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Correlation of the Score Obtained Through The "Functional Movement Screen" (FMS) Test with The Incidence of Musculoskeletal Injuries in Players of The Mexican Professional Basketball League (LNBP) During The 2023 Season

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ABSTRACT

Background. The assessment of mobility is important to determine the degree of functionality inherent in the ability to move and, therefore, sports performance. Likewise, mobility is related to the development of musculoskeletal injuries, but this is little known in professional basketball players.

Objective. Correlation of the FMS score with the incidence of musculoskeletal injuries in LNBP players during the 2023 season.

Methodology. An observational, cross-sectional, analytical, prospective study was conducted on professional basketball players from the Mexican League who played during the 2023 season. Before the start of the 2023 season, the FMS test was performed on the players. Other useful information for the study was recorded: history of musculoskeletal injuries, presence of pain, or limitation to movement at the time of the test. After that, a follow-up was carried out throughout the 2023 season to identify if the players had any musculoskeletal injury, including fracture, muscle injury, connective tissue injury (meniscal, capsular, fascial, etc.), ligamentous injury, tendinopathy, and low back pain. A musculoskeletal injury was defined as physical damage to the body secondary to athletic activity or an event for which the athlete sought medical attention and resulted in modified training or required splitting or protective taping. The affected joint or body site (knee, ankle, elbows, shoulders, wrist, other) and the number of injuries during the season were also recorded. Finally, the information was captured in the SPSS v.26 statistical program to determine if there were significant correlations between the scores obtained from the FMS test and the incidence of musculoskeletal injuries.

Results. Among the 27 players, the average age was 29.4±3.7 years (range 21-39 years). The overall incidence of musculoskeletal injuries throughout the season was 88.9%, only 3 players did not present musculoskeletal injuries (11.1%). The average was 2.7±1.4 injuries per player throughout the season. First-time injuries represented 69.2% of the cases and recurrent injuries represented 30.8%. 41.5% of the players had a minor injury, 36.9% mild, 10.8% moderate, and 10.8% severe. The mean FMS score was 14.5±1.8. The Pearson correlation between the FMS score and the number of lesions was r=0.084 (p=0.900). There were no significant differences in games lost, days out, and number of injuries, but there was a trend toward fewer games lost and days out in players with more than 14 points on the FMS scale. No significant differences were found in the FMS score by injury severity (p=0.472). The area under the curve for predicting moderate-severe musculoskeletal injuries based on the FMS score was 0.581 (0.419-0.742,

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p=0.359). In those over 30 years of age, a significant correlation of the FMS score with age was found (r=-0.406), but not in those under 30 years.

Conclusion. The incidence of musculoskeletal injuries was high. Although the FMS score was not a determining predictor for its development, our study suggests its potential usefulness in identifying players with a higher risk of severe injuries, especially individuals over 30 years.

KEYWORDS: Incidence, musculoskeletal injuries, players, basketball, FMS, professional league.

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PROFESSIONAL BASKETBALL WORLDWIDE

Basketball is one of the most practiced sports in the world with more than 450 million players until 2013. It is also estimated that 11% of the world's population practice it with an incremental tendency inside and outside the court since a specific culture arises from sports that is expressed in music, literature, cinema, and video games. (1)

The International Basketball Federation (FIBA) emerged in 1932 as an amateur sport that was subsequently professionalized and debuted at the Summer Olympics in 1936, today there are 212 participating nations. Numerous leagues and championships are played worldwide, especially in the United States of America, Europe, and more recently in Asia, where sport has emerged in the 21st century. In 1946 the main professional league of the United States was founded, the National Basketball Association (NBA) is to this day the tournament with greater relevance followed by the Liga Endesa Española (ACB) and the Euroleague. Some variants have been developed, such as wheelchair basketball for disabled athletes, Street Ball, and 3x3 basketball. (38)

Unfortunately, as the number of practitioners worldwide increases, sports injuries associated with basketball represent 4.3 million visits to the hospital emergency department annually in the United States. Basketball is the most common sports activity that generates emergency service visits for men and the second most common for women after riding a bike. (1)

PROFESSIONAL BASKETBALL IN MEXICO

In Mexico, many athletes practice basketball at a professional level, as shown in the various leagues that are played annually. One of the leagues that hosts a greater number of teams and has one of the best levels of play, is the National Professional Basketball League, which is currently made up of 16 teams throughout the country. The regular season lasts four months, from July to October. The interest in the sport has also increased the incidence of injuries to novice and professional players. (2,3)

In Mexico, the body in charge and associated with FIBA is the Mexican Basketball Association A.C. (ADEMEBA), which regulates professional and amateur leagues and national teams. At the state level in Yucatan different amateur leagues are held being the main state basketball league with the participation of 15 to 21 teams.

