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The impact of COVID-19 lockdown on soccer positional and physical demands in the Spanish La Liga

Tomás García-Calvo [a], Javier Fernandez-Navarro [b], Jesús Díaz-García [a], Roberto López-Del Campo [c], Fermín Martínez Fernández [c] and Daniel Memmert [d]

[a]Faculty of Sport Sciences, University of Extremadura, Cáceres, Spain; [b]School of Science and Technology, Nottingham Trent University, Nottingham, UK; [c]LaLiga Sport Research Section, Madrid, Spain; [d]Institute of Exercise Training and Sport Informatics, German Sport University Cologne, Cologne, Germany

ABSTRACT

The present study aimed to analyse the playing surface area, dispersion and distance covered of professional football teams comparing the pre-lockdown and post-lockdown periods. Positional and match physical demands data were collected from all matches played in the First Spanish Division (n = 760) during season 2019/2020. Pre-lockdown (1st–27th matchday) and post-lockdown periods (28th–38th matchday) were compared. Variables related to team-level spatial (i.e., convex hull, team width and team length) and physical performance (i.e., total distance and high-speed running distance) were analysed using an optical tracking system (i.e., ChyronHego). In addition, these variables were concerned with respect to the match location contextual variable. Linear mixed models were used to examine the difference between the pre-lockdown and post-lockdown periods following a hierarchical structure considering players, matches and teams. The results revealed that the pandemic lockdown affected the teams' performance when comparing the periods before and after lockdown, showing a general decrease in the average values of the spatial and physical variables measured. The current data could assist practitioners in making informed decisions in order to design and improve training plans for similar situations in which teams return to competition after an unusual period with no training.

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KEYWORDS
Professional soccer players; tactical performance; tracking technology; positional data; pandemic

Introduction

The COVID-19 pandemic has had a considerable impact on competitive football for all leagues and tournaments (Mohr et al. 2020). Competitions were cancelled or postponed, causing a substantial period without any training or matches for the players. Although football players could train individually during the pandemic, they could not train with their teammates. Hence, the teams could not keep improving the tactical aspects of their play. It can be suggested that this long period could influence the tactical behaviour of teams when returning to competition. Since this situation was very recent, there is a lack of literature exploring the effect of the pandemic lockdown on football match-play. Current studies like the present one are trying to shed light on the impact of the COVID-19 pandemic on football performance.

Recent research explored the effect of the pandemic on the home advantage in football. A study evaluating German football showed that the COVID-19 lockdown led to a home disadvantage (Tilp and Thaller 2020), possibly due to the missing crowd of supporters and playing in an empty stadium. However, another study analysing the top European football leagues found contrasting results, indicating no changes in terms of the home advantage when comparing the pre-lockdown and the post-lockdown periods (Wunderlich et al. 2021). These contradictory results suggest a need for research about the effect of the pandemic in sport and, specifically, how playing games with no spectators influence the teams' performance. The study by Wunderlich et al. (2021) also found that the match dominance of home teams decreased in the post-lockdown period, suggesting that the teams' performance was affected by playing with no supporters in the stadium. Due to the changes in competition, from playing with supporters to playing in an empty stadium, it could be hypothesised that this would also influence the teams' play and positioning on the pitch as these are aspects of the tactical behaviour of a team that may be affected by the crowd.

Although previous studies explored the effect of the pandemic on home advantage evaluating simple indicators such as goals, points, or fouls; there are other relevant variables that should be analysed in order to describe the teams' tactical behaviour. Considering the variables that help determine football teams' tactical performance from positional data, a reference to the pre-pandemic results can be found in the literature. The surface area of a team or group of players provides insight into the space that players are covering at a specific moment and their compactness. It can be measured using a convex hull (i.e., the polygon generated by all the players). Previous research used this approach to analyse the organisation of the teams on the pitch during the competition (Moura et al. 2012; Clemente et al. 2013) and small-sided games (Frencken et al. 2011) and showed that teams present a greater surface area and spread when attacking than when they are

CONTACT Javier Fernandez-Navarro javier.fernandeznavarro@ntu.uc.uk Senior Lecturer in Performance Analysis School of Science and Technology Nottingham Trent University, Nottingham, UK

defending. Therefore, these results proposed that teams tend to be more compact when supporting to protect their own goal. Players spread more when attacking to take advantage of the available space to create scoring opportunities. In addition, there is evidence of previous studies that analysed tactical and physical variables combined to evaluate the performance of football teams, finding that teams' running performance was different depending on player positioning (i.e., formations) (Bradley et al. 2011; Aquino et al. 2019) and playing strategies (da Mota et al. 2016; Yi et al. 2019).

