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Variations in physical performance during a competitive season in Mexican female varsity soccer players by playing position

Variaciones en rendimiento físico durante una temporada competitiva en jugadoras seleccionadas universitarias de soccer por posición de juego

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Abstract. Soccer is the most popular sport worldwide, with a recent increase in the number of women participating, demanding greater physical performance for this population according to the competition level. Nevertheless, available data regarding Mexican soccer players' physical performance are limited; therefore, this study aimed to investigate temporary changes in physical performance during a competitive season in university soccer players. Nineteen female players, divided into three player positions (defenders, midfielders, and forwards), participated in the study. All participants completed three evaluations (T1, T2, and T3) that included intermittent aerobic endurance performance (30-15 intermittent fitness test [IFT]), jump height (countermovement jump [CMJ]), linear speed (20-m and 40-m sprints), agility (modified T-test), and maximal strength (1RM-SQ). Regarding results, we found general changes during the season; among these, the 20-m sprint in T2 (ES = 0.60; 90% CI: 0.22; 0.97) and the 1RM-SQ in T2 (ES = 0.57; 90% CI: 0.16; 0.98) and T3 (ES = 1.04; 90%CI: 0.63;1.44) stand out. The main changes were in VO2max30-15IFT in midfielders (ES = -0.86; 90% CI: -1.49; -0.23) in T2 and 1RM-SQ in all positions in T2 and T3, with moderate to large changes. It is important to monitor physical ability during the season to prepare individualized training programs for each player's position.
Keywords: Soccer, Female, 1RM, Sprint, Agility.

Resumen. El futbol es uno de los deportes más populares a nivel mundial con un incremento reciente en el número de participantes mujeres, lo que exige un mayor rendimiento físico para esta población acorde al nivel competitivo, no obstante, los datos disponibles relacionados al rendimiento físico de futbolistas mexicanas son limitados, por lo que el objetivo de este estudio fue investigar los cambios temporales en el rendimiento físico durante una temporada competitiva en futbolistas universitarias. En el estudio participaron 19 jugadoras universitarias de futbol divididas en tres posiciones de juego (defensas, mediocampistas y delanteras). Todas completaron tres evaluaciones (T1, T2 y T3) que incluyeron: rendimiento de la resistencia aeróbica intermitente (30-15 intermittent fitness test [IFT]), altura de salto (salto contramovimiento [CMJ]), velocidad lineal (sprint de 20 y 40 m), agilidad (prueba T modificada) y fuerza máxima (1RM-SQ). En cuanto a los resultados, encontramos cambios de forma general a lo largo de la temporada donde destaca el sprint de 20-m en T2 (ES = 0.60; 90%CI: 0.22;0.97) y en 1RM-SQ en T2 (ES = 0.57; 90%CI: 0.16;0.98) y T3 (ES = 1.04; 90%CI: 0.63;1.44). Por posición los principales cambios fueron en $VO_2max^{30\text{-}15}{}_{IFT}$ en mediocampistas (ES = -0.86; 90%CI: -1.49;-0.23) en T2, así como en 1RM-SQ en todas las posiciones en T2 y T3 con cambios de moderado a grandes. La monitorización de las capacidades físicas a través de la temporada es muy importante para la elaboración de programas de entrenamiento individualizados para cada posición de juego.
Palabras clave: Soccer, Femenil, 1RM, Sprint, Agilidad

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Introduction

Women's soccer has recently become one of the fastest-growing sports, with a large number of professional leagues (Hammami et al., 2020). It is estimated that there were 13,36 million players worldwide in 2019, according to the Fédération Internationale de Football Association (FIFA; Randell et al., 2021).

Soccer is a team sport with intermittent high-intensity contact that requires certain physical abilities to perform successfully. In addition to technical-tactical skills, soccer players need to develop and maintain a high physical performance level (Turner & Stewart, 2014). The most significant play patterns that determine the final score are one-on-one defense and attack, precision in passes, and effective execution of dead ball situations; therefore, functional skills should include high speed, agility, strength, power, and aerobic endurance levels (Milanović et al., 2017). Physical-sports tests are important in maximizing physical training and performance during games while minimizing unfavorable adaptations and fatigue during the competitive season (Ishida et al., 2021b).

