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Injury surveillance in Spanish professional female soccer players: A three-season retrospective study

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ABSTRACT

Introduction: Despite the popularity of soccer at the male elite level, data on the incidence of injuries in female players are limited. The study aimed to evaluate the injury incidence and rates in female soccer players in a professional setting over 3 consecutive seasons.

Methods: Data compiled from 71 elite female players with different playing positions and belonging to the same team were analyzed. The location and severity of injuries were reported according to international consensus statements on the process of conducting epidemiological studies in professional soccer. The injury incidence rate (IIR) for matches and practices and the rate ratio (RR) were calculated, and time-loss injuries during the season were also recorded.

Results: A total of 53 injuries were documented, with an overall IIR of 1.08 injuries per 1000 h and an overall rate ratio of 0.61. The lower limbs were the most affected region (86,8 %). The majority of these injuries occurred around the thigh and knee and were predominantly traumatic, with markedly higher rates of injury during match play (2.78 injuries per 1000 h) when compared to injury incidence during training (0.79 injuries per 1000 h). Traumatic injuries accounted for 48 (91 %) and 24 (45,3 %) were indirect contact injuries. Reinjuries amounted to 15 % of total injuries and August was the predominant month for injury, being goalkeepers the least injured players (13.2 %).

Conclusions: Female professional soccer players displayed injury incidence rates and patterns comparable to those of male players. This study provides epidemiological information that will help to inform future injury surveillance studies and the development of prevention strategies to reduce the number of injuries in elite female soccer players, focusing specifically on thigh and knee regions. All match involvements should be considered when exploring associations between the type of exposure and injury risk.

Introduction

Soccer is a popular team sport among women and is played by approximately 40 million women in >100 countries worldwide (www.fifa.com / FIFA *Women's Football Strategy, 2016.Available:* https://img.fifa.com/image/upload/z7w21ghir8jb9tguvbcq.pdf *[Accessed 23 Feb 2021*). In Spain, soccer is the largest female team sport, with approximately 70,000 registered players (www.rfef.es), 30,000 of whom were registered between 2016 and 2019. Despite this, little attention has been given to female soccer injuries involving a world-elite playing population within the scientific literature. Female soccer has evolved in intensity with a greater number of professional training squads and the subsequent increase in physical demands.

Sports injuries are disabling events that interrupt and occasionally threaten athletes' careers. A vast body of literature addresses injury profiles in male soccer players, including studies focusing on specific aspects such as certain conditions, skill-level individualities, or mechanisms of production. Systematic reviews have concluded that an injury is more likely to be sustained during a match rather than during practice, that lower extremities are more prone to injury, that the most common

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types of injuries were muscle/tendon, and that a direct proportionality relationship exists between age and injury incidence [1,2]. However, the distributions of injuries and injury rates have been shown to differ between female and male soccer players. Several investigations have demonstrated a greater incidence of knee injury, especially anterior cruciate ligament injury, in female soccer players than in their male counterparts [3]. A clear definition of both genders' injury profiles and their causative factors is desirable.

Injury occurrence data among female soccer players are limited compared to those among male players [4]. More specifically, the injury profile of high-level populations has rarely been studied. In addition, most of these investigations have been developed across 1 or 2 seasons or during tournaments [5]. Therefore, comparisons are difficult because contradictory results exist. Consequently, there are gaps in the evidence on the patterns of injury and illness in these elite sports populations. More longitudinal, systematically-collected-data-based research initiatives are then desirable.

This study aimed to analyze the general incidence, features, seasonal disposition, and recurrence of injury and to compare injury incidence in a cohort of elite female soccer players across three consecutive seasons.

Methods

Study design

We conducted a retrospective review of prospectively collected data regarding all sport-related injuries that occurred on a single Spanish professional squad during 3 consecutive seasons. All data were entered by 2 sport physicians or by the team's board-certified physical therapist after consultation with the head orthopedic team physician. For the purposes of this study, a season was defined as the period comprised between the beginning of the preseason and the competitive phases.

Participants

A total of 71 elite female players between 18 and 31 years old composed the sample. All players performed 5 to 6 outdoor training sessions, 2 to 3 strength training sessions, and 1 to 2 official matches per week.

