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ORIGINAL ARTICLE

Playing at altitude. Performance of a Mexican professional football team at different level of altitude

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KEYWORDS
Altitude;
Soccer;
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Abstract
Background: Football is the most popular sport in the world, and matches are commonly played at different levels of altitude. As the altitude increases, the availability of oxygen decreases. The dynamics of the ball will be altered due to the decrease in air resistance. These conditions can affect the physical and/or sports performance of football players.

The objective of this study is to determine if there is a relationship between altitude and performance of a professional football team.

Methods: A total of 130 matches of a Mexican professional football team were analyzed. Physical performance was measured by Match Analysis®, a video and statistical analysis; sports performance was measured according to the score. Altitude was measured with Geo Elevation.

Results: No relationship was found between altitude and total distance covered (p=0.165), Distance in first half (p=0.441) sprints number(p=0.115) and time between sprints (p=0.237)

There was a significant increase between total distance covered during the second half (p=0.009) and mean speed on "Low altitude' (p=0.000)

We found no relation between the altitude level and the obtained result (p=0.28) number of goals in favour (p=0.209) and against (p=0.629).

Conclusion: We found no relationship between the altitude level and physical and sports performance of a professional football team

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Introduction

Football is the most popular sport in the world,[1] due to his popularity it is common for matches to be played in different level of altitude.[2] As altitude increases, the a oxygen concentration will decrease.[3] This will produce a decrement in oxygen availability and in arterial oxygen content.[4,5] This produces a series of physiological mechanisms, mainly an increase in the respiratory and heart rate, an increase in diuresis, and excretion of bicarbonate, a decrease in phosphocreatine hydrolysis, a decrease in muscle contractibility, and a decrease in maximum oxygen consumption[34]. Moreover a decrease in air resistance that will alter the physics

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and dynamics of the ball.[6] This set of altitude conditions can cause a negative effect on the physical and/or sports performance of soccer players.[3,4,6-8]

The objective of this study is to determine if there is a negativity relationship between the altitude level and the physical and sports performance of a professional football team.

Material and methods

The data were obtained from 130 matches played by a professional of football team of Liga Mx during 4 years (Apertura 2014 to Clausura 2018).The players were classified as defenders, midfielders and forwards.[9-11] Only players who played an entire match were included. If football players were expelled or replaced, they were excluded. Goalkeepers, were not included. The minutes added in the time were not included. Matches in which played overtime were eliminated.

Data obtained from Match Analysis ® K2 Plus (Emeryville, California, USA), which is a soccer performance analysis system that use cameras to measure physical performance in our study.[12]

The report includes the performance of the two teams in the match.

Total distance covered (m) mean speed (Km/h), number of sprints (Number), and time between sprints (min) were recorded. Information regarding the matches, namely, goals for, goals against, and final score; was obtained from the official website of the Liga Mx.[13] These data were used as measurements of sports performance.

The altitude of the stadiums where the matches were held was measured by Geo Elevation® software, taking as a reference point the center of the pitch and subsequently classified according to the FIFA Medicine Manual[14] as "Near Sea Level" (0-500 m), "Low Altitude" (500-2000 m), "Moderate Altitude" (2001-3000 m), High Altitude (3001-5,500 m), and Extreme Altitude (> 5500 m).

The study was authorized by the Ethics Committee of the School of Medicine of the Universidad Autonoma de Nuevo Leon. Due to the nature of the study, informed consent was not required.

Team characteristics

The stadium where the team plays as a local, "Universitario stadium" is located at an altitude of 525 m and its training center is at 370 m. When the team is visitor, arrives at the venue 24 hours before.

Statistical analyses

Numerical variables were reported as means (± SD) The distribution of the numerical variables was assessed using the Kolmogorov-Smirnov normality test.

