

How did three consecutive matches with extra time affect physical performance? A case study of the 2018 football Men's World Cup

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ABSTRACT: The purpose of this study was to ascertain the effect of playing three consecutive matches with extra time (ET) on the physical performance of selected Croatian players in their subsequent match, the final of the 2018 Men's World Cup in Russia. The case study consisted of 4 players on the Croatian national team (16 observations) who had played in all three matches up to 120 min. The consecutive full time matches (90 minutes) and extra time (30 minutes) were compared. The analysis was conducted using data collected by an advanced motion analysis system known as STATS and from interviews with the strength and conditioning coach of the Croatian national team. The recorded variables used were: total distance covered [m], distances covered [m] at intensity ranges of 20–25 km/h and above 25 km/h, and number of sprints performed. All the studied parameters systematically increased in each match up to 90 minutes of play, reached their maximum values in the semi-final and then decreased in the final match. Compared to the first extra time period, in the third extra time period the players covered twice as much distance with an intensity of 20–25 km/h and above 25 km/h, and recorded twice as many sprints. This investigation shows that players in central positions on the pitch are able to maintain or even increase high and very high intensity activity in three consecutive matches with extra time. These data complement the developing body of literature relating to the influence of accumulation of match play with extra time periods on high level players.

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INTRODUCTION

From 1986 to 2014, 35% of the men's FIFA World Cup matches (including the last three finals) required extra time (ET), and thus the analysis of ET and its effect on subsequent matches is particularly important. The need for ET in soccer tournaments is becoming increasingly common. Harper et al. [1] and Kubayi et al. [2] have shown that during the knockout phases at the 2002 World Cup 25% of matches required 120 minutes, in 2006 it was 38%, and at the 2014 tournament, as many as 50%. Given the fact that extra time often determines success or failure at soccer tournaments, the absence of extensive research is somewhat surprising. In addition, practitioners working in professional soccer have highlighted that understanding fatigue responses in post-ET performance is an important area for future research [3].

Players taking part in the World Cups and continental championships (European Championships, Copa America, African Cup of Nations, etc.) are significantly exposed to the maximum exhaustion of

energy resources – especially when they have to play an additional 30 minutes – which often affects physical activity and increases the risk of injury [4, 5]. This is confirmed by Lago-Peñas et al.'s [6] study that analyses the negative impacts of an additional period of play on physical performance, indicating that physical activity decreases the longer players play. The selected Croatian players in our study appeared for a total of 90 minutes more than other teams in the period of the round of 1/16, the quarter-finals and the semi-finals. This could, over a short period, potentially result in residual fatigue and underperformance, due to insufficient time for physical recovery in comparison to other competitors [7].

During the most important tournaments, estimating match related fatigue is necessary in order to more effectively manage recovery strategies and training loads [8]. Recovery status, according to Carling [9], is influenced by myriad factors, including physical activity in the previous match or matches, the use or absence of

post-competition recovery strategies (e.g. ice baths, nutrition), individual physical characteristics, and/or training workload between match. Teams tend to conduct post-match recovery modalities immediately after, and the day after matches (e.g. cold-water therapy) in an attempt to alleviate fatigue and quicken recovery [10, 11]. Furthermore, Nedelec et al. [8] show that during the 72-hour recovery period, jumping, isometric strength of the hamstring muscles, and peak sprint speed significantly decreased, whereas muscle soreness increased.

A study by Chmura et al. [12] demonstrated that the percentage of distance with high intensity during matches at the 2014 FIFA World Cup was more than 10% of the total distance covered and had a significant impact on the German national team winning the tournament. This demonstrates that players cover significantly greater distance with high intensity in matches that are won than matches lost. This is also confirmed by Faude et al. [13], who showed that in order to win a match, players have to repeat their maximum efforts and sprints numerous times when trying to run away from an actively attacking or defending opponent or to run into free space to take a shot or perform a “key pass”. They also noted that 45% of the goals scored were preceded by a straight line sprint. Additionally, analyses from recent years indicate that the covered sprint distance and numbers of sprints performed are of major significance in modern soccer [14, 15, 16].

However, matches played during the knockout phase at the World Cup, especially in consecutive extra times, usually lead to high or sometimes even to extreme mental and physical fatigue [17]. In the current literature, there is no research that sufficiently explains the effect of playing three consecutive matches with extra time on physical activity during the next match. From a cognitive point of view, it is interesting to study the effect of accumulating residual fatigue in terms of total distance, distance covered with intensity of 20–25 km/h and above 25 km/h, number of sprints in players playing all full matches in the knockout phase, and, moreover, what recovery-enhancement methods should be used to reduce residual fatigue and prevent lowering of physical activity in the short time between matches, especially in terms of playing with high intensity and the ability to repeat sprints. Therefore, the aim of this study was to ascertain and

analyse the effect of three consecutive matches with extra time on the physical activity of selected Croatian players in the final match.