Data collection and inclusion criteria

Data were collected and analyzed based on the international consensus statement on the process of conducting epidemiological studies in professional soccer [6]. Patients were included in the study if they had been diagnosed by a team physician with a sport injury [7]. Diagnoses were made from case history, physical examination and clinical findings, diagnostic imaging, subjective/objective assessment scores, and medical judgment. Injuries were coded using a modified Orchard Sports Injury Classification System (V.10) which recorded the location of injury, the bodily region affected by the injury, and the description of the injury [8]. Whether the injury was a recurrence was also registered. Any data related to sickness or other general medical conditions or any injury sustained out of the squad routine (training or game) were excluded from this study.

Once the players with a diagnosis of sport injury were identified, all individual characteristics and injury profiles were assessed. The players' baseline data, including weight, height, body mass index (BMI), playing position, and dominant lower limb were recorded by both medical and fitness staff at the start of each market/season. Subject variables that were taken into consideration included season at time of injury, player position, and demographic data. Players were classified by their primary playing position as goalkeepers, defenders (back), midfielders (wing and line), or forward players, and injuries were recorded according to this predesignated individual playing position. To characterize the injury episode in these players, location, tissue at fault, nature and mechanism of injury, surface, and setting/sports event (i.e., practice vs friendly match vs official match) were registered.

This study adhered to the following practical definitions. *Injury* was considered as any musculoskeletal complaint newly incurred due to competition and/or training during the tournament that received medical attention regardless of the consequences concerning absence from competition or training [6]. Thus, a player was considered injured until she was able to fully participate in collective training and was ready for match selection [9]. According to the mechanism, an injury was classified as an *overuse/cumulative* injury if it was the consequence of repetitive microtraumas and was considered as *traumatic* if it was caused by a single traumatic incident [10].

Injury severity involved the number of days that have elapsed from the date of injury to the date of the player's return to full participation in team training and availability for match selection. The severity of injury was categorized according to its duration, so that injuries of 3 days or less were categorized as *minor* or *minimal*, injuries greater than 4 days but less than 7 days were categorized as *mild*, injuries greater than 8 days but less than 28 days were categorized as *moderate*, and injuries greater than 28 days were categorized as *severe* [6]. A *recurrent injury* was defined as any injury of the same type and at the same site as an index injury that occurred after a player's return to full participation from the index injury. Therefore, recidivism is that one which includes the same type of injury to the same side and location within 2 months after the final rehabilitation day of the previous injury, with a minimum of 1 week with no symptoms when participating in soccer [3]. Those reinjuries occurring more than 2 months or more than 12 months after a player's return to full participation are referred to as *late recurrence* and *delayed recurrence*, respectively [6,11].

The mechanisms of injury were divided into *direct contact*, which directly leads to health problems immediately and proximally, *indirect contact*, which occurs when force is not applied directly to the injured area, but contributes to the causal chain leading to the damage, and *non-contact*, which occurs when no direct or indirect contact from any external source exists [12,13]. For the purpose of this study, other suggested football-specific contact subcategories, such as objects from the crowd, objects into balls, pitch objects, pitch invaders and other pitch-side staff, or other (unspecified) objects were not considered [14].

Training exposure was defined as team-based and individual physical activities under the control or guidance of the team's coaching or fitness staff that are aimed at maintaining or improving players' football skills or physical condition. Separately, *match exposure* was defined as any exposure that resulted from games between teams from different clubs. Any match activity between teams from the same club or squad was regarded as training exposure [6].

Statistical analysis

An epidemiologic analysis was performed to assess the rates and patterns of soccer injuries and to analyze variables, including player position, setting, surface area, type of injury, mechanism of injury, duration of absence, and number of lost matches. Continuous data were presented as the percent values, the means and standard deviations (means±SDs), and frequency tables were created for categorical data. Normal distribution was evaluated for metric data with the Kolmolgorov-Smirnov test. Statistical analyses included calculation of injury incidence rate ratios, whereas χ^2 tests were employed for comparison in case of qualitative variables.

The injury incidence rate (IIR) was reported as the number of injuries divided by overall exposure (training and match hours) multiplied by 1000, equivalent to injuries per 1000 h of exposure [13,24]. The injury rate per player-season, burden, and rate ratio (RR) were also calculated. *The injury rate per player-season* was the total number of injuries during the observed study period divided by the total number of participants in a season, whereas *burden* was reported as the number of absence days divided by overall exposure (training and match hours) multiplied by

1000. The *RR* represented the injury incidence rate during matches in relation to training. For incidence rates, 95 % confidence intervals (CIs) were calculated according to the following formula: 95 % CI = incidence ± 1.96 × (incidence/square root [number of incidents]).

