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Human Kinetics
ORIGINAL INVESTIGATION

Variation in Physical Performance of Futsal Players During Congested Fixtures

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Purpose: To investigate the match-to-match variation of physical performance during official congested fixtures in elite futsal players. ***Methods:*** Physical performance was measured by external and internal load metrics in 12 elite male futsal players. Two periods with 3 matches within 4 days were analyzed. The variation in physical performance of the players during matches was analyzed using the latent growth curve modeling that estimated interindividual and intraindividual growth paths. ***Results:*** Playing time had a significant effect on physical performance growth with significant paths of interindividual and intraindividual variability. Players who competed for more time revealed lower initial levels (ie, first match) of total distance covered ($\beta = -0.62$), high-speed running ($\beta = -0.18$), accelerations ($\beta = -0.31$), decelerations ($\beta = -0.44$), and session rate of perceived exertion ($\beta = 0.81$) than players who competed for less time ($P < .05$). In addition, players who competed for more time revealed higher increases in total distance covered ($\beta = 0.47$), high-speed running ($\beta = 0.16$), and session rate of perceived exertion ($\beta = 0.66$) and lower increases in accelerations ($\beta = -0.21$) and decelerations ($\beta = -0.58$) than players who competed for less time from the first to the third match ($P < .05$). ***Conclusions:*** Congested fixtures did not affect physical performance in elite futsal players. Playing time showed to be a key performance factor. There was a considerable heterogeneity in the responsiveness to physical performance over congested fixtures, suggesting an analysis of individual variability to evaluate real changes in match performance, training intensity, and workload.

Keywords*:* match play, load, playing time, individual variability, tracking system

Futsal is a 5vs5, intermittent, high-intensity, indoor team sport involving short, high-intensity actions, such as accelerations (ACCs), decelerations (DECs), changes of direction, and sprints with short recovery time between efforts.[1–3] In fact, futsal players need to have or develop a great capacity for agility and explosive strength of the lower limbs.[4]

Interestingly, most futsal international competitions and playoffs of the main leagues around the world are played in congested periods with matches played with very short recovery times. The current knowledge about the demands of congested fixtures in team sports has increased the interest of medical and technical staff in developing strategies to improve performance and reduce the probability of injuries.[5,6] When teams play 2 to 3 matches per week, the stress imposed on the players increases; therefore, congested fixtures might increase fatigue levels and injury risk.[7–9] Also, performance and muscle function might be affected due to the increased levels of inflammation and muscle damage.[10,11]

The concerns about congested periods have been largely debated in the literature of match analysis in football.[12,13] On the other hand, research available on the impact of futsal match play in short congested periods is very scarce and remains unclear. To date, only 2 studies have examined the physical performance of futsal players in congested match periods.[14,15] Charlot et al[14] analyzed the intensity of matches on a 4-day FIFA futsal tournament and reported no differences in heart rate, recovery kinetics, and well-being but a small decrease in sprinting activity between matches. In turn, a second study revealed a general small decrease in sprinting and an increase in walking activity of players after a multiday futsal tournament.[15] Further information is required to understand the impact of congested fixture periods on the physical performance of elite futsal players.[16,17]

Most traditional approaches to match analysis in team sports use central tendency measures without considering intraindividual variability between players. However, it is necessary to consider the nonlinear responses of each player during match play[2] according to playing time variations caused by coaching decisions, disruptions, and substitutions in futsal.[11,16] For this purpose, we used the latent growth curve (LGC) modeling: a structural equation modeling technique for longitudinal data that helps to characterize the interplayer and intraplayer growth trajectories (intercept and slope) over the matches.[18] Such models have been used on different sports for the evaluation of youth players' development.[19,20]

The aim of this study was to evaluate the longitudinal variation of physical performance (ie, external and internal load) of elite male futsal players over a short congested period during two 4-day FIFA futsal world cup qualifiers, encompassing 2 periods of 3 games in 4 days. Through the LGC model, we expected to identify interindividual variability and the average growth between each match.[18]

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Methods

Subjects

The participants were elite male futsal players from the Portuguese National team (n = 12, aged 29.6 [3.9] y). Data were collected in two 4-day periods of the qualifiers for the 2020 FIFA Futsal World Cup. Each period comprised 3 matches. A total of 6 matches against 6 different opposing teams were considered. Players performed 3 matches at each congested period in different moments of the season (match day—1 [MD1], match day—2 [MD2], and match day—3 [MD3]). From MD1 to MD2, there was a 24-hour recovery time, whereas from MD2 and MD3, recovery time was 48 hours. This resulted in 3 matches within 4 days. The characteristics of the matches are presented in Table 1.