Currently available scientific studies provide information regarding physical changes during the competitive season of various performance characteristics in women's soccer in semi-professional categories (Dragijsky et al., 2017; Emmonds et al., 2020; Lesinski et al., 2017) and national teams (Stepinski et al., 2020), considering changes in body composition (Roelofs et al., 2020) and diverse health, performance, and recovery biomarkers (Walker et al., 2019). However, few studies have focused on physical changes during the competitive season in female university soccer players (Ishida et al., 2021a; Peart et al., 2018). Therefore, we examined physical changes during the competitive season in Mexican female university soccer players at three different time points using the same participants. The data that quantify physical changes will help trainers and other professionals prepare players to anticipate their physical needs and provide data that will serve as a reference for similar populations to carry out physical performance more efficiently, providing greater specificity in training player positions. Thus, this study aimed to meas-

ure and observe temporal changes in aerobic endurance, lower limb strength, linear velocity, agility, and maximum strength in female university soccer players using three time points over a four-month period.

Material and methods

Design

A longitudinal study was conducted to analyze physical changes in female varsity university soccer players at three different time points during the season, using a quantitative methodology and descriptive scope.

Participants

Nineteen players (Table 1) of the women's soccer varsity team that competed during the 2019-2020 season before the COVID-19 health contingency voluntarily participated in this study. G*Power version 3.1.9 (Universität Düsseldorf, Germany) was used to determine if the sample was large enough for the analysis determining an effect size of d = 0.67, statistical power of $1-\beta$ = 0.80, and an alpha of α = 0.05.(Faul et al., 2007) The positions were divided into defenders (n = 7), midfielders (n = 7), and forwards (n = 5). The selection criteria included belonging to the varsity team, not being injured at the start of or during the study period, attending all training sessions, and performing all physical tests. The participants were informed about the benefits and risks of the investigation prior to signing an informed consent document to participate in the study. The project was approved by the Research Department of the Sports Organization Faculty of the Autonomous University of Nuevo Leon, and the study protocol adhered to the guidelines of the Declaration of Helsinki (World Medical Association, 2013). According to Article 17, Paragraph II of the Regulations of the General Health Law in Health Research Matter of Mexico, ethically, the methods used include moderate exercise in healthy volunteers, making it so that the research is categorized as posing minimal risk.

Table 1.
Descriptive data of the players

Variables	Mean ± SD	Range
Age (years)	18.6 ± 1.56	17 – 22
Weight (Kg)	57.28 ± 6.99	47 – 73
Height (m)	1.62 ± 0.05	152 – 173
Sports Experience (years)	10.68 ± 2.21	6 – 14

Procedure

This research was conducted with female soccer athletes during the 2019-2020 season. As a control measure, height was evaluated once in a standing position, without shoes, with the back slightly leaning toward the instrument vertically, and with the head in the Frankfort plane using a SECA 213 portable stadiometer (Hamburg, Germany) and weight with a TANITA TBF 410GS electronic scale (Tokyo, Japan), the tests carried out in weeks one, ten, and twenty were used only as testing weeks and were executed in the following order: day one, 30-15 Intermittent Fitness test; day two, Countermovement jump; day three, 20 and 40-meter sprint test, and modified agility T-test; day four, active rest; and day five, one-repetition maximum in the squat movement. All the tests' procedures are further described in detail in this document.

The study lasted four months, during which 112 training sessions were carried out with a frequency of five or six times a week for 90 minutes for each session, with a schedule of Monday to Friday from 5:00 A.M. to 6:30 A.M. and in the evening from 7 P.M. to 8:30 P.M. The performance evaluation results are shown in Figure 1. The athletes reported to their usual training facility to perform the physical tests one week before the start of the preseason.