In the bivariate analysis, Student's t-test was used to compare two quantitative variables with a parametric distribution. For the comparison of numerical variables in three or more groups, the ANOVA or Kruskal-Wallis test was used according to the distribution of the variable. The comparison of qualitative variables between groups was made with the Chi-square test. A p-value of less than 0.05 was considered significant. The statistical analysis was performed with SPSS Statistics version 24. The effect size was calculated using the partial eta squared (small: 0.01, moderate: 0.06, large: 0.14).

Results

The player of team has a mean age of 27.23 ± 3.83 years. Of the 130 matches, 6.92% (9) were held at "Near sea level", 71.53% (93) at "Low Altitude" and 21.53 % (28) at "Moderate Altitude". The altitude of the different stadiums shows in the Table 1.

Table 1 Altitude of the stadiums in Liga Mx.

Stadium	City /State	Altitude(m)	Classification
Luis Pirata Fuente	Boca del Rio,Veracruz	17	Near sea level
Caliente	Tijuana, Baja California	57	Near sea level
BBVA*	Guadalupe, Nuevo Léón	493	Near sea level
Victor Manuel Reyna	Tuxtla Gutierrez, Chiapas	516	Low Altitude
Universitario	San Nicolas de los Garza, Nuevo León	525	Low Altitude
TSM	Torreón, Coahuila	1121	Low Altitude
Jalisco	Guadalajara, Jalisco	1563	Low Altitude
Chivas *	Zapopan,Jalisco	1671	Low Altitude
León	León, Guanajuato	1802	Low Altitude
Corregidora	Queretaro, Queretaro	1876	Low Altitude
Morelos	Morelia,Michoacan	1944	Low Altitude
Azul	Ciudad de México, México	2239	Moderate Altitude
Cuautémoc	Puebla, Puebla	2243	Moderate Altitude
Azteca *	Ciudad de México, México	2287	Moderate Altitude
Olimpico Universitario	Ciudad de México, México	2291	Moderate Altitude
Hidalgo	Pachuca, Hidalgo	2390	Moderate Altitude
Alberto Chivo Córdoba	Toluca, Estado de México	2691	Moderate Altitude
Nemesio Diez	Toluca, Estado de México	2691	Moderate Altitude

* Will be host in World Cup 2026.
Near Sea Level: 0-500 m. Low Altitude 501-2000 m. Moderate Altitude:2001-3000 m.

Global performance

In the global performance of the team at "Near sea level" a distance of 9854.77 ± 835.98 m was covered at a mean speed of 6.26 ± 0.52 km/h and a total of 19.20 ± 7.55 sprints with a time of 5.30 ± 2.44 min between each. At "Low Altitude" the team had a displacement of 10102.39 ± 1930.45 m, a mean speed of 6.40 ± 0.57 km/h, 20.48 ±7.88 sprints and 5.06 ±2.49 minutes between each.

At "Moderate Altitude" a distance of 9878.46 ± 835.95 m was covered at a mean speed of 6.22 ± 0.54 km/h and a total of 19.37 ± 7.39 sprints with a time of 5.38 ± 2.41 min between each sprint (Table 2).

We compare the performance in "Near sea level" and "Moderate altitude" against the parameters for "Low altitude". There was a decrease of 2.45% in the total distance covered in "Near sea Level" and of 2.22% in "Moderate Altitude. Mean speed decreased 2.19% in "Near sea Level" and 2.81% in "Moderate Altitude". It decreased in the number of sprints by 6.25 %% "Near sea Level" and by 5.42% in "Moderate Altitude", with an increase of 4.47% in the time between sprints in "Near sea Level" and 6.32% in "Moderate Altitude".

No statistical differences were found between altitude and the total distance covered (p=0.165; ES 0.004) A significant difference was observed in the mean speed at "Low Altitude" (p=0.000; ES 0.20). No relationship was found between altitude and the total number of sprints (p= 0.115; ES 0.005) and the time between sprints (p=0.237; ES 0.003).