The recent developments in technology have allowed the approaches to improve the evaluation of tactical performance in football (Rein and Memmert 2016). For example, tracking technologies provided positional data of the players on the pitch. This kind of data has been used to develop new performance indicators to measure the collective behaviour of players in training and competition (Memmert et al. 2017). The x- and y-coordinates from positional data have been shown to help measure variables using length, width and space between a group of players in the team or other locations over the football pitch (Memmert et al. 2017). Those variables include the surface area covered by players, centroids, or stretch indexes (Sarmento et al. 2018). Moreover, tracking data also allows the measurement of physical variables such as the total distance covered and the high-intensity distance covered by players in a match (Randers et al. 2010).

Hence, there is a need to evaluate the effect of the pandemic on teams' tactical behaviour and running performance using variables available from positional data. The pandemic led to an unusual situation in football competitions in which the lockdown entailed a period of no training followed by a congested fixture schedule. This scenario suggests that there could be changes in the teams' tactical and physical performance and the exploration of the differences between the pre-pandemic and post-pandemic periods would shed some light into understanding the effect on COVID-19 pandemic on elite football competition. Therefore, the present study aimed to analyse football teams' playing surface area, dispersion, and distance covered (total and high-speed running, HRS) comparing the pre-lockdown and post-lockdown periods while controlling the contextual variable of match location.

Methods

Sample

The sample included the match observations of all matches played in two phases or periods of the top Spanish soccer league (i.e., La Liga Santander) during season 19/20: pre-lockdown period, from the 1st (16–18th August) to the 27th matchday (6–8th March) and post-lockdown period, from the 28th (11–14th June) to the 38th matchday (19th July). The lockdown period duration was between 60 and 65 days. Therefore, to analyse collective positional data, a total of 760 records belonging to all matches played over the season by all teams of LaLiga Santander were included. On the other hand, to analyse the distances covered by soccer players, a total of 8,347 individual match observations of all players who participated in matches (starters and non-starters) were included (n = 457). Only goalkeepers and players (starters or non-starters) that played less than 10 minutes were excluded because it was observed in the present study that average values obtained from these players were higher than the team average. We would like to remark that La Liga changed for the 5-substitute rule.

Procedures

Data were provided to the authors by LaLiga^{TM}, and the study received ethical approval from the University of Extremadura; Vice-Rectorate of Research, Transfer, and Innovation – Delegation of the Bioethics and Biosafety Commission (Protocol number: 239/2019).

Match data were obtained using an optical tracking system (Mediacoach® System). This multi-camera tracking system consists in eight super 4 K-High Dynamic Range cameras based on a positioning system (Tracab-ChyronHego VTS) that film from several angles and analyse X and Y positions of each player, thus providing real-time three-dimensional tracking. This instrument is also based on the correction of the semi-automatic VTS (the manual part of the process). The validity and reliability of the Tracab® videotracking system have been analysed, reporting average measurement errors of 2% (Pons et al., 2019). Mediacoach® System automatically transferred the raw data using internal filters; therefore, authors received the data filtered directly.

Study variables

Team-level spatial, physical and contextual-related variables were used as performance indicators. Similar to other authors (Moura et al. 2013; Vilar et al. 2013; Castellano and Casamichana 2015; Memmert et al. 2019), we used the following spatial variables because they can give us interesting information about the dispersion and positioning of the teams:

1) Convex Hull, defined as the effective playing area formed by the positions of the players in each team, except to goalkeeper (Moura et al. 2013). Two different types of convex hull could be identified: Offensive Convex Hull, represented by the area of the convex hull formed by the positions of the teammates, when the team is in ball possession; and Defensive Convex Hull, represented by the area of the convex hull formed by the positions of the teammates, when the team is not in ball possession.