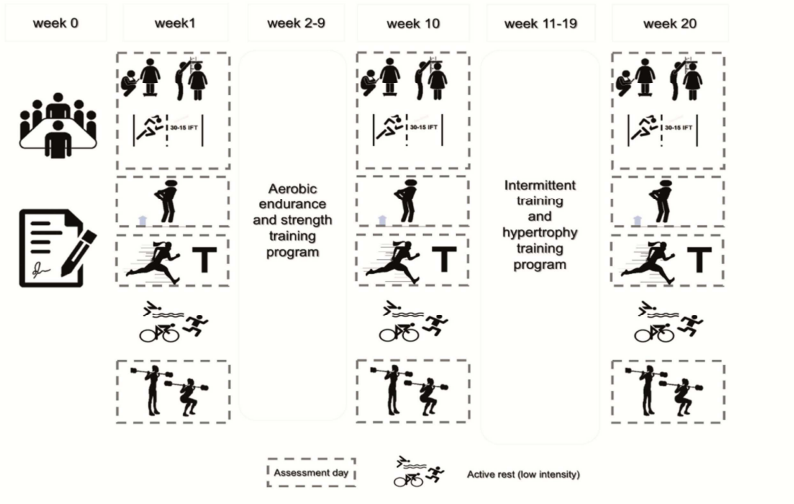

Figure 1. Protocol for physical assessment.
Note. Every square outlined with dashes equals a day with its corresponding assessment/assessments.

Training Program

The training program was designed to maintain physical performance during the competitive season, incorporating strength training, muscle hypertrophy, aerobic endurance training, high-intensity intervals, and technical-tactical training, and carrying out tests a week before the

beginning of each training program. The content used throughout the season is described in Table 2.

Table 2.
Components of the full training season

Week	Training components	Frequency
Week 1 to 4	Physical assessments	The first full week
	Strength training	3 times a week
	Aerobic training	4 times a week
	Technical training	5 times a week
	Match Preparation	
Week 5 to 9	Strength training	3 times a week
	Aerobic training	2 times a week
	Technical training	5 times a week
	Match Preparation	1 time per week
Week 10 to 18	Physical assessments	The first full week
	Hypertrophy training	3 times a week
	Intermittent training	3 times per week
	Technical-tactical training	5 times a week
	Match Preparation	1 time per week
Week 20	Physical assessments	Full week

30-15 IFT (Intermittent Fitness Test)

After a general warm-up, the 30-15 IFT assessment was conducted. The distance was previously measured, and each area was delimited with the help of the team staff. Line A and C were separated by 40 meters, divided by line B at 20 meters with a three-meter safety zone on the side of lines A, B, and C. Participants were told that they had to go from one point to the next, guided by a recorded sound. The test starts at a speed of 8 km/h. After each 30-second stage, participants rest for 15 seconds, and the velocity is increased by 0.5 km/h at each stage. The participants must continue completing stages until they are totally exhausted, which is represented by the inability to get to the next line on time for more than three consecutive attempts (Buchheit, 2010).

Countermovement jump (CMJ)

Vertical jump capacity was evaluated using the CMJ. Before starting the test, two practice jumps were made to become familiar with the activity. The instructions were to keep the hands on the hip, perform a hip flexion movement quickly, and descend until reaching 90° to finally perform hip extension seeking to jump as high as possible. It was extremely important to always perform the jumps the same way with the balls of the feet pointing upwards to standardize the measurements (Maulder & Cronin, 2005). Three jumps were performed with a three-minute rest between them.

20-m and 40-m Sprint Test

The 20-m and 40-m Sprint Test was used to evaluate linear velocity (Buchheit et al., 2012) This test consisted of sprinting in a straight line for 40 meters in the shortest time possible. Time was measured with Witty photocells (Microgate, Bolzano, Italy) placed at the start. Other photocells were placed 20 meters from the starting line and others 40 meters from the starting line. The subjects were placed 0.5 meters from the starting photocell to avoid early or involuntary activation.

