated a large increase in defensive performance during the

NCM (ES=0.92), while no change was noted for U17 (ES=0.00). During the VCM, however, no change was observed for U15 (ES=0.00) or U17 (ES=0.07).

**Figure 4 HERE**

*Perceived Match Intensity (session-RPE)*

No interactions (condition [schedules] vs time [matches]) (F=0.50; *p*=0.73) or time (F=0.93; *p*=0.44) effects were observed for U15. In contrast, there was a condition effect (F 7.50; *p*=0.001), with higher match intensity observed for the VCM. No effect of interaction (F=2.24; p=0.95), time (F=1.07; *p*=0.39), or condition (F=0.98; *p*=0.35) was observed for match intensity in U17. Figure 5 presents the match intensity descriptive values for conditions (schedules) in U15 and U17.

**Figure 5 HERE**

## Discussion

This study compared physical and technical match performance and perceived intensity during very congested versus regular match schedules in elite youth male players. Contrary to the hypothesis, higher values for physical performance parameters were observed in the VCM for U15 and U17 teams. In both teams, analysis of ACC and DEC showed a decrease from the 1$^{st}$ to the 2$^{nd}$ half in both match schedules. In contrast, MP values for the NCM increased in the 2$^{nd}$ compared to the 1$^{st}$ half, in both teams. The U17 performed a higher number of offensive and defensive actions in the VCM versus NCM. In U15, however, a lower number of offensive technical actions was observed in the VCM. There was a large increase in offensive performance from the 1$^{st}$ to the 2$^{nd}$ half for U15 and U17 in the NCM whereas a lower increase occurred during the VCM.

The U15 demonstrated a large increase in defensive performance (1st vs 2nd half) during the NCM, but not in the VCM. A greater perceived match intensity (higher S-RPE) was observed for the VCM in the U15 but not the U17.

The higher relative values observed for ACC, DEC and MP in the VCM show that players elevated their running output (per minute) when participating in this intensive tournament format. Based on the present results and considering data from the literature (1, 13, 15, 20, 25, 28), it is reasonable to assume that the intensity of the match play was higher during the VCM. This is an important finding as it shows that youth players were able to cope physically during these intensive schedules. A reasonable explanation for the higher work intensity observed in the VCM might be the players' knowledge of the reduced duration of the match. The players' response to match demands during a congested schedule could be associated with a self-regulation or pacing strategy, consciously or subconsciously, of physical effort (5, 10, 21). As numerous factors can influence pacing strategies (31), including the knowledge of exercise end-point and bout duration, it can be speculated that players worked harder during the VCM compared to the NCM due to their knowledge about the shorter duration of the match.

The possible influence of the quality of the opponent on these findings on running performance should also be highlighted and cannot be ruled out as a possible contextual factor that potentially impacted performance (14). Indeed, the higher intensity in VCM might be also associated with an elevated players competitiveness (and perhaps higher motivation), due to playing against higher-level (international) opponents.

A decrease in the ACC and DEC from the 1st to the 2nd half was observed in both schedules in U15 and U17. However, during the NCM, MP values increased in the 2nd

343 half. Taking into account the direct role of velocity in setting instantaneous metabolic
344 power (24), the increase in 2nd half MP during the NCM, suggests that players
345 performed a higher number of other high-intensity (speed) actions in the 2nd half (e.g.
346 straight runs); but were unable to do this in the VCM.

347 The present results regarding S-RPE corroborate an early study in youth players
348 reporting a range of S-RPE values between 7.1 ± 1.2 AU (arbitrary units) to 8.2 ± 0.7
349 AU for the 7 matches played during a national VCM schedule (21). Here, the mean S-
350 RPE value during the VCM was 7.92 AU (0.51) for the U15 and 8.01 AU (1.31) for the
351 U17, respectively. It is noteworthy that the evaluated matches were played in a high-
352 perceived intensity zone (> 7 AU). The results for S-RPE also indicate that the U15
353 perceived the VCM as more intense than NCM. Again, this finding may be linked to the
354 higher standard of the opponents played against in this competition although no
355 difference between the competitions was observed for U17. The results for S-RPE
356 might also be associated with findings for the analysis of physical and technical actions.
357 The lower number of offensive and defensive actions observed for the U15 during the
358 VCM vs NCM might be due to an elevated perceived exertion in the VCM, which in
359 turn was induced by the higher external work load performed by these players during
360 the VCM. Working harder and perceiving a higher exertion might lead the players to try
361 to reduce their involvement in the match to preserve energy.

362 As pointed out by Boksem and Tops (4) individuals can try to minimize the
363 energetic costs of performance by adopting behavioral strategies that require minimal
364 levels of effort. Reducing the involvement (lower number of performed technical
365 actions) in the match might be a behavioral strategy to attempt to reduce perceived
366 exertion to preserve energy. The match outcomes cannot be ruled out as a factor
367 influencing the higher S-RPE values in U15 during the VCM; this team won 1 of 5

played matches, while during the NCM, the U15 won 4 of 5 played matches. The effect of match outcome during different types of match schedules in similar populations merits investigation in future studies.