When one injury episode resulted in more than one diagnosis the main injury was used for statistical analysis, unless stated otherwise. Statistical analysis was conducted using SPSS 25.0 software (SPSS Inc. Chicago, IL, USA). The level of accepted statistical significance was set at $p < 0.05$.

Ethical considerations

The International Ethical Guidelines for Epidemiological Studies and the Strengthening the Reporting of Observational *Studies* in *Epidemiology* Extension for Sports Injury and Illness Surveillance (STROBE-SIIS) were followed in the reporting of this epidemiological study [7]. This investigation was performed in accordance with the The Code of Ethics of the World Medical Association (Declaration of Helsinki) [15]. All related sport and clinical data were anonymized before analysis to ensure team and player confidentiality. Ethical approval was obtained from our institutional review board (CEI-MCF 3–2021-H, 2021.06.23). All players were contacted and informed about the rationale of the study, and provided informed consent, with guardian consent obtained for players aged <18 years.

Results

Seventy-one professional female soccer players, with an average age of 23,68 ± 4,11 years, were included in this surveillance study over the three seasons. A total of 53 data records were reported in our sample -height 167 cm ± 0.05 (range 1.57–1.79), weight 59.88 ± 4.96 kg (range 49–70); BMI 21.40 ± 1.1 kg (range 18.67–24.21)- over this period, with an average of 0.68 injuries per player per season. These consisted of 20 match injuries (38 %) and 33 practice injuries (62 %). All these episodes resulted in a total of 1726 absence days and a corresponding burden of 35.1 days lost per 1000 h. The average layoff time was 32.56 days per injury. The players' characteristics and exposure features are summarized in Table 1.

Over the 3-season period, the 71 players were exposed to 41,980.6 h of practice time and 7200 h of match time, for a total of 49,180.6 h of exposure time. The players assumed 5.83 h of practice per match-hour, with a ratio of 6.5 practice sessions per match. The overall IIR per 1000 h of exposure was 1.08. Overall match IIR (2.78 injuries per 1000 h) was more than three-fold higher than total practice injury incidence (0.79 injuries per 1000 h), which generated an overall rate ratio (RR) of 0.61. The overall IIR was slightly increased in the last season, mainly due to an increase in the overall match IIR (table 2).

The detailed anatomical locations of injuries were broadly grouped into 3 groups: 1) head, neck, and trunk, 2) upper limb, and 3) lower limb. The majority of reported injuries were located in the lower limb (86,8 %), with the thigh being the most common site (39,6 %), followed by the knee (20,8 %), ankle (17 %), foot/toe, and lower back/pelvis/sacrum (5,7 %) (Table 3). Muscle injuries accounted for 47,2 % of all injuries and were the most common tissue involved, followed by joint/ligament (41,5 %), and bone (5,7 %) injuries.

Table 1
Characteristics and exposure time of female soccer players. Values are mean ± SD. h: hours.

Total n. of players	71
Age (yrs)	23,68 ± 4,11
Height (cm)	167 ± 5,5
Weight (kg)	59,89 ± 4,96
Body mass index (kg/m^2)	21,4 ± 1,1
EXPOSURE	
N. training sessions	654
N. of games	80
N. of weeks	111
Training exposure [hours (minutes)]	699 (41,980,6)
Match exposure [hours (minutes)]	120 (7200)
Training hours/player/season	13,993,53
Match hours/player/season	2400

During the 3-season period, August (35.8 %) was the month with the highest injury rate, while December (1.9 %) had the lowest injury rate. Regarding nature of the events, overuse injuries peaked equally in August and January (40 % each) in our sample, whereas traumatic injuries peaked in August (35.4 %). According to our particular sport season periodization, June and July were considered off-training months.

No significant differences were found in the comparison of injury incidence or injury severity between seasons except for the 19/20 season ($p < 0.01$) (30 % and 28 % versus 42 %). On average, we calculated 3.55 ± 5.52 lost matches per player, and each player missed 32.57 ± 48.37 days due to injury each season, which means that approximately 10 % of the season was lost due to injury if a given season lasted for 300 days.