The MAT (modified agility T-test)

The modified agility test (Sassi et al., 2009) was selected because the traditional agility test exceeds the distances of the fields of other team sports. This modified test simulates the true demands required during a game with greater specificity (Scanlan et al., 2021).

The test was performed by placing the starting point. From this point, a cone was placed five meters away, and from this reference point (A), 2.5 meters were measured to the left, and a cone was placed (B), then 2.5 meters were measured to the right (C).

A joint lubrication procedure using a rotation of the shoulder joint simulating arm movement when running was performed as a warm-up. Later, hip flexion and extension, knee flexion and extension, and ankle flexion and extension movements were made to reduce the risk of injury, enhance the neuromuscular system, and increase activation levels.

The test consisted of sprinting in a straight line in the shortest time possible and touching each 30-cm cone starting from point A to point B, then shuffling sideways from point B to point C, followed by shuffling sideways from point C to point D and back from point D to point B, and finally from point B to point A with backward displacement until crossing the initial point traveling a total of 20 meters. Time was measured with Witty photocells (Microgate, Bolzano, Italy) placed at the initial-final point. The procedure is represented in Figure 2.

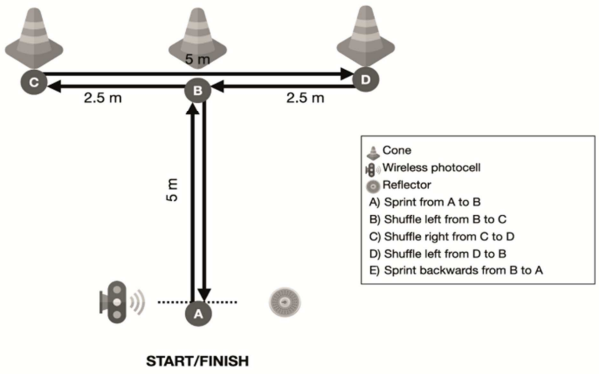

Figure 2. Running directions and distances of the modified agility test.

One-repetition maximum in squat (1RM-SQ)

Maximum strength was evaluated in the weight room using Eleiko bars and standard Olympic discs (Halmstad, Sweden). The indirect method described in the National Strength and Conditioning Association protocol was used to evaluate squat movement. This procedure was supervised by professionals in strength and physical conditioning (Haff & Triplett, 2015). The protocol consisted of lifting weights close to 50% of the 1RM, later increasing weight with a significant decrease in the number of repetitions until no more than 5 repetitions were performed. Each attempt was followed by a four-minute rest (Mayhew et al., 2004). Once the protocol was concluded, the result

was recorded, and the Brzycki formula was applied to obtain the equivalent 1RM weight.

Statistical analysis

A progressive statistical approach was used for the statistical analysis. Data are presented as means and standard deviations. The standardized effect size difference with 90% confidence intervals (ES; 90% CI) was used to compare means. Modified change thresholds were used following Cohen's principle, as follows: ≥ 0.2 (small), ≥ 0.6 (moderate), and ≥ 1.2 (large). Qualitative chances of change <1%, almost certainly not; >1–5%, very unlikely; >5–25%, unlikely; >25–75%, possible; >75–95% likely; >95–99%, very likely; and >99%, almost certain (Hopkins et al., 2009).

Results

Table 3 shows the descriptive data of the behavior of physical performance variables during the season.

Table 3.
Descriptive data of the variables

Variable	T1	T2	T3
	M ± SD	M ± SD	M ± SD
VO2max 30-15IFT (mL·kg-1·min-1)	42.44 ± 2.54	44.01 ± 2.44	42.36± 2.12
VIFT (km·h-1)	19.02 ± 1.12	19.02 ± 1.12	18.23 ± 0.93
20-m Sprint (s)	3.46 ± 0.16	3.58 ± 0.11	3.44 ± 0.19
40-m Sprint (s)	6.23 ± 0.28	6.39 ± 0.29	6.25 ± 0.24
Modified Agility T-test (s)	6.80 ± 0.28	6.74 ± 0.28	6.80 ± 0.25
CMJ (cm)	25.30 ± 3.38	25.02 ± 3.53	25.31 ± 3.24
1RM-SQ (kg)	89.04 ± 12.68	101.41 ± 18.73	111.32 ± 18.07