No studies related to the variables considered in this research at the national or local level were found.

THE MOST COMMON INJURIES IN BASKETBALL AND THEIR INCIDENCE

During the last few years, it has been observed that basketball has presented numerous changes in the game itself and the way to carry out the training, demanding more demand and hours of practice, resulting in a high incidence of injuries. It has been estimated that the injury rate in amateur basketball has been between 1.83 and 7.9 for adolescent players/ as per 1,000, noting that the incidence of injury decreases more than 50% in both genders during the moments of practice, compared to competitive moments, for both amateur and elite or semi-professional basketball. (4.5)

In professional basketball players, it has been reported that the frequency of injuries is 24.8% (1310 injuries) in the foot and ankle, followed by the thigh, hip, and leg with 1074 injuries (20.4%), the knee with 19.5% (1027 injuries) and finally, lesions in the trunk and spine with 586 lesions (11.1%). (6)

Ankle injuries are worldwide, the most common among basketball players. In Australia, it was determined that more than half of the total time lost due to injury (53.7%) is due to ankle pathology. This injury represents between 16% and 40% of all injuries reported with the sport. Lateral sprains of the ankle are the most frequent and result from hyper supination of the retro-foot with plantar flexion that causes tension or tearing of the lateral ligaments of the ankle.

Nearly 85% of ankle sprains involve the lateral ligaments. In approximately 65% of the cases, there is an isolated lesion of the anterior talofibular ligament and in 20%, there is a lesion of both the calcaneofibular ligament and the talofibular ligament. The remaining 15% involve medial ankle sprains and syndrome. Patients usually present with clinical manifestations of lateral ankle swelling (local or diffuse), pain, bruising, and limited range of motion (ROM). (7,8)

In addition to ankle injuries, knee injuries are common among basketball players. Knee injuries most often take the form of meniscus tears or tears in the anterior cruciate ligament. Anterior cruciate ligament (ACL) tears are more severe in terms of lost time and rehabilitation demands, often requiring

reconstructive surgery and up to a year off the court. Likewise, meniscal pathology has been described as the incidence, risk, amount of time lost on the court, and the effect on the performance of the National Basketball Association (NBA) athletes. During 21 seasons of NBA games, 129 isolated menial tears were identified in athletes. Of this number, 77 (59.7%) affected the lateral meniscus and 52 (40.3%) the medial meniscus. (9)

Spinal injuries are also common and account for 11.4% and 13.5% of all injuries in competitions and practices, respectively, among all university athletes. These injuries, if left untreated, may persist and lead to significant morbidity or loss of involvement in the future. (10)

The contusions, being a translation sport with ballistic movements and ball projection, are part of the range of injuries associated with basketball, both by collision and by falls. The clinical manifestations of these lesions include pain, restricted movement inability to run properly, and bruising. (11,12)

FACTORS ASSOCIATED WITH MUSCULOSKELETAL INJURIES IN BASKETBALL PLAYERS

Injury risk factors can be classified into anatomical, hormonal, biomechanical, and environmental factors. Modifiable factors include central strength, proprioception, hamstring strength, neuromuscular recruitment, and hormonal profile. Non-modifiable factors include anthropometric alignment, knee hyperextension, femoral notch size, inherited skills, and coordination. (13,14)

Other risk factors for musculoskeletal injuries in athletes include sportswear, body mass index, duration of heating, flexibility, and aerobic endurance. Increased height and weight contribute to increased momentum and strength during a collision with another athlete increasing stress and load on skeletal structures. (17).