According to the definition of injury severity used in this study, most injuries were moderate (50.9 %), whereas 1 out of 4 injuries were severe (24.5 %). The most reported mechanism of injury was indirect (45.3 %), followed by direct (34 %), and non-contact (20.8 %). Regarding nature, 48 of these injuries were traumatic (91 %), whereas 31 of them (58.5 %) occurred on artificial surfaces. Recidivism was only detected in 15 % of all cases, and it caused significantly longer absences than non-re-injuries (36.63 ± 52.579 vs 31.84 ± 48.189 days, $p < 0.05$). Most injuries were treated conservatively (94,34 %), and only 3 cases required surgery.

Player position at the time of injury was recorded for 71 players. In our series Defenders sustained most injuries (17, 32.07 %) with an incidence of 0,34 injuries per 1000 exposure hours, followed by midfielders (14, 26.41 %, 0.28 injuries per 1000 exposure hours), forwards (12, 22.64 %, 0.24 injuries per 1000 exposure hours), and goalkeepers (7, 13.21 %, 0.14 injuries per 1000 exposure hours). On average, per season, goalkeepers and defenders sustained 0.77 and 0.7 injuries per player respectively, compared to 0.66 for midfielders and 0.86 for forwards. No significant differences were reported for injury incidence between playing positions (p.0.572).

Defenders and forwards sustained the majority of their injuries to the thigh (52.94 % and 50 %, respectively). Most goalkeeping injuries concerned equally the hand, knee and lower back (28.57 %), whereas the knee and the thigh (35.71 % each) were the most affected region in midfielders.

Discussion

This retrospective observational study documented injury incidence and rates for a professional women's soccer team over the course of 3 consecutive seasons. To our knowledge, our three-season retrospective injury surveillance investigation is the first study to be conducted on professional female soccer players from a single team. Data on injury type, injury location, injury severity, and injury burden have been presented in combination with previously published consensus statements regarding injury definitions and epidemiological data collection procedures for epidemiological in soccer studies [6,14]. The duration of exposure was strictly documented since training and match scheduling represent essential requirements for successfully managing a sporting season.

The results revealed a notably higher injury incidence rate during match play than during practice. The prevalence of moderate and severe injuries was higher than that of minor and mild injuries, and a predominant proportion of these injuries affected muscle and joint/ligament tissues. The thigh was the most injured region and was reported to be the greatest burden in all playing positions, followed by knee injuries. Ankle injury was the third most common injury in this cohort but was surprisingly the most common injury in the Le Gall et al. study [16]. This finding was in agreement with previous research on elite female soccer

Table 2
Overall injury rates (IR) and injury rates per player exposures and per player-season. IIR: injury incidence rate; RR: Rate ratio.

Season	Overall IIR	Overall PRACTICE IIR	Overall MATCH IIR	RR	IIR per athletic exposures	IIR per athlete-season	Burden
17–18	0,99	0,81	1,71	0,33	0,06	0,66	–
18–19	0,87	0,63	2,08	0,67	0,06	0,6	–
19–20	1,39	0,87	5,05	0,83	0,09	1	–
All seasons	1,08	0,79	2,78	0,61	0,07	0,68	35,09

Table 3
Injury incidence rates according to both specific and general location. Values in parentheses show percentage of total injuries.

Injury location (specific)	2017–18 season	2018–19 season	2019–20 season	All seasons
Head/Neck	0 (0)	0 (0)	0 (0)	0 (0)
Shoulder/Clavicle	2 (3,8)	0	1(1,9)	3 (5,7)
Arm	0 (0)	0 (0)	0 (0)	0 (0)
Elbow	0 (0)	0 (0)	0 (0)	0 (0)
Hand/Finger	0 (0)	1 (1,9)	1 (1,9)	2 (3,8)
Waist/Trunk/Lower back/Pelvis Sacrum	0 (0)	1 (1,9)	2 (3,8)	3 (5,7)
Groin	0 (0)	0 (0)	0 (0)	0 (0)
Thigh	5 (9,4)	7 (13,2)	9 (17,0)	21(39,6)
Knee	4 (7,5)	2 (3,8)	5 (9,43)	11(20,8)
Lower leg/Achilles	0 (0)	0 (0)	0 (0)	1 (1,9)
Ankle	4 (7,5)	3 (5,7)	2 (3,8)	9 (16,98)
Foot/Toe	1 (1,9)	1 (1,9)	1 (1,9)	3 (5,7)
Total	16 (30,18)	15 (28,3)	21 (39,6)	53 (100)

players, where the lower limbs, including the thigh, the knee, and the ankle, which are the most injured subregions both in male and female cohorts, were highlighted as the most frequently affected body location [9,17]. Regarding specific conditions, two specific injury diagnoses affecting the foot (fifth metatarsal complete and incomplete fracture) showed low incidence yet high impact regarding time loss days (150 and 120, respectively). These injuries tend to be associated with a longer mean return to play and are considered as a potential career-ending disease [18].