Note. T1 = Take one; T2 = Take 2; T3 = Take 3; M = mean; SD = standard deviation; VO2max 30-15 IFT = estimated oxygen consumption during the 30-15 IFT test; VIFT = final intermittent velocity, CMJ = countermovement jump height, 1RM-SQ = one-repetition maximum in squat.

Regarding the changes found, Table 4 shows slight modifications in all the physical performance variables in T2. Among these, a change in the 20-m sprint stands out with an ES = 0.60 (90% CI: 0.22;0.97). However, 1RM-SQ was the only variable in which considerable changes were observed in T2 (ES = 0.57; 90% CI: 0.16;0.98) and T3 (ES = 1.04; 90% CI: 0.63;1.44).

Table 4.
Changes in the overall performance of female soccer players

Variable	Measurement	Changes % (90% CI)	ES (90% CI)	QA	Chances
$VO_2max^{30\text{-}15}{}_{IFT}$ (mL·kg^{-1}·min^{-1})	T1-T2	1.58 (0.20;2.97)	0.41 (0.05;0.77)	Likely	84/16/0
	T1-T3	-0.08 (-1.38;1.23)	-0.02 (-0.39;0.34)	Trivial	16/64/20
V_{IFT} (km·h^{-1})	T1-T2	------	------	------	------
	T1-T3	-0.79 (-1.36; -0.22)	-0.50 (-0.85; -0.14)	Likely	0/8/92
20-m Sprint (s)	T1-T2	0.13 (0.05;0.21)	0.60 (0.22;0.97)	Very Likely	96/4/0
	T1-T3	-0.01 (-0.11;0.09)	-0.04 (-0.40;0.32)	Trivial	13/64/23
40-m Sprint (s)	T1-T2	0.16 (0.00;0.32)	0.36 (0.01;0.72)	Likely	78/21/1
	T1-T3	0.02 (-0.11;0.17)	0.06 (-0.29;0.42)	Possibly	27/62/11
Modified Agility T-test (s)	T1-T2	-0.06 (-0.21;0.09)	-0.14 (-0.50;0.20)	Unclear	5/55/40
	T1-T3	-0.00 (-0.15;0.13)	-0.01 (-0.37;0.33)	Trivial	15/65/20
CMJ (cm)	T1-T2	-0.28 (-2.17;1.60)	-0.05 (-0.41;0.30)	Trivial	12/63/25
	T1-T3	0.00 (-1.80;1.82)	0.00 (-0.35;0.35)	Trivial	18/65/17
1RM-SQ (kg)	T1-T2	12.37 (3.49;21.25)	0.57 (0.16;0.98)	Likely	93/7/0
	T1-T3	22.27 (13.62;30.93)	1.04 (0.63;1.44)	Most Likely	100/0/0

Note. T1 = Take one; T2 = Take 2; T3 = Take 3; ES = effect sizes; QA = quality assurance $VO_2max^{30\text{-}15}{}_{IFT}$ = estimated oxygen consumption during the 30-15 IFT test; V_{IFT} = final intermittent velocity, CMJ = countermovement jump height, 1RM-SQ = one-repetition maximum in squat.

For the changes found by game position (Table 5), a slight increase in all positions with small changes from T1 to T2 was found in $VO_2max^{30\text{-}15}{}_{IFT}$. However, in T3, with respect to T2, a decrease was observed with a moderate change in midfielders (ES = -0.86; 90% CI: -1.49; -0.23), while in defenders and forwards, there was no clear change. On the other hand, there was no change observed in VIFT from T1 to T2 (Table 5). However, as in the previous variable, there was a moderate decrease in midfielders from T2 to T3 (ES = -0.91; 90% CI: -1.51; 0.46), while no clear change was observed in the defenders and forwards.