Inclusion criteria were the following: (1) outfield player, (2) any report of physical limitations or skeletal muscle injury that could affect performance, and (3) only data from participants who played >5 minutes were analyzed. Goalkeepers were excluded from the analysis. Players were informed that they were free to withdraw their individual data from the study at any time. Written informed consent obtained from all individual participants was included in the study. The study protocol was approved by the local ethics committee of University of Beira Interior (CE-UBI-Pj-2018-029) and conformed to the recommendations of the Declaration of Helsinki. To ensure player confidentiality, all data were anonymized prior to the analysis.

Procedures

An observational, descriptive research design was used to analyze physical performance of elite male futsal players. Players' activity was assessed using inertial measurement units with ultrawideband tracking system technology (WIMU PRO™; RealTrack Systems, Almeria, Spain). The sampling frequency of the tracking system was 18 Hz. The units were turned on about 10 to 15 minutes before the warm-up and worn by players in a specific custom neoprene vest located on the middle line between the scapulae at C7 level. The system has 6 ultrawideband antennas, placed 4 m outside the futsal court, and operates using triangulation between the antennas and the units to derive the *X* and *Y* coordinates of each unit. Data from the beginning to the end of each match, except half time and timeouts, were analyzed using corporative software (SPRO Software; RealTrack Systems). The accuracy and reliability of the system have been reported and validated elsewhere.[21]

Table 1 Characteristics of Qualifying Tournament Matches

Match	Score	Match outcome
Congested period 1		
MD1	4–0	Win
MD2	5–0	Win
MD3	4–1	Win
Congested period 2		
MD1	2–1	Win
MD2	2–2	Draw
MD3	4–1	Win

Abbreviations: MD1, match day—1; MD2, match day—2; MD3, match day—3.

Measures

The measures of physical performance were classified into external and internal load. External load was measured to identify the capacity of players to maintain highly demanding critical actions over the match in 2 dimensions[22]: kinematic and mechanical. Kinematics variables included total distance covered (TDC; in meters), and 2 thresholds were used to evaluate the distances covered in 2 categories of intensity: high-speed running (HSR, 12.1–18 km/h) and sprinting (>18 km/h). Mechanical variables consisted of the number of ACCs (>3 m/s^2) and DECs (> −3 m/s^2). The selected variables granted a reliable analysis of the most demanding actions required to maintain high levels of performance in futsal.[1,3,23] Data were normalized according to the effective playing time of each player during each match (ie, m/min or n/min). To quantify internal load, the rate of perceived exertion (RPE) was used.[24] Each player was asked about the global perceived intensity approximately 10 minutes after each match using a scale from 0 to 10, with 0 corresponding to "rest" and 10 to "maximal effort."[25] The RPE scores were used to determine the RPE of the session (s-RPE), which was calculated by multiplying the RPE score by the duration of the playing time (in minutes) of each player.

Statistical Analysis

The Shapiro–Wilk test was performed to identify the data distribution. Descriptive statistics including mean and SD were calculated for all studied variables. To analyze the interindividual and intraindividual longitudinal changes of the physical performance of futsal players over the congested fixtures, an LGC model was used. According to Byrne,[26] there are 2 major advantages in testing for individual change with the framework of the structural equation modeling: (1) this approach is based on the analysis of mean and covariance structure and (2) a distinction can be made between observed and unobserved (or latent) variables in the specification of models. In addition, this type of analysis is characterized by estimating intraindividual (growth parameters intercept and slope) and the interindividual (differences among subjects) growth paths.[27] The intercept and slope are latent variables, which means that they are not directly observed but, rather, inferred. The intercept determines the interindividual differences of participants' performance at the baseline (first match), that is, significant values of intercept suggest the existence of interindividual performance differences in MD1. The slope expresses the different individual trajectories of performance through each game in the congested period, that is, significant values of slope suggest the existence of interindividual performance differences between moments. Thus, it shows the differences between the observed games in congested fixtures and whether interindividual variability exists or not.[26] The covariance between the intercept and slope can reveal the relationship between the initial result (MD1) and the level of growth for MD2 and MD3. A negative result suggests that (high) initial values promoted low growth, and a positive result suggests that (high) initial values promoted high growth between the moments of analysis. A dummy variable designated by playing time was created and included in the model as predictor of growth to generate the following groups: group 1—more playing time (players with an average playing time equal to or greater than the average playing time) and group 2—less playing time (players with an average playing time less than the average playing time) (see Table 2 for more details).