In terms of seasonal disposition, we found a peak of injuries in August, whereas in other studies the highest number of injuries was found to occur in October [19] or September [16], which are the predominant months for injury. A strong correlation between the incidence rates and the concentration of competing events has been demonstrated, where a congested match fixture list exists [17]. We hypothesized that our findings might be more related to an initial pre-competitive phase when anatomical and physiological pre-season adaptations have not been fully integrated.

An important finding of this investigation is the unexpectedly low occurrence of head injuries and concussion, even though when female soccer players are known to be more prone to these injury events and to suffer more severe traumatic brain injuries [20,21]. According to previous studies, incidents of concussion have rarely been reported in professional football yet are present, ranging from 2 [22] to 14.5 % [21], with an incidence rate of 0.11–0.41 per 1000 exposures [23]. The relatively small size of our sample may be an explanation for our low rates.

Although most of the epidemiological research has been conducted during the last three decades, the methodological variability among these studies regarding injury definition, data collection, or study periods makes comparisons difficult. In recent years, multiple high-quality injury and illness surveillance studies of male elite male soccer players have been performed during several consecutive full training and competition seasons [9,24–28]. However, information on the health problems sustained by high level female players is scarce. Traditionally, most research on female soccer players has included injuries during one or two separate seasons or different types of tournaments, where many matches are played in a short period of time [2,17]. In this study one can find three seasons of high-quality surveillance data from one squad with more ordinary competing and training conditions. These data may be valuable for guiding future efforts to prevent injuries and illnesses among these female athletes and for properly designing evidence-based intervention programs.

The IIR values of injuries in professional soccer players vary considerably from study to study, probably due to methodological differences or the characteristics of the samples being examined. Recent systematic reviews indicate that the overall IIR in female elite club soccer players is 5.63/1000 h and the stratification by activity has shown ranges from 13.73 to 26.47/1000 h time-loss in matches −19.07/1000 h (match IIR)-, and from 2.15 to 4.96 per 1000 h time-loss in training contexts −3.27/1000 h (training IIR)- in different countries and competitions [17]. Le Gall et al. in their 8-season prospective study on a female cohort documented an average of 6.4 injuries per 1000 h of exposure [16]. In this sense, Horal et al. prospectively explored 8 different elite Irish clubs over two seasons and concluded that players sustained 0.69 injuries per season on average, with an overall injury incidence rate of 7.9/1000 h [29]. Research on male cohorts has shown similar variability and features. Ekstrand et al. reported an average incidence of 2 injuries per player every season within men's professional soccer, with a team of typically 25 players expecting approximately 50 injuries each season. This investigation demonstrated a mean total injury incidence of 8.0 ± 3.4 per 1000 h for all involved teams during seven consecutive seasons [9]. Data from other disciplines showed that sport populations sustained a variable number of injuries per season. The reported injury incidence in competitive swimming ranges from 3.78 to 5.55 injuries per 1000 exposed athletes and 3.04 to 4.6 events per 1000 h of practice, with a predominance of overuse injuries [30,31]. Our findings showed an overall IIR of 1,08 injuries per 1000 h, with an average incidence ranging from 0,6 to 1 injuries per player/season. These data are consistent with Giza et al., who prospectively studied 202 players from 8 teams during the first 2 seasons of the Women's United Soccer Association[3]. They found an IIR of 1,93 injuries per 1000 player hours. Similar data have been also reported in the tennis discipline but with a wide range of rates [32].

An extensive variety of rates are then found in the literature, depending on the country, age, or gender being analyzed. In recent years, regional, age, and gender differences in the risk of injury have been ascribed to several factors such as differences in weather and pitch conditions, season distribution and off-periods, team compositions, type of competition, training intensity, playing style, tactical approach, referee judgments, and medical protocols [30]. However, the impact of these factors has not yet been fully determined.