Performance by position

Defenders covered a distance of 9577.44 ± 578.55 m at "Near sea level", 9820.01 ± 2611.38 m at "Low Altitude" and 9577.44 ± 699.22 m at "Moderate Altitude". Midfielders covered a distance of 10501.25 ± 701.50 m at "Near sea level", 10676.89 ± 931.14 at "Low Altitude" and 10470.09 ± 705.41 at "Moderate Altitude". Forwards covered a distance "Near sea level" of 9529.31 ± 964.56 m, at "Low Altitude" 9750.52 ± 931.14 m and at "Moderate Altitude" 9530.95 ± 787.56 m.

In the total distance covered according to the position of the players, we observed in the defenders a decrease of 2.84% in "Near sea level" and of 9.40% in "Moderate Altitude". In midfielders it decreased by 1.65% and 1.94% in "Near sea level" and "Moderate Altitude" respectively. Forwards decreased by 2.27% in "Near sea level" and 2.25% in "Moderate Altitude".

No relationship was found between level of altitude and total distance covered in defenders (p= 0.561; ES 0.003), midfielders (p= 0.064; ES 0.017) and forwards (p= 0.342; ES 0.013) (Table 3).

Mean speed of the defenders was 6.06 ± 0.36 km/h "Near sea level", 6.16 ± 0.37 km/h at "Low Altitude" and 6.03 ± 0.41 km/h at "Moderate Altitude". Midfielders had a mean speed of 6.66 ± 0.36 km/h "Near sea level", 6.80 ± 0.40 km/h at "Low Altitude" and 6.61 ± 0.47 km/h at "Moderate Altitude" while forwards had a mean speed of 6.07 ± 0.62 km/h "Near sea level", 6.23 ± 0.53 km/h at "Low Altitude" and 5.99 ± 0.53 km/h at "Moderate Altitude".

The mean speed of the defenders decreased by 1.62% in "Near sea level" and 2.11% in "Moderate altitude". The mean speed of midfielders decreased by 2.06% in "Near sea level" and 2.97% in Moderate Altitude". Forwards also decreased by 2.57% on "Near sea level" and 3.85% on "Moderate Altitude".

Mean speed was significantly higher at "Low Altitude" in defenders (p= 0.005; ES 0.024) and midfielders (p=0.004; ES 0.034).This relationship was not found in forwards (p=0.53; ES 0.034).

Defenders had 17.19 ± 6.91 sprints at "Near sea level", 17.05 ± 6.90 at "Low Altitude" and 16.34 ± 6.80 at "Moderate Altitude". Midfielders had 22.28 ± ±7.85 sprints "Near sea level", 24.41 ± 7.95 at "Low Altitude" and 22.75 ± 7.49 at "Moderate Altitude". Forwards had 18.69 ± 7.19 sprints

Table 2 Physical performance of the team in different levels of altitude.

Variable	Level of Altitude	Mean ± SD	95% Confidence Interval		Effect Size	P value
Total distance (m)	Near Sea Level	9854.77 ± 835.98	9667.52	10042.02	0.004	0.165
	Low Altitude	10102.39 ± 1930.45	9954.73	10250.05		
	Moderate Altitude	9878.46 ± 835.95	9759.77	9997.15		
Distance in first half (m)	Near Sea Level	5018.29 ± 404.36	4927.72	5108.86	0.002	0.441
	Low Altitude	5098.05 ± 1807.88	4959.77	5236.34		
	Moderate Altitude	4939.66 ± 436.33	4877.71	5001.61		
Distance in second half (m)	Near Sea Level	4836.48 ± 486.47	4727.52	4945.44	0.10	0.009 *
	Low Altitude	5004.33 ± 499.34	4966.14	5042.53		
	Moderate Altitude	4938.80 ± 457.49	4869.30	5008.29		
Mean Speed (Km/h)	Near Sea Level	6.26 ± 0.52	6.14	6.38	0.20	0.000*
	Low Altitude	6.40 ± 0.51	6.36	6.44		
	Moderate Altitude	6.22 ± 0.54	6.15	6.30		
Number of Sprints	Near Sea Level	19.20 ± 7.55	17.51	20.90	0.005	0.115
	Low Altitude	20.48 ± 7.88	19.88	21.08		
	Moderate Altitude	19.37 ± 7.39	18.32	20.42		
Time between Sprints (min)	Near Sea Level	5.30 ± 2.44	4.75	5.84	0.003	0.237
	Low Altitude	5.06 ± 2.49	4.87	5.25		
	Moderate Altitude	5.38 ± 2.41	5.04	5.73		