RESEARCH ON THE CONNECTION BETWEEN FMS AND OTHER SIMILAR SCALES AND THE OCCURRENCE OF MUSCULOSKELETAL INJURIES

Several studies have evaluated the association of FMS and other similar scales with the incidence of musculoskeletal lesions. Martin et al in 2017 determined whether a total pre-season FMS score is a valid predictor of season-long injuries among teen bowlers. The authors conducted a quantitative observational prospective study. Bowlers performed the FMS before the start of the season. The incidence of injuries was monitored monthly throughout the season. Student's t-test and Fisher's exact test were used to compare the FMS scores of injured and non-injured bowlers, as well as injured and non-injured bowlers who scored 14. Twenty-seven adolescent bowlers, male, without injuries, were applied to the FMS (score criteria and scorecard) and the standardized self-administered injury questionnaire. There was no difference between the non-injured group (16.55 2.57) and the injured group (16.1 2.07) regarding FMS score. There was no significant difference between injured and uninjured bowlers who scored 14. The authors state that an FMS score of 14 or lower does not provide the necessary sensitivity. More research should be done to determine whether a specific FMS test will be a more valid predictor of injury. (16)

Bushman et al. (2016) determined the association of FMS with the risk of injury, evaluated predictive values, and identified optimal cut-off points using 3 types of injury. In a cohort study, physically active male soldiers aged 18 to 57 years (N = 2476) completed FMS. Demographic and fitness data were collected through a survey. Data were obtained from medical records for overuse injuries, traumatic injuries, and any injuries 6 months after the FMS evaluation. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated along with the receiver operating characteristic (ROC). Soldiers who scored 14 had a higher risk of injury than those who scored >14. Multivariate logistic regression analysis identified poor FMS performance as an independent injury risk factor. The authors associated a low FMS score with an increased risk of injury, showing low sensitivity. Based on these findings, the use of FMS to detect the risk of injury in this population is not recommended due to the low predictive value and the erroneous classification of the risk of injury. (17)

Kiesel et al. (2014) sought to determine whether motor control of fundamental movement patterns and asymmetry of patterns are related to loss of time injury over the course of the pre-season in professional football. An injury risk study was conducted at professional American football facilities, where 238 professional American football players participated. To measure motor control of 1 body weight fundamental movement patterns, FMS scores were obtained before the start of the training camp. The previously established cut-off score of 14 and the presence of any asymmetry in the FMS were examined using relative risk to determine whether there is a relationship with the time-loss injury. Measurement of skeletal muscle injury was performed with defined time loss as any practice time loss or competition due to a musculoskeletal injury. Players who scored 14 showed a relative risk of 1.87. Similarly, players with at least 1 asymmetry showed a relative risk of 1.80. The results of this study suggest that fundamental movement patterns and asymmetry of patterns are identifiable risk factors for pre-season time loss injuries in professional football players. (18) Chorba et al. (2010) determined whether compensatory movement patterns predispose female college athletes to injury and whether FMS can predict injury in this population. Scores were calculated in the FMS, which consists of seven movement tests, for 38 NCAA Division II college athletes before the start of their respective fall and winter sports

seasons (football, volleyball, and basketball). Seven athletes reported a history of anterior cruciate ligament (ACLR) reconstruction. Injuries sustained during sports activities were recorded throughout the seasons. Eighteen injuries, 17 lower extremities, and one lower back, were recorded during this study. A score of 14/21 or less was significantly associated with injury. Sixty-nine percent of athletes with a score of 14 or less suffered an injury. A significant correlation was found between low-score athletes and injuries. A score of 14 or less on the FMS tool resulted in a 4-fold increase in the risk of lower extremity injuries in college athletes participating in fall and winter sports. The screening tool was able to predict injuries in female athletes with no history of major musculoskeletal injuries such as ACLR. In conclusion, compensatory fundamental movement patterns can increase the risk of injury in female university athletes and can be identified using a functional motion detection tool. (19)

Mokha et al.(2016) determined whether an asymmetry or a score of 1 in an individual FMS test would predict the incidence of musculoskeletal injuries in college athletes. A musculoskeletal injury was defined as physical damage to the body, secondary to physical-sporting activity or an event for which the athlete sought medical attention and resulted in a modified training or required division or protective bandage. A cohort study was conducted in Division II of the National Association of Collegiate Athletics. A total of 84 rowers, volleyball, and football players in Division II (men: n = 20, age = 20, ± 1.3 years, height = 1.77± 0.04 m, mass = 73.5 ± 4.8 kg; women: n = 64, age = 19.1 ± 1.2 years, height = 1.69 ± 0.09 m, mass = 64.8 ± 9.4 kg) FMS was performed during pre-season examinations. Each team's certified athletic coach tracked injury incidence data for one academic year through computer software. Composite FMS scores were classified as low (<14) or high (>14). Athletes with FMS scores of 14 were no more likely to suffer injury than those with higher scores. However, athletes with an asymmetry or individual score of 1 were 2.73 times more likely to suffer an injury than those who did not. It was concluded that asymmetry or a low score in the individual FMS test was a better predictor of musculoskeletal injury than the composite FMS score. (20)