Considering the low number of degrees of freedom (df) in the model analyzed, the model adequacy was verified through the

Table 2 Descriptive Statistics for the Considered Variables

Variable	MD1			MD2 (24 h)			MD3 (48 h)		
	All players	More playing time	Less playing time	All players	More playing time	Less playing time	All players	More playing time	Less playing time
Play time, min	14.2 (5.6)	18.6 (3.9)	8.7 (3.6)	14 (5.5)	18.7 (3.6)	8.9 (2.9)	14.2 (7.3)	19.3 (4.1)	6.7 (3.1)
External load									
TDC, m/min	211.6 (71.5)	155.9 (41.1)	338.7 (199.7)	256.3 (76.2)	225.8 (23.0)	344.4 (139.8)	265 (110.1)	206.0 (37.2)	369.2 (129.2)
HSR, m/min	31.4 (12.4)	25.0 (11.0)	35.2 (11.5)	34.1 (10.4)	35.5 (8.6)	33.8 (12.1)	35.8 (16.9)	33.4 (12.8)	33.4 (23.8)
SPR, m/min	6 (4)	3.6 (1.7)	9.3 (4.4)	7.1 (3.9)	6.8 (2.7)	7.5 (4.9)	6.9 (4.6)	7.4 (3.2)	5.1 (5.9)
ACC, n/min	2.7 (2.1)	3.1 (2.7)	5.0 (6.4)	2.8 (2.2)	2.4 (0.9)	3.6 (3.2)	2.8 (2.5)	2.7 (1.2)	5.5 (9.6)
DEC, n/min	3.2 (3.4)	4.2 (4.3)	9.2 (18.0)	2.9 (2.4)	2.3 (0.8)	3.5 (3.3)	6.3 (6.3)	6.2 (5.0)	14.3 (15.9)
Internal load									
s-RPE, au	95.6 (67.3)	152.5 (54.3)	47.5 (26.9)	97.9 (61.5)	139.7 (50.7)	48.5 (25.5)	109.7 (71.1)	168.7 (47.2)	39.7 (29.5)

Abbreviations: ACC, acceleration; au, arbitrary units; DEC, deceleration; HSR, high-speed running; MD1, match day—1; MD2, match day—2; MD3, match day—3; SPR, sprinting; s-RPE, session rating of perceived exertion; TDC, total distance covered.

normalized chi-square (χ^2/df), and the following cutoff values were adopted: $5 < \chi^2/\text{df}$, poor adjustment; $2 < \chi^2/\text{df} \le 5$, reasonable adjustment; $1 < \chi^2/\text{df} \le 2$, good adjustment; and χ^2/df approximately 1, very good adjustment. Besides that, a multigroup analysis was performed to verify how important playtime was to the model, as recommended by Byrne.[26] Therefore, 2 models were created: (1) model with playing time effect and (2) model without playing time effect. The differences between 2 models were assessed via $\Delta\chi^2$, $P > .05$ (Byrne[26]).

The computer software IBM SPSS AMOS (version 20.0) was used to process all models.

Results

A general increase both in internal and external load from MD1 to MD3 (Table 2) was observed for all players. No significant changes were observed according to playing time. In general, players with more competed time revealed lower relative external load metrics and higher internal load than players with less competed time.

The goodness-of-fit statistics for all the models with playing time effect can be found in Table 3. The variable sprinting was not included in any model because the results were not significant ($P > .05$) and the model presented a poor fit ($\chi^2/\text{df} = 7.78$). The analysis of the proposed models revealed a reasonable adjustment for HSR (model B), whereas all the analysis of other variables revealed an excellent, well-fitting adjustment.