Near Sea Level: 0-500 m. Low Altitude 501-2000 m. Moderate Altitude:2001-3000 m.

Table 3 Physical performance of the team by positión in different levels of altitude.

Variable	Position	Level of altitude	Mean ± SD	95% Confidence Interval		Effect size	P value
Total, distance (m)	DF	Near Sea Level	9541 ± 578.557	9348.26	9734.06	0.003	0.561
		Low Altitude	9820.01 ± 2611.38	9530.06	10109.98		
		Moderate Altitude	9577.55 ± 699.22	9430.26	9724.84		
	MC	Near Sea Level	10501 .35 ± 701.50	10218.00	10784.69	0.017	0.064
		Low Altitude	10676.89 ± 671.62	10588.04	10763.73		
		Moderate Altitude	10470.09 ± 705.41	10298.03	10642.15		
	DL	Near Sea Level	9529.31 ± 964.56	9015.33	10043.30	0.013	0.342
		Low Altitude	9750.52 ± 931.14	9580.76	9920.28		
		Moderate Altitude	9530.95 ± 787.56	9268.36	9793.53		
Distance in first half (m)	DF	Near Sea Level	4854.84 ± 271.241	4764.40	4945.27	0.002	0.704
		Low Altitude	5001.65 ± 2571.67	4716.10	5287.20		
		Moderate Altitude	4793.34 ± 330.66	4723.68	4862.99		
	MC	Near Sea Level	5369.38 ± 333.378	5233.57	5503.20	0.014	0.114
		Low Altitude	5334 .21 ± 355.33	5287.74	5380.68		
		Moderate Altitude	5236.10 ± 393.65	5140.08	5332.12		
	DL	Near Sea Level	4827.38 ± 413.25	4607.16	5047.59	0.14	0.294
		Low Altitude	4900.29 ± 522	4805.12	4995.46		
		Moderate Altitude	4754.84 ± 460.92	4601.16	4908.52		
Distance in second half (m)	DF	Near Sea Level	4886.32 ± 379.519	4559.79	4812.86	0.008	0.179
		Low Altitude	4818.37 ± 399.79	4773.98	4862.76		
		Moderate Altitude	4784.21 ± 494.06	4680.14	4888.29		
	MC	Near Sea Level	5132.96 ±428.54	4959.87	5306.06	0.024	0.019 *
		Low Altitude	5341.67 ± 433.57	5284.97	5398.38		
		Moderate Altitude	5233.99 ± 375.17	5142.47	5325.50		
	DL	Near Sea Level	4701.94 ± 592.91	4386.00	5017.88	0.009	0.463
		Low Altitude	4850.23 ± 523.46	4754.79	4945.66		
		Moderate Altitude	4776.11 ± 417.84	4636.79	4915.43		
Mean Speed (Km/h)	DF	Near Sea Level	6.06 ± 0.36	5.9404	6.1809	0.024	0.005 *
		Low Altitude	6.16 ± 0.37	6.1281	6.2115		
		Moderate Altitude	6.03 ± 0.41	5.9428	6.1185		
	MC	Near Sea Level	6.66 ± 0.44	6.4912	6.8482	0.034	0.004 *
		Low Altitude	6.80 ± 0.40	6.7518	6.8580		
		Moderate Altitude	6.61 ± 0.47	6.5005	6.7341		
	DL	Near Sea Level	6.07 ± 0.62	5.7430	6.4048	0.034	0.053
		Low Altitude	6.23 ± 0.53	6.1404	6.3369		
		Moderate Altitude	5.99 ± 0.53	5.8217	6.1770		
Number of Sprints	DF	Near Sea Level	17.19 ± 6.911	14.88	19.49	.002	0.67
		Low Altitude	17.05 ± 6.909	16.28	17.81		
		Moderate Altitude	16.34 ± 6.80	14.90	17.77		
	MC	Near Sea Level	22.38 ± 7.85	19.21	25.56	.011	0.187
		Low Altitude	24.41 ± 7.95	23.37	25.45		
		Moderate Altitude	22.75 ± 7.49	20.92	24.58		
	DL	Near Sea Level	18.69 ± 7.19	14.85	22.52	.032	0.067
		Low Altitude	22.06 ± 5.96	20.97	23.15		
		Moderate Altitude	20.54 ± 5.45	18.72	22.36		
Time between Sprints (min)	DF	Near Sea Level	5.94 ± 2.78	5.0132	6.8673	.002	0.711
		Low Altitude	6.05 ± 2.94	5.7323	6.3857		
		Moderate Altitude	6.31 ± 2.79	5.7305	6.9072		
	MC	Near Sea Level	4.43 ± 1.51	3.8244	5.0479	.008	0.261
		Low Altitude	4.09 ± 1.66	3.8767	4.3113		
		Moderate Altitude	4.42 ± 1.66	4.0191	4.8295		
	DL	Near Sea Level	5.22 ± 253	3.8778	6.5785	.050	0.014
		Low Altitude	4.27 ± 1.24	4.0510	4.5041		
		Moderate Altitude	4.89 ± 1.71	4.3224	5.4668		