2) Team Width (AMP), established as the distance between the two players furthest-apart across the width of the pitch (Bourbousson, et al., 2010). Two differences in team width could be identified: Offensive team width, represented by team width when team analysed is in ball possession; Defensive team width, represented by team width when team analysed is not in ball possession.

3) Team Length (PRO) determined as the distance between the two players furthest-apart along the length of the pitch (Bourbousson, et al., 2010). Two differences in team length could be identified: Offensive team length, represented by team length when team analysed is in ball possession; Defensive team length, represented by team length when team analysed is not in ball possession.

Table 1. Comparative analysis of positional and physical demands between pre-lockdown and post-lockdown.

Variables	Offensive Convex Hull		Defensive Convex Hull		Offensive Width		Offensive Length		Defensive Width		Defensive Length		Total Distance (mt/m)		High Speed Running (mt/m)	
	Coeff (SE)	*p*	Coeff (SE)	*p*	Coeff (SE)	*p*	Coeff (SE)	*p*	Coeff (SE)	*p*	Coeff (SE)	*p*	Coeff (SE)	*p*	Coeff (SE)	*p*
Intercept*	1039.45 (18.84)	<0.01	765.04 (8.12)	<0.01	45.15 (0.62)	<0.01	34.1 (.16)	<0.01	35.55 (.20)	<0.01	31.45 (0.14)	0.06	110.26 (.38)	<0.01	15.98 (.09)	<0.01
Diff Post Covid	−14.21 (7.58)	0.06	−17.95 (5.30)	<0.01	.53 (0.23)	0.02	−.65 (.11)	<0.01	.15 (.03)	0.21	−.66 (.17)	0.03	−2.87 (.16)	<0.01	−.41 (.03)	<0.01

Note. Coeff = Coefficient; SE = Standard Error; Intercept* = mean values of matches pre-COVID; Diff post Covid = Difference values between pre- and post-covid matches.

4) Centroid, identified as the value of computation of the geometric centre of a team (i.e., Euclidean distance between each player and the ball; Clemente et al. 2013).

In all the spatial variables, the average of the teams with offensive and defensive positioning in each game has been calculated, using this value for statistical analysis.

Physical performance was examined into the following speed thresholds (Pons et al., 2019, 2021): Total distance covered by players in meters (i.e., TD) and distance covered by players in meters by minutes, at a speed greater than 18 km·h^{-1} (i.e., HSR).

In addition, the contextual variable match location was included in the research. Specifically, we distinguished between matches played at home and away: 1 = the team is playing at home; 0 = the team is playing away.

Finally, to identify the matches played before and after the lockdown by COVID-19, another dichotomous variable was included: 0 = matches played before lockdown; 1 = matches played after lockdown.

Statistical analysis

All statistical analyses were performed using R-studio (R Core Team, 2020). A Linear Mixed Model (LMM) was carried out for each of the distance variables using the lme4 package (Bates, Machler, Bolker, & Walker, 2015). LMM lets analyse data with a hierarchical structure in nesting units and has demonstrated its ability to cope with unbalanced and repeated-measures data (Heck, Thomas, & Tabata, 2014). For example, distances covered in match variables are nested for players (i.e., each player has a record for every match they have participated in), and players are nested into teams. Also, spatial variables are nested into matches, and these matches can also be nested into teams.

Following the procedure proposed by Heck et al. (2014), unconditional models were analysed exclusively including dependent variables (i.e., spatial and distance covered variables), to see if the grouping variables at level 2 and 3 (i.e., players and teams) significantly affect the intercept (mean) of each dependent variable. These models may be used as baselines for comparing more complex models. Then, included the lockdown variable as fixed effects, testing differences between team matches pre and post confinement (Table 1), including random intercept. Finally, we included in the models the match location as fixed effects (Table 2). The inclusion of teams as a random effect in the models accounts for the variability of the fixed effects (i.e. dependent variables) across the different teams in the sample. Therefore, this hierarchy in the mixed models employed for the analysis accounts for the non-independence of the data.