The variance of intercept and slope was significant for all variables analyzed, suggesting a heterogeneous growth rate of physical performance and, therefore, an interindividual and intraindividual variation from MD1 to MD2 and MD3. The intercept variance at MD1 revealed significant values for TDC ($\beta = 0.83$, $P < .05$), HSR ($\beta = 0.73$, $P < .05$), ACCs ($\beta = 0.77$, $P < .05$), DECs ($\beta = 0.79$, $P < .05$), and s-RPE ($\beta = 0.91$, $P < .05$), suggesting interindividual variability on the performance in MD1. In addition, the standardized indirect effects between playing time and dependent variables trough intercept and slope showed the following significant effects: TDC (M1 = −.51; M2 = −.52; M3 = −.53), HSR (M1 = −.06; M2 = −.11; M3 = −.01), ACCs (M1 = −.24; M2 = −.23; M3 = −.22), DECs (M1 = −.35; M2 = −.18; M3 = −.38), and s-RPE (M1 = .73; M2 = .75; M3 = .84). Indeed, a nonlinear increase in all variables was observed; from MD1 to MD2, HSR increased by 68%, ACCs increased by 88%, and DECs increased by 82%. In opposition to the s-RPE that only increased from MD1 to MD2, 18% of the total performance increased in congested fixtures period (Figure 1).

To further understand the levels of variability between players' performance in MD1 and between moments (MD2 and MD3), playing time was included in the model as a predictor of growth.

Table 3 Multigroup Analysis Across Models Analyzed

Model	$\Delta\chi^2$	*df*	*P*
TDC (model A)	12.68	2	.222
HSR (model B)	.28	2	.869
SPR	16.51	2	<.001
ACC (model C)	2.64	2	.268
DEC (model D)	4.11	2	.128
s-RPE (model E)	20.03	2	.323

Abbreviations: ACC, accelerations; DEC, deceleration; HSR, high-speed running; s-RPE, session of rating perceived exertion; SPR, sprinting; TDC, total distance covered.

Playing time revealed a significant effect on physical performance growth with significant paths to intercept and slope for all models (Figure 1). Players who competed for more time revealed lower initial levels (MD1) of TDC ($\beta = -0.62$, $P < .05$), HSR ($\beta = -0.18$, $P < .05$), ACCs ($\beta = -0.31$, $P < .05$), and DECs ($\beta = -0.44$, $P < .05$) and higher s-RPE ($\beta = 0.81$, $P < .05$) than players who competed for less time. Also, players who competed for more time, and revealed lower initial values, revealed a higher increase in TDC ($\beta = 0.47$), HSR ($\beta = 0.16$), and s-RPE ($\beta = 0.66$) and a lower increase in ACCs ($\beta = -0.21$) and DECs ($\beta = -0.58$) than players who competed for less time from MD1 to MD3.

Discussion

Despite the advances in the knowledge of futsal demands, information regarding the effects of successive matches in physical performance and their relationship with playing time is still scarce. The concerns about fixture congestion are justified based on the likelihood of increasing residual fatigue, risk of injury, and underperformance due to reduced time for appropriate physical recovery. With that purpose in view, the present study attempted to evaluate the longitudinal variation of physical performance (ie, external and internal load) of elite male futsal players over a short congested period.

Results revealed that physical performance did not decrease during the short congested period. In opposition, there was a tendency for an increase in physical performance of players over the congested periods in analysis. Also, players who competed for more time revealed a lower external load and a higher internal load in MD1 with a higher increase from MD1 to MD3 in almost all variables in comparison with players who competed for less time. This evidence reinforces the importance of controlling not only the intensity of performance but also the volume to enhance the performance state of each player during the congested periods.

Such results are not in line with previous research in futsal in which a decrease of physical performance was observed during congested tournaments.[15] These differences could be justified by the differences in the congested periods considered in each study. Doğramaci et al[15] analyzed a competition with 6 matches in 3 days and recommended caution when comparing data from different congested fixtures (eg, number of matches vs number of days). In turn, results from Charlot et al[14] were partially in agreement with the results presented here by showing stability in physical performance and a slight increase in the subjective perception of players' effort throughout the competition without decreasing the high level of physical performance.