Dossa et al. (2014) assessed whether injuries in major junior hockey players can be predicted using a pre-season FMS. A convenience sample of 20 hockey players was rated at the FMS before the start of the hockey season. Injuries and the number of lost games per injury were documented throughout the season. The average FMS score was 14.7+/ 2.58. Those with an FMS score of ≤ 14 were not more likely to suffer an injury as determined by Fisher's exact test. This study did not support that lower FMS scores predict injuries in leading junior hockey players. (21)

Smith et al. (2017) evaluated whether the functional motion screen (FMS) can accurately predict non-contact injuries in adult football players by normalizing the occurrence of non-contact injuries against match exposure levels. Senior male players from 5 semi-professional Irish League clubs participated in the study. Participants performed the FMS during the pre-season, and their injury occurrence rates and game minutes were tracked for 1 season. In total, 66 non-contact injuries were recorded. No significant differences in composite FMS scores were found between players who suffered non-contact injuries and players who did not suffer a non-contact injury. There was no significant difference in the incidence of non-contact lesions standardized by exposure between those who scored 14 or less and those who scored higher than 14 in the FMS (0.36 versus 0.29 non-contact injuries per player per 1000 minutes of game). Players scoring 14 or less in the FMS had a 0.63 probability of receiving a non-contact injury. Despite previous research showing links between low composite FMS scores and subsequent injuries, these results suggest that the FMS cannot accurately predict the likelihood of suffering a non-contact injury and that a lower FMS composite score does not significantly increase its incidence rate of non-contact injuries per 1000 minutes of match. Therefore, caution should be taken when using FMS as a predictor of non-contact injuries, and the prevalence of pain during FMS, previous injuries, and levels of training/match exposure should also be considered. (22)

Finally, Letafatkar et al. (2014) investigated the relationship between the FMS score and injury history, trying to determine which active students are prone to injury. One hundred physically active students (50 women and 50 men), between 18 and 25 years old, with no history of musculoskeletal injury in a previous period of 6 weeks. All participants performed the FMS and were graded using the previously established FMS standardized criteria. Of the 100 subjects, 35 suffered an acute injury to the lower extremity (ankle = 20, knee = 15) in practice or competition. A probability ratio of 4.70 was calculated, meaning an athlete was approximately 4.7 times more likely to suffer a lower extremity injury during a normal competitive season if he scored below 17 in the FMS. There were statistical differences between the pre-season FMS scores of the injured and non-injured groups, the groups with an ankle injury, knee injury, and non-injured, and between the groups with contact injury, non-contact injury, and no injury. This cross-sectional study provides FMS reference values for physically active students, which will help interpret individual scores when evaluating athletes for musculoskeletal injuries and performance factors. Further research is still required before implementing the FMS as part of a physical exam before participation in athletics, an action that doctors and researchers should consider, as it is a low-cost and easy test to implement. (23)

FMS SCALE (FUNCTIONAL MOVEMENT SCREEN)

The FMS is a validated scale developed for trainers to identify the possible limitations of certain movement patterns and then prescribe preventive exercises to prevent musculoskeletal

injuries. Its use has been extended to other sports, and military personnel, to estimate the risk of musculoskeletal injuries. This test could classify patients according to the degree of joint mobility to plan strategies for treatment and have control of the progress or deterioration of these. (24,25)

The FMS consists of 7 individual tests: the deep squat, the in-line lunge, the obstacle step, the flexibility of the shoulder, the bending of arms, the lifting of the stretched leg, and the evaluation of the rotating stability of the trunk. Each FMS criterion is rated on a scale of 1 to 3, with the instrument's total score of 21 points. A "0" score is awarded on an individual test if the subject experiences pain during the evaluation process. For each criterion, a score of 1 indicates poor performance, 2 if you use compensations, and 3 for excellent performance. (26,27)

MUSCULOSKELETAL INJURIES AND BASKETBALL

Musculoskeletal injury is a general term that includes any acute or overuse trauma that causes damage to muscles, bones, tendons, joints, ligaments, and other soft tissues.

Basketball is a team sport characterized by plyometric movements such as race and deceleration, repetitive jumps and the respective landing impact, turns, lateral movements in multiplanar vectors, sudden direction changes, contact, and risk of collision with players, ball, playing surface, and stage. These actions may result in a risk of musculoskeletal injury in this sport (28). Therefore, it would be relevant for those who practice this sport to have the physical abilities and skills required.