Results

Table 1 shows the evolution of data analysed during pre-lockdown and post-lockdown periods. With regard to team-level spatial variables, all variables have decreased after the lockdown of the league, except Team Width. In this vein, significantly decreases were observed for defensive convex hull ($p < .05$) and offensive and defensive lengths ($p < .001$; $p < .05$, respectively). In other words, after stoppage, matches were played in less surface area, with the convex hull being smaller, both offensively and defensively. Only, team width was increased. Differences in offensive and defensive convex hull between the pre- and post-lockdown periods are shown in Figures 1. Regarding to physical performance data, there is also a significantly decrease in total distance covered by the players ($p < .001$), as well as the HSR distance ($p < .001$) after the lockdown.

Table 2. Comparative analysis of positional and physical demands between pre-lockdown and post-lockdown according to match location.

Variables	Offensive Convex Hull		Defensive Convex Hull		Offensive Width		Offensive Length		Defensive Width		Defensive Length		Total Distance (mt/m)		High Speed Running (mt/m)	
	Coeff (SE)	*p*	Coeff (SE)	*p*	Coeff (SE)	*p*	Coeff (SE)	*p*	Coeff (SE)	*p*	Coeff (SE)	*p*	Coeff (SE)	*P*	Coeff (SE)	*p*
Intercept*	1048.27 (19.24)	<0.01	772.25 (8.59)	<0.01	45.37 (.62)	<0.01	34.26 (.17)	<0.01	36.60 (.21)	<0.01	31.46 (.14)	0.07	111.01 (.49)	<0.01	16.14 (.11)	<0.01
Diff Post Covid Home	−14.57 (10.66)	0.16	−19.75 (7.45)	<0.01	.67 (.33)	0.04	−.76 (.14)	<0.01	.01 (.17)	0.21	−.65 (.16)	<0.01	−3.52 (.54)	<0.01	−.75 (.13)	<0.01
Pre Covid Home- Pre Away Matches	−17.64 (7.97)	0.02	−14.43 (5.51)	<0.01	−.43 (.25)	0.08	−.34 (.11)	<0.01	−.10 (.12)	0.44	−.01 (.18)	0.94	−.40 (.18)	0.03	−.09 (.04)	0.06
Post*Away	.64 (15.11)	0.96	3.59 (10.12)	0.73	−.29 (.47)	0.52	.22 (.21)	0.29	.30 (.24)	0.21	−.01 (.34)	0.98	.43 (.34)	0.21	.21 (.18)	0.01

Note. Coeff = Coefficient; SE = Standard Error; Intercept* = mean values of matches pre-COVID played at home; Diff post Covid Home = Difference values between pre- and post-covid matches played at home.

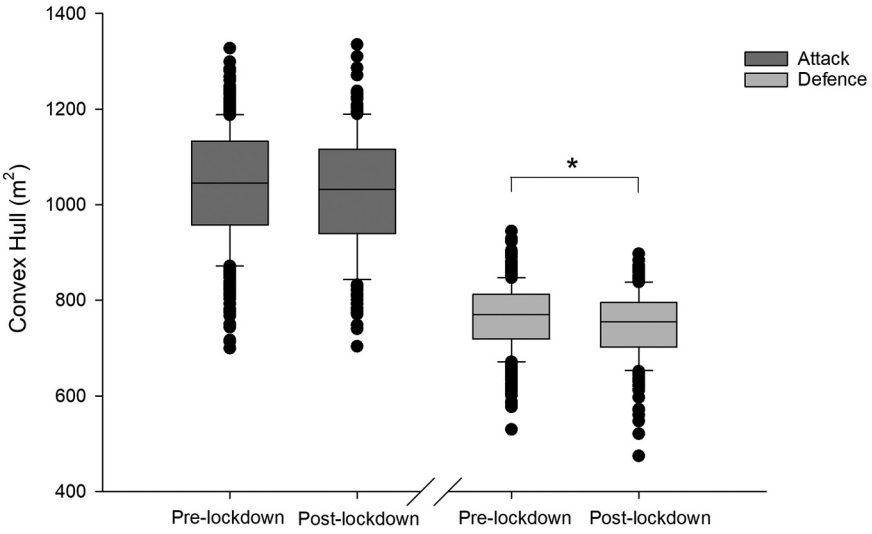

Figure 1. Offensive and defensive convex hull during the pre- and post-lockdown periods. * significantly different from the other period ($p < 0.05$).