DF:Defenses MC: Midfielders DL:Forwards.
Near Sea Level: 0-500 m. Low Altitude 501-2000 m .Moderate Altitude:2001-3000 m.

"Near sea level", 22.06 ± 5.96 at "Low Altitude" and 20.54 ± 5.45 at "Moderate Altitude".

Regarding the number of sprints performed, defenses increased in 0.82% in "Near sea level" and decreased by 4.16% in "Moderate Altitude". Midfielders decreased 8.32% in "Near sea level" and 6.80% in "Moderate Altitude". Forwards decreased 15.28% in "Near sea level" and 6.89% in Moderate altitude ". No relationship was found between the number of sprints performed and the level of altitude in defenders (p=0.670; ES 0.002), midfielders (p=0.187; ES 0.011) and forwards (p=0.067; ES 0.032).

At "Near sea level" the time between sprints in defenders was 5.94 ± 2.78 minutes, 6.05 ±2.94 min at "Low Altitude" and 6.31 ± 2.79 at "Moderate Altitude". In midfielders, this time was 4.43±1.51 minutes at Near sea level", 4.09 ±1.66 min at "Low Altitude" and 4.42 ±1.66 at "Moderate Altitude". Forwards had a time of 5.22 ± 2.53 minutes between sprints at "Near sea level", 4.27 ±1.24 min at "Low Altitude" and 4.89 ±1.71 at "Moderate Altitude".

The time between sprints in the defenders, decreased 1.82% in "Near sea level" and increased 4.30% in "Moderate Altitude". Midfielders increased by 8.31% in "Near sea level" and 8.07% in "Moderate Altitude". Forwards increased 22.25% in "Near sea level" and 14.52% in "Moderate Altitude"

No relationship was found between the time between each sprint performed by defenders (p=0.711; ES 0.002), midfielders (p=0.261; ES 0.008) and forwards (p=0.14; ES 0.050).