Musculoskeletal injuries represent one of the most common health conditions in athletes, with consequences not only in decreased performance or abandonment of competitions but also in economic costs, risk of further injury, and daily activities (29,30).

Identifying the risk of sports injuries and implementing appropriate preventive measures would help doctors, physiotherapists, coaches, sports trainers, and specialists reduce these injuries, improve sports performance, and minimize healthcare costs among their players (31).

The FMS has received much attention in recent years, and studies have consistently found it reliable. However, no studies using FMS have been published on professional basketball players (32).

Even when large amounts of money are invested in infrastructure and services aimed at improving the biopsychosocial sphere of athletes, the incidence of injuries maintains an upward trend, Therefore, conducting a prior evaluation to determine who is most susceptible to injury or attacking the main causes that may reduce the risk of injury should be a priority in the medical-sports minutes.

To this day, the use of an instrument is not systematized before the competitive period, which helps determine the risk of injuries in professional basketball players and contributes to consecutive actions in injury prevention.

METHODOLOGY

A quantitative study was conducted with a correlative, cross-sectional, and prospective scope. The study population was the Halcones de Xalapa team players of the Mexican Professional Basketball League registered to play in the 2023 season. The summer period was before the 2023 season until the end of the 2023 season. (July to December 2023).

The inclusion criteria were professional basketball players hired to play the 2023 season, being part of the Halcones de Xalapa team of the Mexican Basketball League, and who accepted their participation by signing informed consent. The exclusion criteria were players with musculoskeletal injuries at the time of the study and with other sports activities besides basketball.

A month before the start of the 2023 season, those players who accepted to participate in the study applied the FMS test in person with paper and pencil, recording the overall score and each item in the format designed for that purpose (annex 2). Personal data including age and history of musculoskeletal injuries were also recorded. Subsequently, a follow-up of accompaniment and medical attention was carried out during training and games throughout the 2023 season to identify if the players presented any musculoskeletal injury, recording these, in an Excel format. (Annex 3). Finally, the data were captured in the SPSS statistical program to perform the analysis, obtain results, and conclusions, and deliver a final research report.

DEFINITION AND OPERATIONALIZATION OF STUDY VARIABLES

Score in FMS.

Overall FMS score.

The tool evaluates functional mobility, to identify compensatory movement patterns that affect optimal function, and consists of seven functional tests. Each test is rated on an ordinal scale from "0" to "3"; with "0" indicating that pain was present with movement, a score of "1" indicates poor performance, "2" if using compensations, and "3" excellent performance, therefore, the best possible composite score is 21.

SCORE OF EACH FMS ITEM

1. Squat score with stretched arms: Evaluate the bilateral symmetrical mobility of the hips, knees, and ankles when performing a deep squat gesture. At the same time, with the cane, you examine the scapular and thoracic mobility.
2. Fence pass score: Designed to assess body control during walking. Evaluate the bilateral functional mobility and

stability of the hips, knees, and ankles when performing the gesture of fence attack with a rod held in the coronal plane at the acromial level. Unilaterally, both limbs are graded.

3. Lunge score: This allows us to analyze the postural control, mobility, and core activity of the muscles involved when we rotate, slow down, and make lateral displacements and changes of direction when making a thrusting gesture.
4. Shoulder mobility score: Analyzes the bilateral range of motion combining internal adduction and rotation of the upper extremities. It is done bilaterally.
5. Score active elevation with straight leg: Assesses core stability, pelvic control, and hip flexion and extension. It is done bilaterally.
6. Flex trunk stability score: This shows the stability and strength of the core in the sagittal plane. Also, the ability to execute the movement symmetrically, maintaining the neutral position of the column.
7. Rotational trunk stability score: Evaluates multidimensional stability of shoulders, trunk, and pelvis in simultaneous upper and lower extremities movements. It is done bilaterally.

Musculoskeletal injury.

A term that includes any acute or overuse trauma that causes structural or metabolic damage to muscles, bones, tendons, joints, ligaments, and other soft tissues, diagnosed by specific clinical assessment and imaging tests (x-rays, high-definition ultrasound, and magnetic resonance) and limiting function or sports participation (33).

RESULTS

Demographic characteristics of the players

The Halcones de Xalapa team of the Mexican League of Professional Basketball was formed during the 2023 season by 27 players of average age 29.4 3.7 years (range 21-39 years).