Table 2 shows the results of comparative analysis between pre- and post-lockdown data taking into account the match location. Firstly, it can be verified that all the variables (positional and physical) are lower in away games than in home games. In this vein, significantly decreases were observed for offensive ($p < .05$) and defensive convex hull ($p < .001$), offensive length ($p < .05$), and total distance ($p < .05$). Secondly, regarding differences between home matches before and after lockdown, all variables decreased, except team width. Specifically, significantly decreases were observed for defensive convex hull ($p < .001$), offensive and defensive length (both $p < .001$), and total and HSR distance (both $p < .001$). However, the effect of stoppage concerning match location was fragile, and there are only decreases in team width, both offensive and defensive widths. There is only a significant increase, the HSR distance ($p < .01$).

Discussion

The present study aimed to analyse football teams' playing surface area, dispersion, and distance covered (total and HSR) considering the pre-lockdown and the post-lockdown periods. The results revealed that the lockdown caused by the COVID-19 pandemic affected the teams' performance when comparing the periods before and after lockdown, showing a general decrease in the average values of the spatial and physical variables measured.

The findings of this study showed that teams played in smaller spaces during match-play after the COVID-19 lockdown. Teams increased the compactness of the group of players both in attacking and defensive phases, and this behaviour could be since the players in a team did not train together during the lockdown period. A prior study by Cordes et al. (2012) exploring the tactical adherence of a football team revealed that tactical adherence increases as the season progressed. The team analysed in that study showed a lower tactical adherence at the beginning of the season than the last stage, as players needed some time after the summer break to familiarise themselves with the tactical principles and strategies suggested by the coach. Therefore, as the lockdown period comprised a considerable period with no team training, similar to the summer break in football leagues, it is possible that the teams did not have enough time to train their predetermined tactics after the lockdown, thus playing more compact to avoid potential mistakes. Our results showed no significant differences in the defensive width of the teams when comparing the pre-lockdown and post-lockdown periods, indicating that the width in the defensive phase was constant and unaffected by the lockdown. One of football's main defensive tactical principles is that teams should be compact in defence to protect their own goal. Then this behaviour could be unaltered regarding any contextual variables. Hence, teams displayed a similar width before and after the COVID-19 lockdown, aiming to maintain the team compact and preventing receiving a goal. This is in line with previous research showing that football teams' playing area and width is reduced in areas close to the own goal (Caro et al. 2019). During the offensive phase, compactness may also facilitate that other teammate help you after an error, however it may also facilitate to the other team to defend due to there are less space and amplitude (Coutinho, Goncalves, Wong, Travassos, Coutts, & Sampaio, 2018)

As for total distance and HSR distance covered by teams, data showed decrease after the lockdown. This reduction in players' physical performance may be due to the same reason that could explain the decline in the spatial variables. Teams were not allowed to train in their training facilities with all the players involved in the sessions; therefore, the teams could not do specific football training practice that responds to the demands of the game, which is relevant to the competition and adequate to improve performance (Di Salvo et al. 2007; Bradley et al. 2009; Dellal et al. 2011). This is supported by Mohr et al. (2020), who suggested that a decline in football-specific training caused by the lockdown period due to the long duration and restricted possibilities to train is likely to affect the physical performance of football teams. Similarly, Rampinini et al. (2021) showed that total and very high-speed distances decreased in the post-lockdown period in comparison with the

pre-lockdown one for football teams in the Italian Serie A. The study revealed that the total distance was −5.4 ± 22.3 m·min^{-1} and very high-speed distance was −1.0 ± 6.9 m·min^{-1} after the lockdown, showing a small-moderate effect. Mohr et al. (2020) also stated that the return to football training and competition after the lockdown period could have a potential risk of non-contact injuries due to a sudden workload increase after a period of individual training or no training at all. Hence, it is reasonable that teams showed a decrease in the physical performance compared to the pre-lockdown period to avoid potential non-contact injuries due to the little time available to adapt to the football-specific actions.