Our results revealed that elite male futsal players have an appropriate level of conditioning and an adequate capacity for the body to recover and regenerate after multiple stress stimuli. More than that, interindividual variability in performance was observed from MD1 to MD3. Even knowing that different players can reveal different recovery profiles,[28] in general, all players seemed to maintain the levels of performance between matches. Nevertheless, in future studies, the variations in internal and external load should be interacted with other variables of fatigue and recovery to better understand the real impact of match play in the level of players' readiness.

Interestingly, considering the significant effect of playing time on physical performance growth, it was observed that the players who competed for more time revealed lower intensity per minute in each game but increased their performance (high TDC and HSR) over the congested periods (from MD1 to MD3) more than the

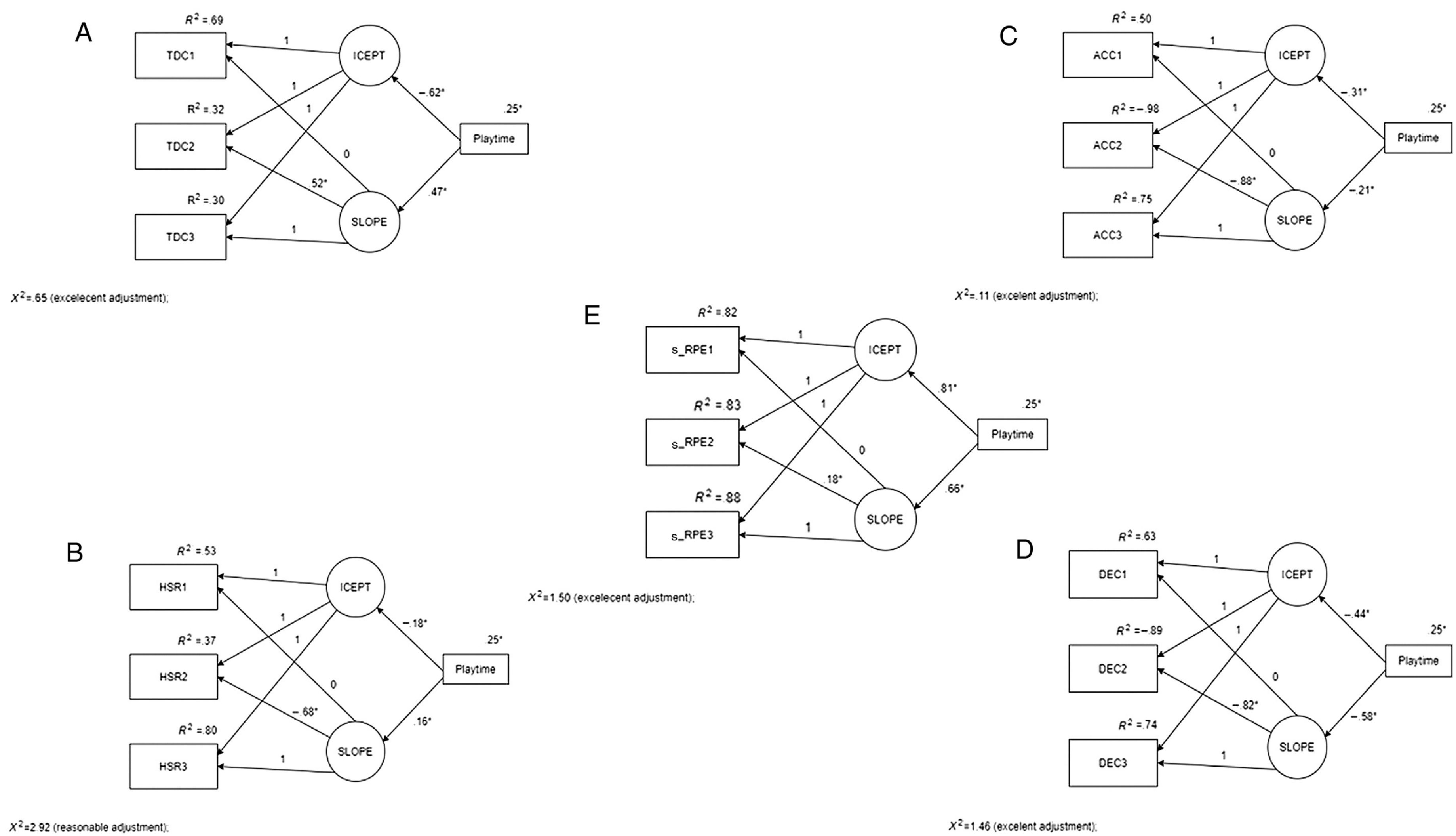

Figure 1 — Latent growth curve models for the considered variables. ACC indicates acceleration; DEC, deceleration; HSR, high-speed running; ICEPT, Intercept; s-RPE, session rating of perceived exertion; TDC, total distance covered.