MATERIALS AND METHODS

Experimental approach to the problem

The case study method used employed an embedded, single-case design in our study [18]. Quantitative and qualitative methods were most appropriate for this type of investigation because they allow researchers to delve deeply into the subject matter at hand, affording flexibility in pursuing emergent lines of investigation. The premise of this study is that observation of changes is necessary to identify effects of extra time team performance, because the averaging out of experiences of multiple teams can lead to a fallacious “no-effect” result. Due to the exploratory nature of this study, and the broad range of factors that could potentially affect the physical activity of soccer players in a dynamic game environment, it was deemed appropriate to conduct match-by-match knockout phase analysis. The choice of the team and players to study was necessarily governed by the prospect of the first ever situation at a soccer World Cup where one team played three consecutive matches with extra time (3 x 30 min, a total of 90 minutes of extra time). Physical activity parameters were expected to be maintained or decrease in the players who formed the “core” of the team and who played from beginning to the end in every match in the knockout phase of the tournament.

Players and match data

The sample was limited to the 4 players (two central defenders and two central midfielders) on the Croatian national team (16 observations) who played for entire matches, up to 90 min, and the entire extra time period (i.e. totalling 120 min per match) in three consecutive matches in the knockout phase and the entire 90 min of the final at the 2018 World Cup held in Russia. Other players who did not play in one of the matches in the knockout phase or were substituted in/out during regulation time or extra time were excluded from the analysis. Mean body height among players was 183.40 ± 6.67 cm, mean body mass 78.57 ± 7.34 kg, and mean age 26.64 ± 4.03 years. Match data for goalkeepers were excluded from the analysis, given the specific nature of that position.

TABLE 1. Schedule, breaks between matches, and results by Croatian national team during the World Cup in Russia.

	Round of 16	Quarter-final	Semi-final	Final
Opponent	Denmark	Russia	England	France
Date	2018-07-01	2018-07-07	2018-07-11	2018-07-15
Break between matches	6	4	4	
Match outcome	Win on penalties	Win on penalties	Win after extra time	Defeat
Score goals	1:1 p.3:2 (1:1)	2:2 p.4:3 (1:1,1:1)	2:1 et. (1:1,1:0)	2:4 (2:1)

Table 1 presents general information about the consecutive matches in the knockout phase played by the Croatian national team at the 2018 World Cup in Russia.

This study maintains the anonymity of the players following data protection law, was conducted in compliance with the Declaration of Helsinki, and was approved by the local Board of Ethics.

Data collection and analyses

In this case study, two methods were used:

1) the physical activity of players was measured using an advanced motion analysis system known as STATS (Chicago, IL, USA), operated at 25 frames per second and allowing for simultaneous tracking of players' actions during each second of the game, in all sections of the soccer pitch. The validity and reliability of this system for taking such measurements have been described in detail elsewhere [19, 20]. Match data were retrieved from the official website of FIFA [21]. Data from the same resource have been previously used for FIFA World Cup related research by Da Mota and colleagues in a review [22], which discussed in detail the tracking and coding process of the FIFA official dataset.

In the analysis, the recorded variables used were as follows: total distance covered [m], distances covered [m] at intensity ranges of 20–25 km/h and above 25 km/h, and number of sprints performed.

To better show the trends of increase or decrease in the physical preparation of the selected Croatian players, percentage change of the examined variables was used. It was calculated from the proportion, comparing consecutive matches played in the knockout phase in relation to the final match. We assumed that the recorded value in the final match was 100% of the physical activity of the variables examined.

2) The interview with the strength and conditioning coach of the Croatian national team focused on the most frequently used methods of regeneration for the Croatian national team and whether there was

individualization of training loads between matches. The interview consisted of six questions:

1. Which recovery methods were used most often between matches?
2. What methods of regeneration were used immediately after matches?
3. What recovery methods were used during the days following matches (the first day after the match, the second after the match)?
4. Describe the physical preparation for players before the World Cup.
5. What did the players do at the training base?
6. What were the main physical and regenerative aims?

Statistical analysis

Data for the players' physical activity are presented as means ± SD and as the percentage change between the final match and the consecutive knockout phase matches. Practical significance was assessed by calculating Cohen's effect size (ES) [23]. Thresholds for ES statistics were described in line with the following assumptions: ≤ 0.35 – small effect size; > 0.35 and < 0.65 – medium effect size, ≥ 0.65 – large effect size [23]. Following transcription from the reports, analysis of the data obtained was carried out using the STATISTICA (ver. 13.1) statistical program (StatSoft. Inc., the USA) software package.