It has been proven that match location affects the tactical performance of football teams (Gomez et al. 2012; Diana et al. 2017; Lago-Peñas et al. 2017). The current study showed that the area covered by teams (i.e. convex hull) was smaller in both attacking and defensive phases when teams played away. Teams could use different playing tactics and styles of play when playing away as match location influences the effectiveness of these aspects (Fernandez-Navarro et al. 2019). Fernandez-Navarro et al. (2018) reported that when teams played away, they tended to reduce the use of build-up and high-pressure styles of play, which require players to cover a large area. Therefore, these changes in the game plan could be responsible for decreasing the area covered by teams. To our knowledge, no previous study evaluated the effect of match location on the teams' playing area determined by the convex hull. However, other research assessing the impact of match location on team positioning supports our findings that teams are more compact when playing away. Teams playing away decreased the ball recovery location and the position of the defensive and offensive lines (Santos et al. 2017). This behaviour suggests a compact positioning of players in a team, similarly to the results found in our study.

Previous research exploring the effect of match location on physical performance has found contradictory results. Although some studies in elite football found that when teams played away, they covered less distance in comparison with teams playing home (Lago et al. 2010), other studies found contradictory results showing that there were no differences for distances covered at different intensities when comparing home and away teams (Castellano et al. 2011). The results of the present study showed similar findings as in Lago et al. (2010). Total distance and HSR distance covered by the teams analysed in this study were lower when they played away. This discrepancy in the effect of match location on physical performance could be caused by other contextual variables that also affect performances, such as match status or quality of opposition. Paraskevas et al. (2020) showed that total distance and high-intensity running distance were covered by teams playing home but only when they faced a weak opposition. These findings suggest that the quality of opposition was a contextual variable that also influenced physical performance.

The lockdown effect on the variables measured according to match location was only significant for the HSR distance covered by players. The games played by teams after the COVID-19 lockdown were played without supporters due to government regulations. Hence, the impact of match location could be diminished as the crowd was missing in the football games. This is in line with the study by Tilp and Thaller (2020), which found that the lockdown led not only to an inexistent effect of match location but a home disadvantage. Home teams had empty stadiums without any supporters, and this situation could balance the crowd's effect on the game. Our results showed that teams playing away increased their HSR distance covered after the lockdown. The unusual situation of playing away in a stadium without local supporters could motivate the away team players and increase that behaviour, as suggested in previous research (Tilp and Thaller 2020).

Limitations and future directions

This study has some limitations that should be noted. First, it is possible that other contextual variables not measured in this study could add more insight into the effect of the COVID-19 lockdown on the tactical and physical variables in football teams. For example, match status and quality of opposition could help explain the differences in players' playing behaviour when comparing between the pre and post-lockdown periods. Secondly, this study only analysed data from the Spanish La Liga, and, therefore, the results should be interpreted with caution. Further studies could investigate the effect of the lockdown on other leagues, making possible the generalisability of the results. Lastly, other variables such as specific team tactics and more detailed physical indicators could be used to explore the effect of the pandemic lockdown in more detail. Also, to analyse the effects of score, goals and final outcomes, or empty stadiums.

Practical applications

The results from this study helped to understand the effect of a lockdown period on the performance of football teams. Therefore, informed and improved training plans could be designed to return to competition after an unusual period with no training or individual training due to the pandemic lockdown. In addition, these results could help the coaches and practitioners better prepare the upcoming matches considering the effects of the interruption of the league on the team's positioning and play and the impact of an empty stadium on the tactical and physical variables.

*Authors should consider that HSR is >18 km·h^{-1} in Mediacoach. In other instruments, it could be different.

Conclusions

The present study analyses the effect of the COVID-19 lockdown on tactical and physical variables in football teams. The findings showed that teams played in a smaller space and covered less distance overall after the lockdown. The lockdown entailed a period for the players that prevented them from training as a team and therefore changing their performance in competition. The absence of the audience in the stadiums after the lockdown seemed to diminish the match location effect, showing similar values of the tactical and physical variables when comparing pre- and post-lockdown periods. These findings help to understand the impact of an unusual event such as the league interruption due to the pandemic

on the performance of football teams. The present results could support coaches and practitioners' decisions when implementing the training plan and the team's playing strategy.

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ORCID

Tomás García-Calvo http://orcid.org/0000-0002-2550-418X
Javier Fernandez-Navarro http://orcid.org/0000-0002-5367-1575
Jesús Díaz-García http://orcid.org/0000-0002-9430-750X
Roberto López-Del Campo http://orcid.org/0000-0002-9286-6113
Daniel Memmert http://orcid.org/0000-0002-3406-9175

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