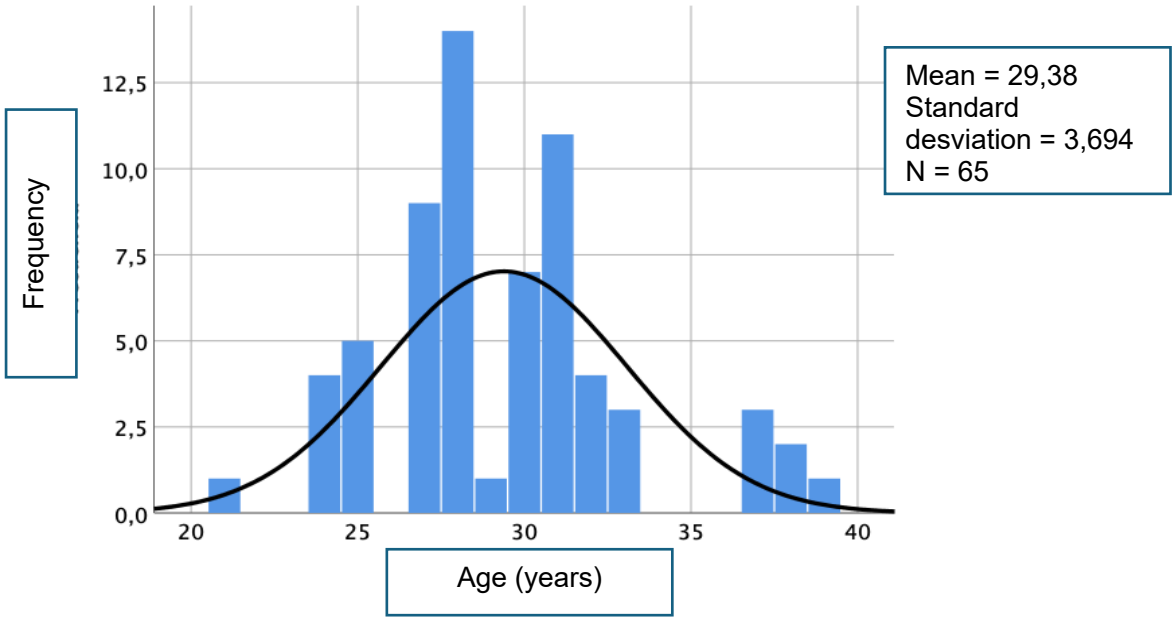

Figure 1. Halcones de Xalapa team players distribution by age.

INCIDENCE AND NUMBER OF MUSCULOSKELETAL INJURIES THROUGHOUT THE 2023 SEASON

The overall incidence of musculoskeletal lesions throughout the season was 88.9%, with only 3 players having no musculoskeletal lesions (11.1%) [Figure 2].

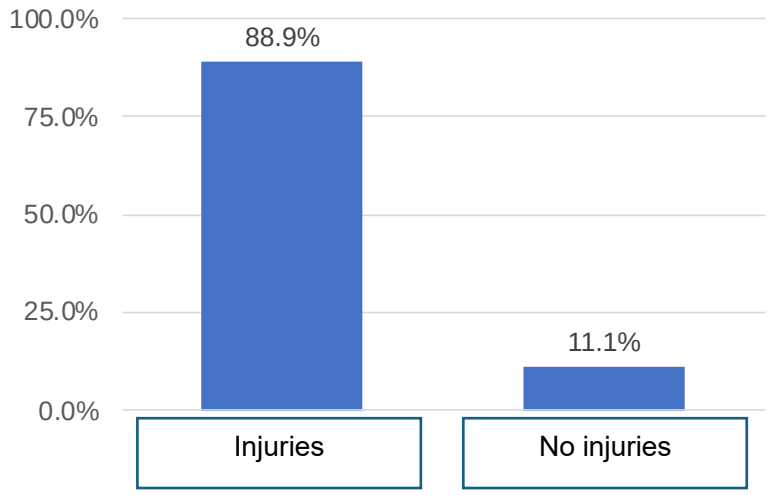

Figure 2. The overall incidence of musculoskeletal lesions throughout the 2023 season.

As for the number of injuries, the average was 2.7 ± 1.4 injuries per player throughout the season. There were 65 injuries among the 27 players. They had an injury of 36.9% of the players, two injuries at 27.7%, three injuries at 20%, four injuries at 9.2%, five injuries at 4.6%, and six injuries at 1.5% of the players [Figure 3].