RESULTS

Analysing the values obtained by the selected Croatian players up to 90 minutes shows that the total distance covered, distance covered with intensity 20–25 km/h, distance above 25 km/h, and number of sprints systematically increased from one match to another of the knockout phase, reaching their maximum values in the semi-final and then decreased in the final match (Table 2). The analysis of changes between the semi-final and final match showed that the biggest difference up to 90 minutes was recorded in the total distance

TABLE 2. Differences in total distance covered [m], distance covered at various zone intensity [m] and number of sprints performed the by selected Croatian players in three consecutive matches with extra times (mean ± SD).

Variables [m]	Value / %	Round of 16		Quarter-final		Semi-final		Final
		Up to 90	Extra time	Up to 90	Extra time	Up to 90	Extra time	Up to 90
Total distance covered	Value	9192 ± 775	2761 ± 153	9540 ± 478	3028 ± 109	9623 ± 793	3350 ± 317	9052 ± 523
	%	101	+31	105	+33	106	+37	100
20–25 km/h distance covered	Value	398 ± 102	85 ± 26	403 ± 50	143 ± 26	462 ± 125	182 ± 48	434 ± 145
	%	91	+20	93	+33	106	+42	100
> 25 km/h distance covered	Value	131 ± 49	28 ± 13	148 ± 52	61 ± 32	178 ± 23	66 ± 20	172 ± 22
	%	76	+16	86	+35	104	+38	100
Sprints [number]	Value	24 ± 6	5 ± 1	25 ± 3	8 ± 3	28 ± 4	10 ± 2	27 ± 6
	%	89	+18	92	+30	104	+37	100

covered (-6%, ES = 0.87) and also reached the lowest level in comparison to the other rounds of the knockout phase. The distance covered with intensity above 25 km/h (ES = 1.15) and number of sprints (ES = 0.50) were higher in the final match than in the round of 16 and also than in the quarter-final (respectively ES = 0.65 and ES = 0.44).

Analysis of the three consecutive extra time periods showed a similar trend (to data for up to 90 minutes of play) of a systematic increase in all four studied parameters made by the Croatian players between the round of 16 and the semi-final (Table 2). The lowest recorded results were in the first extra time and the highest in the third extra time. It was also observed that the distance covered with intensities of 20–25 km/h (ES = 2.62) and above 25 km/h (ES = 2.30) and the number of sprints (ES = 3.33) were at least twice as low in the round of 16 than they were in the semi-final.

An interview with the strength and conditioning coach of the Croatian national team allowed us to determine the recovery methods that were actually used during the tournament. The recovery methods used most often by Croatian players between matches were: manual therapy, nutrition and active recovery. The recovery methods most often used immediately after the match by the coach and medical staff were: cold/contrast bath, nutrition, supplementation. On the first day after the match, players used manual therapy, nutrition, and active recovery, while on the second day after the match active recovery, focus/relaxation variability, sympathetic/parasympathetic balance, variability, and recovery intervals were all used. The most important information from the strength and conditioning coach was that an individual approach was used for physical performance recovery, thanks to which participants had different data recovery protocols. The protocols were created based on their habits, preferences, and physical characteristics.

Before the World Cup, players spent almost an equal amount of time in team and individual work. Distributed loading with no big fitness level drops, and a simplified selection of methods and exercises, meant that training stress was as similar as possible to club systems, albeit with modifications taking into account the World Cup schedule. Main physical and regenerative aims at the training base were also almost equally split between team and individual work. The main focus was on specific endurance, achieved through training variability, from small-sided games (SSG) to large-sided games (LSG), long and short intervals, repeated sprint ability (RSA) and speed, ability and quickness (SAQ). The other recovery methods used by the Croatian national team were: lifestyle design, sleep, games/minutes management, pharmacology, mental techniques, winning, cooling, cooling/warming, travel management, and compression. Injury prevention was based on: load management, stability-mobility, movement mechanics physical, abilities recovery and protocols lifestyle.

DISCUSSION

The aim of this study was to investigate the effect of three matches with extra time on the physical activity of selected Croatian players

in the final match at the 2018 World Cup in Russia. To our knowledge, this research is the first case study related to a team that has played three successive matches with extra time during a top level tournament. Given the importance of high-intensity parameters and changes in soccer tournament scenarios, these data are likely to be of interest to those responsible for the physical preparation of soccer players, especially as the analysis of the total distance covered in extra time showed that in the three rounds of the knockout phase before the finals, the selected players covered an additional 101% of the distance covered in the final match. It is as if the players in this phase of the competition played one additional match lasting 90 minutes. In the case of distances with an intensity of 20–25 km/h, the sum of this parameter was an additional 95%, for distances with an intensity of above 25 km/h an additional 89%, and the number of sprints an additional 85%.