Regarding recidivism, only 15 % of the registered episodes in our study were reinjuries, with most injuries being articular in nature. These findings are lower than previously reported reinjury rates in studies focusing on high-level female soccer players [33,34], but significantly higher than those rates reported for young (<19 years) elite female players [16], where age may represent a protective factor. In accordance with this referred research, most of these re-injuries in our sample occurred in events previously classified as moderate to severe. In contrast, data from amateur soccer tend to reveal higher recidivism rates. Limited human and financial resources leading to a lack of standard and continuous medical and physiotherapy support have been highlighted as possible explanations for this difference. Thus, when no

injury prevention strategies or more personalized, evidence-based rehabilitation programs are systematically applied, injury management constitutes an even greater challenge for medical and coaching staff. This highlights the importance of not only training in preparation but also resources for the return to the demands of match play.

In light of these findings, female professional soccer players displayed injury patterns comparable to those of their male counterparts. Curiously, female elite futsal players have demonstrated a slightly different pattern of injury and small samples have shown the ankle to be the most frequent site of injury, followed by the knee and groin, with the sprain being the most frequent type of injury [35]. One of the first studies on high-level female players focused on the frequency of this injury decades ago [36]. In this sense, similar injury profiles have been identified in women's softball, with 1 up to 3 of injuries being due to sliding [37]. Oppositely, in other sport disciplines, such as field artistic swimming, hockey, or basketball, injuries tend to be more focused on the upper extremity or head/trunk regions [38–40]. We consider these findings to be all of concern and merit further epidemiologic research to establish the intrinsic and extrinsic factors leading to these injuries.

Limitations and weaknesses

The present study provides a consistent body of injury epidemiology data for female elite soccer players with a single medical staff from the same organization diagnosing, treating, and recording injury episodes, revealing potential sources of bias due to different approaches from different medical teams in different settings [41]. However, some limitations must be considered in this study. First, we recognized that a prospective, cohort design would have minimized the occurrence of errors associated with recall, which represents a problem with retrospective study designs. Second, analyses including only one squad per gender necessarily limit the external validity of the results. Although our study may have adequate power to identify differences in the overall injury incidence rate, longer follow-up periods might be needed for less common injuries. In addition, while these data certainly provide a panoramic view of the injury profile in a single soccer squad, the number of players evaluated and injured is limited. This makes it difficult to draw conclusions regarding patterns of injuries sustained during the season and to extrapolate these data to any given team or the entire female soccer league. In addition, due to the small sample size subgroup analysis was not possible. Therefore, the injury patterns revealed by our data might not be representative of the overall injury pattern in the average female soccer player which again threatens generalizability. Another limitation was that the population of the study was modified during the study, due to the changing nature of professional soccer squads, which barely remain the same across seasons. Thus, not all players were followed up during the entire study period.

Since this surveillance study was specifically focused on sport injuries, illnesses were not coded or registered. We must admit that these circumstances may have played a role in causative factors, individuals´ recovery capacity, return to play periods, and possible recidivism.

Conclusions

The present study has closely followed conceptual and methodological guidelines employed in previous epidemiologic investigations focusing on soccer-related injuries affecting elite female soccer players. Our findings revealed markedly high rates of injury during match play when compared to injury incidence during training, which correlates with previous research on this type of athlete with different levels and ages. Female professional soccer players have a high incidence of lower limb injuries from participation in their sport. The majority of these injuries occurred around the thigh and knee and are of soft tissue in nature, with comparable injury patterns to those seen in male cohorts. However, our findings must be considered with caution. This study provides epidemiological information that will help to inform future injury surveillance studies and the development of prevention strategies and recommendations to reduce the number of injuries in elite female soccer.

CRediT authorship contribution statement

Ivan Medina-Porqueres: Writing – original draft, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sara Sancho-Garcia:** Validation, Resources, Project administration, Investigation, Data curation. **Abel Gomez-Caceres:** Writing – review & editing, Validation, Project administration, Methodology, Data curation, Conceptualization. **Rafael Mondragon-Cortes:** Supervision, Resources, Project administration, Investigation, Data curation. **Ana Madrid-Rodríguez:** Validation, Resources, Investigation, Data curation. **Daniel Rosado-Velazquez:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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