Comparison against rivals

When comparing the performance against those rivals that live in "Near Sea Level", we found a non-significant decrease of 5.68% in the "Number of sprints". Compared with those teams that are at "Low Altitude", we found a significant increase of .094% in average speed, a non-significant decrease of 6.15% in the number of sprints and a non-significant increase of 5.03% in the time between sprints. When comparing rivals living in "Moderate Altitude", a non-significant decrease of 15.59% in the number of sprints and a significant increase of 16.91% in the time between sprints was found.

Sport performance

Although at "Moderate Altitude" the percentage of victories decreased, the percentage of defeats increased; Fewer goals were scored, and more goals were received in matches held in "Moderate Altitude." No correlation was found between the result and the number of goals scored and received at different altitudes (Table 4).

Discussion

The main finding of our study was that there was no negative impact on physical and sports performance when playing at different levels of altitude, as well as no statistically significant differences in the total distance covered, the number of sprints, and the time between each sprint. The stadium of the studied team was found at 525 meters above sea level, qualifying as a "Low Altitude" stadium.

Is not statistically significant difference in the total distance covered, the number of sprints and the time between each sprint at different altitudes. When we compare teams that live at "Moderate Altitude", we found a non-significant decrease of 13% in the number of sprints and a significant increase of 16.9% in the time between each sprint.

Distance covered

One of the ways in which the effects of altitude can be studied is through the total distance covered.[20] No statistically significant differences were observed between the distances covered between the players at the different altitudes during the entire game or in each half of the game, this contrasts with the information obtained by Bohner,[15] where statistically significant differences were observed when comparing the distance by average minute between a game played on a Near Sea Level playing field and another at moderate altitude, although in this study the total distance was not evaluated and that the games were played in a collegiate soccer league. In addition to this, the distances were measured through a GPS device on the players' arms where the margin of error of the devices was not reported, in contrast to the data obtained in the Mexican league through a camera system, tracking the exact position and distance that the players covered.

Also, we found a decrease of the 2.2% in the total distance covered in "Moderate Altitude" contrary to a significant decrease in the distance traveled reported by university soccer players, although in this study the absolute values or reduction percentages were not reported, so this conclusion was obtained from the graphics in the full text.[15]

Garvican found in his study a decrease of 9.1% of the total distance obtained on day 4 of training at an altitude of 1600, compared to the game at sea level, however, in this study, 3 periods of 25 minutes were played in the moderate altitude in contrast to the game at sea level which was a standard 2

Table 4 Goal performance in different levels of altitude.

Variable	Level of Altitude	Mean ± SD	Effect Size	P value
Goals scored	Near Sea Level	1.36 ± 1.120	.024	0.209
	Low Altitude	1.67 ± 1.476		
	Moderate Altitude	1.15 ± 1.167		
Goles receveid	Near Sea Level	0.64 ± 0.67	.007	0.629
	Low Altitude	0.9 ± 0.915		
	Moderate Altitude	0.85 ± 0.77		

halves 45-minute match.[16] In our study, only those players who had played the two 45-minute halves were considered in different altitudes. This could explain the smaller difference between the distances covered at sea level and a higher altitude compared to Garvicań s study,[16] where matches times were shorter at higher altitudes. Trewin et al.[17] found a 4% decrease in performance in elite women's soccer players when the altitude increased, and Nasis[18] who found a decrease of 3.1% in the total distance covered in 1200 m (Low altitude in our study). In this study decrease was of 2.5%. Nasis[18] in her study hypothesizes that the decrease in the distance traveled may be due to the reduction of the Vo2 Max which results in a greater intensity of the exercise.

These changes can be explained due to a lower oxygen pressure with increasing altitude with a decrease in ATP production, producing energy through the anaerobic pathway.

In addition to this, Nasis's study was carried out during the World Cup, where there were significant differences in the physical conditions between the teams where their players belong to elite teams in championships such as Europeans and where the geographical conditions of each country are different. There is evidence that players who play in high altitude conditions tend to have a shorter adaptation time when taken to places near sea level and then to high altitudes than those who have played exclusively near sea level, on average 7 days less.[5] In Liga MX, teams are constantly traveling each week to play matches outside of their local stadiums, usually at higher altitudes.[19–22] This could explain the smaller difference compared to previously reported studies.