While the current investigation adds novel evidence to the literature, some limitations should be acknowledged. As two teams from the same club were assessed, caution is required in making inferences regarding the results which might be associated to personal game philosophy and the tactical strategies adopted by the coaches. Other contextual factors (e.g different opponent standards, winning, defeating or drawing at a given moment of the match, motivation in the competitions) might also have influenced the results. The use of more than one ACC and DEC threshold might provide a clearer picture of differences in physical performance between conditions (VCM vs NCM match). It is also important to highlight that the present findings are representative of a very unique congested match schedule for elite male youth players. Thus, the results should not be generalized to elite senior players while may also not be appropriate for application to populations with a potentially lower level of skill and competitiveness.

Additionally, the implications of using MP should be considered. Buchheit et al. (6), for example, questioned the MP value for monitoring purposes in soccer. The authors argue that locomotor-derived MP largely underestimates the actual net metabolic demands. On the other hand, Osgnach et al. (24) question the use of a direct comparison of actual $VO_2$ and MP to validate MP. Even recognizing the importance of the arguments for adopting or not adopting the MP for monitoring physical performance in soccer, it should be highlighted that consideration is necessary concerning MP validity within the limits of the current discussion.

In conclusion, these findings suggest that the present youth players' work rate profiles were not impaired in VCM and that the relative physical intensity of match-play

393 was increased in this type of competition. Moreover, the present results suggest a
394 decrease in the physical intensity of the match-play from the 1st to the 2nd half in both
395 schedules, except for MP during the NCM; and contrasting results were observed across
396 the teams for technical action and session-RPE.
397
398 **Practical Applications**
399
400 The higher intensity of play in the VCM reported here suggests there is a need
401 for preparation strategies to provide players with opportunities to experience playing at
402 greater intensities than usual during training sessions. For instance, players could
403 participate in small-sided-games (SSG) designed to elicit high intensity play (through
404 manipulation of rules, number of players, area per player, etc). Monitoring using GPS
405 devices would ensure real-time adjustments in exercise intensity. Programming and
406 monitoring performance in matches to mimic the very congested schedule could also be
407 relevant to aid preparation for this type of competition. For example, players could
408 perform two simulated matches in a day (i.e. morning and afternoon) over two
409 successive days while receiving real-time feedback from coaches to increase and
410 maintain high intensity play. These approaches would be useful to prepare players
411 physically and mentally to the demands of this type of schedules, and the efforts
412 required as well as being an opportunity to test pacing strategies during the competition.
413
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**Figures legends**

Figure 1. Data normalized per minute of on-field playing time (mean ± SD) for accelerations (ACC [A]), decelerations (DEC [B]), and average metabolic power (MP [C]) for the VCM (very congested) and NCM (regular) match schedules (U15 and U17).

Figure 2. The magnitude of the differences in accelerations (ACC), decelerations (DEC), and average metabolic power (MP), between the VCM (very congested) and NCM (regular) match schedules. The positive scores denote higher values in the VCM compared to the NCM. Grey bar denotes an effect size (ES) > 0.20.

Figure 3. The magnitude of the differences in accelerations (ACC), decelerations (DEC), and average metabolic power (MP) between halves for the VCM (very congested) and NCM (regular) match schedules. Grey bar denotes an effect size (ES) > 0.20.

Figure 4. Offensive and defensive performance during NCM (regular) and VCM (very congested) match schedules (whole matches [total matches; TM] and 1$^{st}$ and 2$^{nd}$ halves; data normalized per minute of on-field time) (mean ± SD).

Figure 5. Match intensity (S-RPE; mean ± SD) for the VCM (very congested) and NCM (regular) match schedules in U15 and U17. *significant difference from NCM.

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Table 1. Competition schedules and results

| UNDER-15 | | | | | | |
|---|---|---|---|---|---|---|
| | VCM | | | | NCM | |
| M | Opponent | Result | Day of the competition; time of the beginning of the match | *M | Opponent | Result |
| 1st | Weder Bremem | 0 – 0 (draw) | 1st; morning;11:00 | 1st | Guarani | 3 – 0 (won) |
| 2nd | Manchester City | 1 – 1(draw) | 2nd; afternoon;16:00 | 2nd | Bragantino | 5 – 1 (won) |
| 3rd | Valencia | 0 – 1 (lost) | 3rd; morning;9:00 | 3rd | Paulista | 2 – 1 (won) |
| 4th | Sagan Tosu | 2 – 1 (won) | 4th; afternoon;14:00 | 4th | AD Guarulhos | 0 – 2 (lost) |
| 5th | Red Bull Salzburg | 1 – 2 (lost) | 5th; morning; 10:00 | 5th | Juventus | 4 – 1 (won) |
| UNDER-17 | | | | | | |
| 1st | Grafshap | 1 – 0 (won) | 1st; afternoon;17:30 | 1st | Guarani | 3 – 1(won) |
| 2nd | Utrech | 0 – 0 (draw) | 2nd; morning;12:00 | 2nd | Bragantino | 2 – 1(won) |
| 3rd | Sporting | 2 – 0 (won) | 3rd; afternoon; 16:00 | 3rd | Paulista | 1 – 0 (won) |
| 4th | Mechelen | 0 – 0 (draw) | 4th; morning; 12:00 | 4th | AD Guarulhos | 3 – 1 (won) |
| 5th | AZ Alkima | 0 – 1 (lost) | 5th; afternoon; 16:00 | 5th | Juventus | 4 – 1 (won) |

543 VCM = very congested match schedule; NCM = regular match schedule; M = match;
544 *all NCM were played on mornings; U15 matches beginning at 9:00 and U17 matches
545 beginning at 11:00; Results (assessed team match outcome).
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