Table 5.
Changes in the performance of the 30-15 IFT by playing position

Variable	Measurement	Defenders	Midfielders	Forwards
		ES (90%CL) QA	ES (90%CL) QA	ES (90%CL) QA
$VO_2max\ ^{30\text{-}15}{}_{IFT}$ ($mL \cdot Kg^{-1} \cdot min^{-1}$)	T1-T2	0.33 (-0.23;0.90) Possibly	0.34 (-0.19;0.98) Possibly	0.33 (-0.33;0.99) Possibly
	T2-T3	-0.33 (-0.90;0.24) Unclear	-0.86 (-1.49; -0.23) Very Likely	-0.23 (-0.90;0.45) Unclear
V_{IFT} ($Km \cdot h^{-1}$)	T1-T2	------ ------ ------	------ ------ ------	------ ------ ------
	T2-T3	-0.39 (-0.95;0.17) Unclear	-0.91 (-1.51; -0.26) Very Likely	-0.20 (-0.87;0.47) Unclear

Note. T1 = Take one; T2 = Take 2; T3 = Take 3; ES = effect sizes; $VO_2max\ ^{30\text{-}15}{}_{IFT}$ = estimated oxygen consumption during the 30-15 IFT test; V_{IFT} = final intermittent velocity.

Figure 3 shows the changes in the 20-m and 40-m sprint variables, the Modified Agility T-Test, the CMJ, and the 1RM-SQ. For the 20-m sprint, there was a slight increase with a small change from T1 to T2 in defenders (Panel A) and forwards (Panel K). In midfielders, there was a moderate change with a subsequent decrease in T3 (Panel F). On the other hand, in the 40-m Sprint, only a slight increase was seen with small changes in midfielders (Panel G) and forwards (Panel L). Regarding the Modified Agility T-Test and the CMJ, no changes were seen for any of these positions. Finally, there was an increase in 1RM-SQ with small and moderate changes in T1, T2, and T3 in defenders (Panel E), midfielders (Panel J), and forwards (Panel O).