Mean speed

It has been empirically assumed that decreasing air resistance would increase the speed of the players.[6] However, there is a decrease in speed of 2.81% in the “Moderate Altitude” stages, in agreement with the observations made by Nassis et al.[18] We hypothesize that the decrease in the availability of ambient oxygen, decreasing the mechanisms of ATP production through the mitochondrial pathway and the little time they have to adapt to rapid changes in altitude negatively impact the speed of the players.

Number of sprints

Although the majority of the distance covered in football is at low speed,[11,23] sprints are of major importance in soccer.[10,24] The distance traveled at high speed distinguishes elite players from others[11,16,25] and it is the most frequent action in goal situations in professional soccer, both for those who assist and those who score.[3]

Due to the decrease in air resistance at higher altitudes, the ability to perform a single sprint would be increased.[7] Because there is a decrease in the hydrolysis of phosphocreatine[11,23,27] and an increase in lactate concentration with increasing altitude.[26]

This may decrease the number of sprints performed as altitude increases, which is consistent with our findings[6,27,28]

We found a non-significant decrease of 6.25% in places near sea level and a non-significant decrease of 5.42% in “Moderate Altitude” stages. Similar changes were observed at “Low Altitude” stages with a 3.1% decrease as reported by Garvican.[16]

The similarity in the decrease in the percentages suggests that these may be caused by factors such as fatigue or weather conditions.[19–22]

Time between sprints

Although a longer recovery time is seen between sprints at a higher altitude which can be explained by the increase in lactate due to the presence of the anaerobic pathway of ATP production could explain this phenomenon.[8,26,28,29] A statistically significant difference was not observed,” Near Sea Level” there was a decrease of 4.47% and 6.32% at “Moderate Altitude”. Despite this, the authors of this work hypothesize that in stages higher than “Moderate Altitude”, the time between sprints may increase as a consequence of the adaptive physiological changes to the decrease in oxygen pressure in the environment, however, they may also be strongly influenced as a load of psychological stress due to playing in a foreign stadium, the tactical strategies used for the game or factors such as the weather.[19–22]

Goals scored

We did not find statistically significant differences in contrast to what was reported by McSharry[7] and Faude,[30] who reported a significant disadvantage when playing matches at "Low, Moderate, and “High Altitude”.

This non-significant decrease in the sport performance parameters at “Moderate Altitude”, can be explained by the decrease in the number of sprints and increase the time between sprints,[31] and addition to the disadvantage of playing games as a visitor.[32] In addition to that each week they travel to different stadiums, located at different altitudes, accompanied by the fact that these conditions are shared by all the teams in the “Liga MX”.

Limitations

One of the weaknesses of our study was that the meteorological conditions were not considered. Considering that in Mexico there are drastic changes in temperature (winter matches have been held at less than 5°Celsius and summer matches have been held at 40 °) .Variables such as tactics, substitutions, age of the players and training methods were not considered.

No statistically significant differences were observed between the general performance of the soccer players of an Liga Mx team at sea level, Low Altitude”, and “Moderate Altitude”, as well as no better performance in variables such as speed and distance, covered. Contrary to what has been reported by other authors, altitude does not seem to be a decisive factor when evaluating the performance of the team, the researchers conclude that the altitude of the stadiums less than 3000 meters from sea level does not diminish the performance of the players. However, more prospective studies should be carried out that include factors such as weather conditions, the training method, and the playing styles of each team.

What does this study add?

- Offers teams the knowledge to focus their physical preparation when playing matches in "Low and Moderate Altitude".
- The altitude less than 3000 meters above sea level, does not influence the sports performance of a football team, which allows creating similar strategies in the game mode regardless of the altitude

Conflicts of interest

The authors declare no conflict of interest in this article.

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