players who competed for less time. However, they also revealed higher increase in s-RPE than the players who competed for less time. Corroborating this finding, others authors have noted that the capacity of players to maintain physical intensity between matches in congested periods can be strongly associated with individual strategies of pacing management in a conscious or unconscious way.[29] Knowing the number of matches needed to successfully perform, players may adjust their performance strategies to preserve energy and maintain the ability to perform high intensity actions.[30] This is very interesting and reopens a new discussion about the relationship between individual pacing management and playing time of players and the individualization of the load analysis and its variability.

In addition, another interesting finding is that players who competed for more time revealed a lower increase in mechanical variables, including ACCs and DECs, than players who competed for less time from MD1 to MD3. In fact, the increase on internal load and the associated fatigue did not decrease the kinematic capacity of players to perform but really might have limited the mechanical capability of players to perform ACCs and DECs, probably due to increased neuromuscular fatigue.[7] Indeed, other researchers noted changes in countermovement jump, high-intensity ACCs,[31] and hard changes of directions (ie, sudden changes in direction during running) at 24 hours[7] and in DECs after 48 hours.[32] Further research is required to evaluate the variation in players' strength and muscle damage over congested fixture periods.

Under this scope, the literature reported a decrement in muscle function, increasing players' muscle damage and inflammation,[33] which can remain up to 72 to 94 hours postmatch.[34] On the other hand, and knowing the impact of playing time in players' capabilities to perform, it seems that the futsal players were able to manage and increase their performance levels with 24- and 48-hour recovery times between matches. The unlimited rolling substitutions that are allowed in futsal, in opposition to football,[16,17] and the good management of each player's playing time by the coach can also allow players to suffer lower muscle damage and general fatigue. Also, as noted in football, the issue of the congested fixtures cannot be viewed as a linear problem related to the physical aspects per se. It is a multidimensional issue in which physical, tactical, and psychological issues interact to constrain the individual performance of each player. Further research is required linking the different dimensions of the problem (physical, technical, tactical, and psychological) for a better understanding of players' adaptations to congested periods. Further analysis should also consider analyzing the performance of teams from lower levels of quality. The high level of the team included in this study can serve as an important reference concerning physical demands of futsal in congested periods; however, it is also important to understand these trends at lower quality levels.

Practical Applications

Knowledge transfer from sports science to futsal coaches needs further improvement; a realistic view of the match exertion is needed for the team and each individual player. Coaches who are well informed about variation in players' match exertion are better prepared to find the optimal balance between exertion and recovery and to subsequently prevent underperformance.

Despite the capacity of players to maintain performance over the short congested fixture periods in analysis, it is suggested that coaches manage players' performance and fatigue based on their individual capabilities. The interplayer variability should be considered in the process of match management and recovering. Technical staff and coaches should develop strategies of monitoring and recovery that allow then to further characterize and understand the individual needs of the players.[28]

Conclusions

The main findings showed that congested periods did not affect match physical performance in futsal. Furthermore, playing time was a key performance factor, thus verifying that players who competed for more time had a lower external load and a higher internal load than players who competed for less time. Following intercept and slope, we observed individual patterns of response where improvements in some external variables were not necessarily associated with improvements in playing time.

There is strong evidence for considerable heterogeneity in the responsiveness to physical performance over congested periods. This evidence reinforces the idea that analyzing just the average values of the external load metrics may not be sensitive enough to detect patterns of fatigue. The analysis of variability from match to match through LGC modeling allows us to assess real changes/differences in match play, training intensity, and load. This would eventually facilitate effective planning and timing of subsequent training and recovery sessions to ensure that the required physiological stimuli are applied.

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