Analysing four consecutive matches up to 90 minutes, from the round of 16 to the final at the World Cup in Russia, it was surprisingly found that players who form the “core” of the team systematically improved their performance for all four of the studied parameters of physical activity. This may indicate very good physical preparation for the tournament and a high tolerance to increasing fatigue during consecutive matches. Support for this interpretation of the results can be found in the research of Silva *et al.* [24], who claimed that residual fatigue after a match does not affect the recreation of the physical activity required during a top-level tournament and players increase their high intensity performance despite playing a large number of matches over a short period of time, and often with extra time. However, this does not apply to situations where players played in three consecutive extra times. Moreover, it was noted that maximum values were obtained in the semi-final, despite the fact that residual fatigue accumulated over successive matches and subsequent incomplete recovery can have the effect of decreasing physical performance [4, 11, 24, 25, 26]. That said, the increase in parameters may be the result of many factors, including the psychological factor associated with the growing importance of each successive match [27, 28]. As indicated above, the studied physical activity parameters decreased in the final match. This was probably due to the fact that over just 14 days the selected Croatian players played 3 matches with extra time (totalling an additional 90 minutes) and also had only a 4-day break between the semi-final and the final. On the other hand, distances covered at high intensity and the number of sprints were higher than in the round of 16 and the quarter-final. This proves the very high physical potential of the analysed players.

Our analysis of the three consecutive extra times showed a similar trend to the one observed for the regulation 90 minutes of the game, that is, a systematic increase in the studied parameters made by the Croatian players between the round of 16 and the semi-final. Unexpectedly, it was also observed that distances covered at high intensities and the number of sprints were twice as low in the round of 16 match than they were in the semi-final. A possible explanation

for obtaining such results is amelioration of the rapid onset of residual fatigue after a 120-minute-long match through the use of individualized methods of regeneration. According to the strength and conditioning coach of the Croatian national team, control of players' recovery through an individualized approach and injury prevention is crucial and should be based on load management, stability-mobility, movement mechanics, recovery, and a proper lifestyle protocol. The most important of these recovery methods were: active recovery, sleep, sympathetic-parasympathetic balance, nutrition, pharmacology, manual therapy, mental techniques, cooling, cooling-warming, travel management, and compression. These interventions probably allowed effective reduction of residual fatigue and accelerated regeneration, which is in line with existing literature [9, 10, 11].

In our analysis, only two central defenders and two central midfielders were selected. Each played every knockout phase match up to 90 minutes as well as all of the subsequent extra times. Players in these positions perform significantly fewer sprints compared to forwards and players, who play on the sides of the pitch, who cover longer distances with higher intensity [29]. The players who played in central positions ran shorter distances, and at various intensities, in comparison to players in other positions who were substituted during the second half of a game or extra time. The study by Konefat et al. [30] noted similar findings, i.e., that central midfielders cover shorter distances at very high intensity, perform a smaller number of sprints and attain a lower peak running speed. Moreover, central defenders perform over 90% fewer sprints than wide midfielders [27]. This confirms that central defence and central midfield positions are the "core" of the team that regulate the pace of play and do not require frequent changes.

The above results show that distances with high intensity are an indispensable factor for performance at a high level [31]. Our analysis shows that the selected Croatian players, who reached the final, maintained physical activity despite playing a large volume of matches with extra time during the knockout phase at the 2018 World Cup in Russia. The findings are also confirmed by the study of Chmura et al. [12], in which the World Champions (players from the German national

team) at the World Cup in Brazil in 2014 covered significantly greater distances at high intensity. The analysis in our paper also shows that well-established methods of regeneration used by the Croatian national team, the individualization of training loads between matches, and the high level of players' aerobic fitness [12, 32] ensured that the parameters of physical activity were maintained and even improved, despite playing three consecutive matches with extra time.

This study is based on the first case in history of playing three consecutive extra times in the knockout phase of the World Cup. Therefore one of the limitations of this study is that the authors analysed only one tournament with a small sample, which makes it impossible to use more precise statistical methods. According to this, the conclusions should be interpreted with caution. These results are limited to central positions and should not be extrapolated to other positions. Additionally, the analysis concerns only physical activity, without reference to technical activity and a qualitative analysis of tactics. Furthermore, further research should also include physiological, biochemical variables and knowledge about maintaining physical activity and the impact of playing matches with extra time. Further research utilizing kinematic data of top-level tournaments is required.

CONCLUSIONS

Players in central positions on the pitch are able to maintain or even increase high and very high intensity activity in three consecutive matches with extra time. Only those with a high level of physical preparation (aerobic and anaerobic capacity and power) are able to meet the demands of repeated match efforts with extra time. Such a situation requires the use of individual regeneration methods and training loads between matches. The situation of playing three consecutive matches with extra time, which has occurred for the first time in history, indicates large physical reserves and exercise capacity of modern professional soccer players. Therefore, the task of coaching staff is to extract the potential of players and to prepare them for the increasing intensity of the game, which will have a growing importance in future tournaments of the highest rank.

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