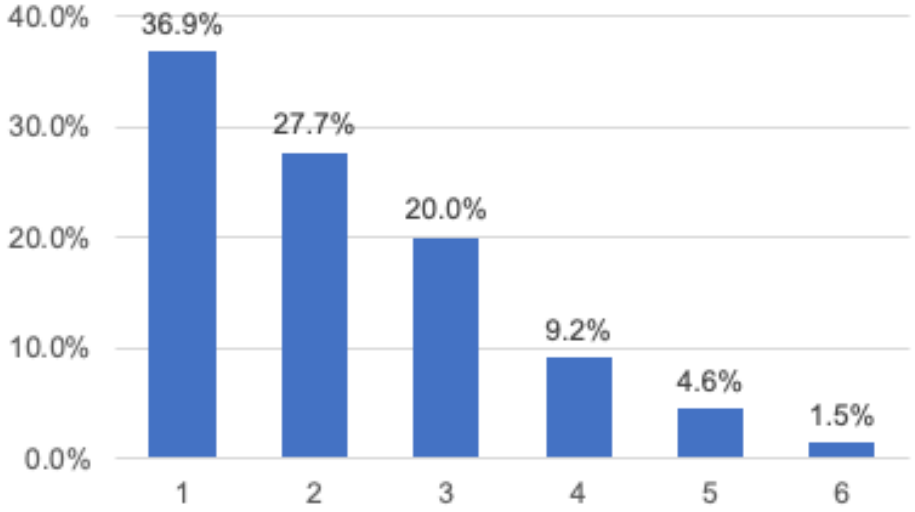

Figure 3. Musculoskeletal injuries that Halcones de Xalapa basketball players had during the 2023 season.

FIRST-TIME AND RECURRENT INJURIES

First-time injuries accounted for 69.2% of cases and recurrent injuries accounted for 30.8% [Figure 4].

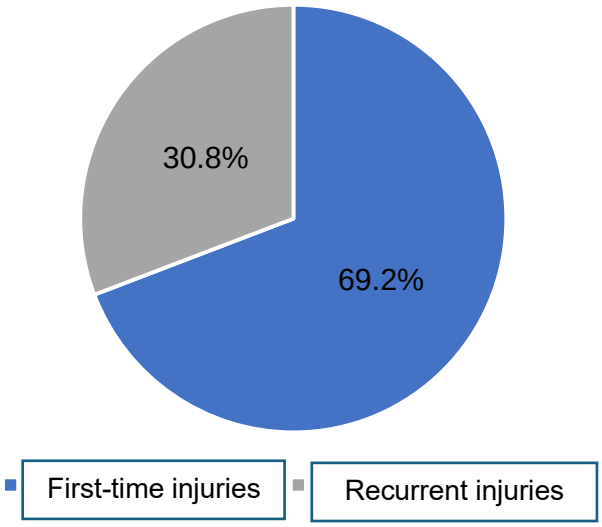

Figure 4. First-time and recurrent injuries to Halcones de Xalapa team players.

Characteristics of musculoskeletal injuries in Mexican professional basketball league players.

Regarding the characteristics of musculoskeletal lesions among the Halcones de Xalapa players, we found that the etiology by contact and without contact was similar (47.7% versus 52.3%), the mechanism by overuse and traumatic was also comparable (46.2% versus 53.8%), and the most concerned body segments were the lower extremities (64.6%) and upper extremities (23.1%). The most affected areas were the ankle (18.5%), knee (13.8%), thigh (13.8%), shoulders/clavicle (12.3%) and legs (10.8%) [Table 1].

Table 1. Characteristics of musculoskeletal injuries in Mexican professional basketball league players

Characteristic	%(n)
Etiology	
Contact	47.7(31)
Contactless	52.3(34)
Mechanism	
Overuse	46.2(30)
Traumatic	53.8(35)
Segment	
Lower body	64.6(42)
Upper body	23.1(15)
Core	7.7(5)
Head and neck	4.6(3)
Zone	
Ankle	18.5(12)
Knee	13.8(9)
Leg	10.8(7)
Thigh	13.8(9)
Hands	10.8(7)
Shoulders and clavicle	12.3(8)
Lower back and pelvis	4.6(3)
Neck and Spine	3.1(2)
Hip and pubis	6.2(4)
Head and face	3.1(2)
Abdomen	3.1(2)

Regarding the affected tissue, the muscles, tendons, and ligaments were the most affected with a frequency of 26.2%, 26.2%, and 24.6%, respectively. The most common injuries, were corners, distensions, tendinopathies, and tears, representing 23.1%, 21.5%, 15.4%, and 13.8%, respectively. Total injuries are presented in Table 2.