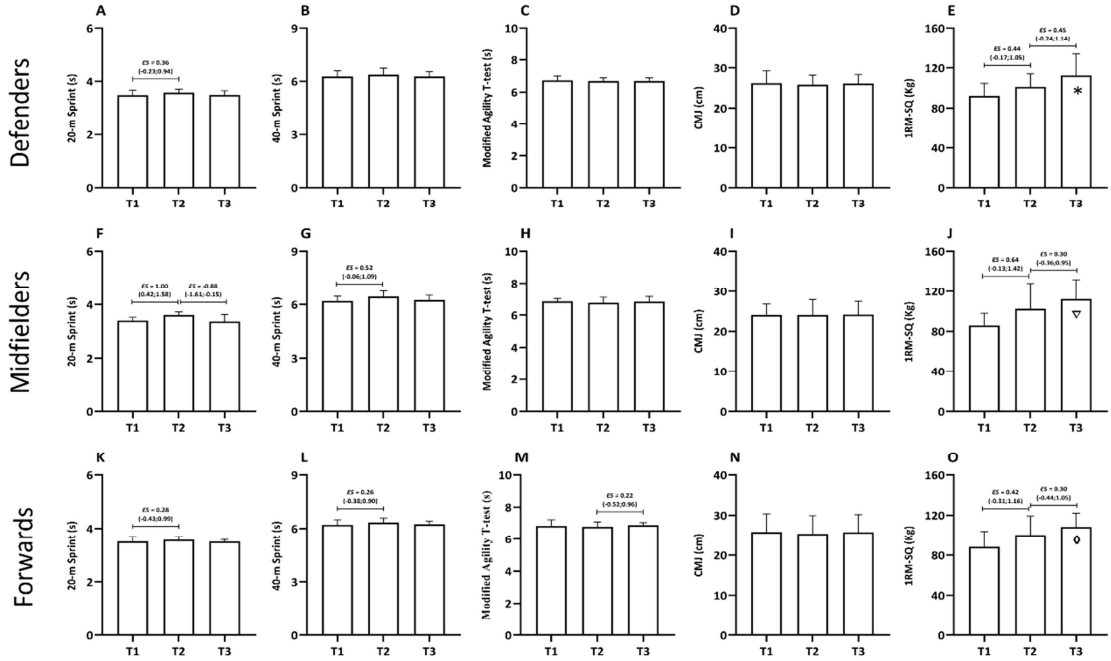

Figure 3. Changes in the performance of the 20-m and 40-m Sprint, Modified Agility T-Test, CMJ, and 1RM-SQ according to playing position.
Note. *ES = 0.83 (90% CI = 0.13;1.54) T1 vs T3. $^{\nabla}ES$= 1.11 (90% CI = 0.43;1.79) T1 vs T3. $^{\Diamond}ES$ = 0.82 (90% CI = 0.10;1.53) T1 vs T3.

Discussion

Several studies have reported the sports performance of female soccer players throughout the season or by position (Booysen et al., 2019; Lesinski et al., 2017; Lockie et al., 2018; Peart et al., 2018). However, to our knowledge, this study is the first that reports the effects of training schedules on changes in fitness in college-level female soccer players by playing position and during a competitive season.

The results showed small group and position changes in most physical performance variables. Nevertheless, substantial changes were observed in the 1RM-SQ variable by group and game position throughout the season. These results are remarkable because they could be useful for designing training programs since they show greater player flexibility for adopting tactical game positions, thanks to the similarities of their physical performance (Lockie et al., 2018).

According to Peart et al. (2018), this could be because aerobic capacity is an indicator of soccer performance (Ingebrigtsen et al., 2011), with levels ranging from 39 to 53 mL kg^{-1} min^{-1} (Edgett et al., 2013; Martínez-Lagunas et al., 2014). The results in our study were within this range. The literature has mentioned that aerobic endurance alone is not enough to measure soccer performance given the intermittent characteristics of this sport (Thomas et al., 2006), a finding that coincides with that mentioned by Peart et al. (2018). For this reason, the training in this study focused on maintaining VO2max levels and mainly emphasized strength and its derivatives, demonstrated by its increase throughout the season, returning to the strongest players, and preserving the performance of the other variables. These findings coincide with Lesinski et al. (2017) on 19 young elite female soccer players. They mention that since the training program focused on strength, plyometrics and speed constituted only a small percentage of the total training volume; thus, the stimulus was insufficient to see significant adaptations.

Furthermore, Peart et al. (2018) previously showed that in NCAA Division II female soccer players, there were no changes throughout the season in variables such as the CMJ, anaerobic power, and aerobic endurance. On the other hand, Lockie et al. (2018) reported no differences in the physical performance of female NCAA Division I players by game position in variables such as the 30-m Sprint, changes of direction, the Yo-Yo test level 1, and the vertical jump. However, despite not finding substantial changes in some of our variables and coinciding with some investigations, we believe that this finding could be due to the confinement that occurred with COVID-19 since a transfer of strength towards explosive strength and speed was intended according to the principle of specificity, the greatest changes in performance occur in this way (Behm & Sale, 1993). However, the restrictions imposed by confinement made it difficult to implement adequate training and access to material resources and infrastructure that would guarantee training comparable to that before the pandemic (Sarto et al., 2020). This study provides an overview regarding specific physical performance by game position and throughout a competitive season in Mexican women's university soccer; however, the lack of measurements on sleep habits, nutrition, and recovery are considered study limitations since it was not possible to monitor them.

In conclussion, although few changes were recorded in terms of physical performance and similar values were present in the different positions, this could be due to the coaches' requirements to have a more homogeneous team for the strategic approach of the matches and substitutions. Therefore, it is extremely important to monitor physical fitness throughout the season to develop specific and individualized training programs for each game position according to the physical abilities required in the sport.

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