Table 2. Characteristics of musculoskeletal injuries in Mexican professional basketball league players

Characteristic	%(n)
Affected tissue	
Ligament	24.6
Muscle	26.2
Tendon	26.2
Bone	10.8
Fascia	1.5
Skin	1.5
Other	9.2
Type of injury	
Tendinopathy	15.4
Distension	21.5
Tearing	13.8
Sprain	23.1
Dislocation	4.6
Bursitis	4.6
Osteoarthritis	3.1
Neuritis	3.1
Bone contusion	3.1
Fracture	3.1
Mild head trauma	1.5
Meniscopathy	1.5
Other	1.5

On the other hand, in terms of the severity of the injury, 41.5% of the players had a minor injury, 36.9% mild, 10.8% moderate and 10.8% severe [Figure 5].

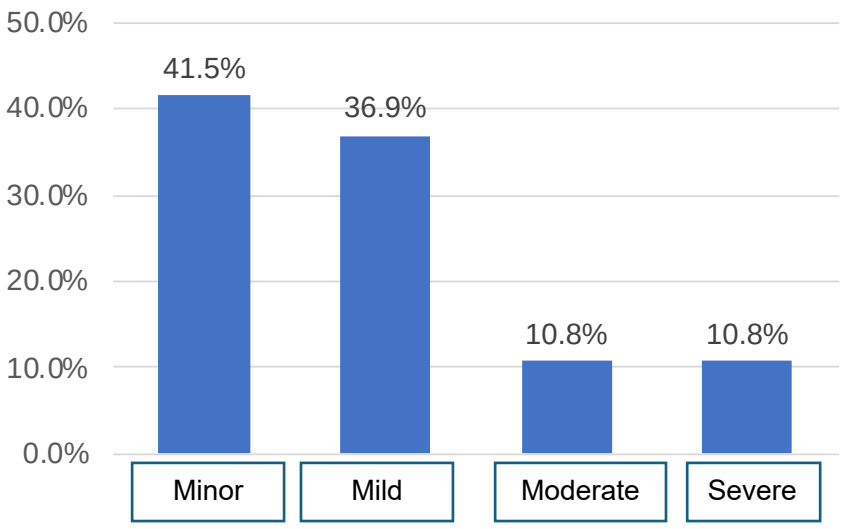

Figure 5. The severity of injury in the basketball team Halcones de Xalapa.

FMS score on Halcones de Xalapa players of the Mexican professional basketball league

The mean FMS score was 14.5 1.8, the range was 12-18 points, and the median was 14(3) [Figure 6].

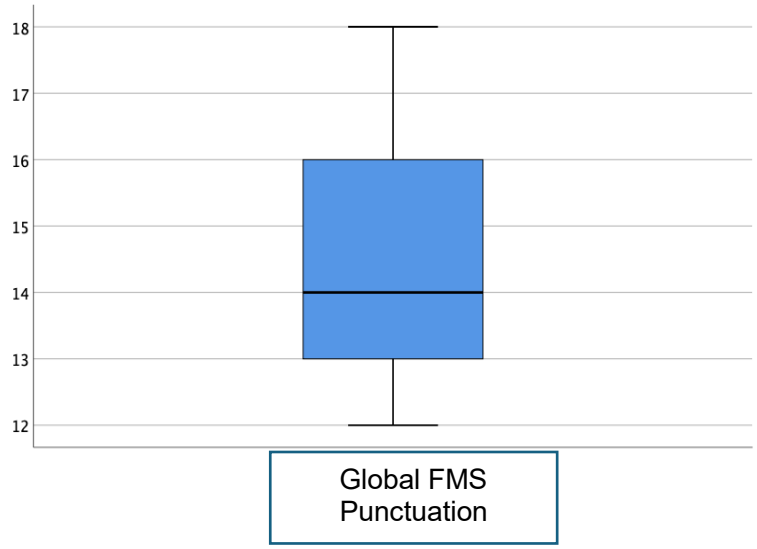

Figure 6. FMS score in players of the Halcones de Xalapa basketball team.

Pearson's correlation between the FMS score and the number of injuries in Halcones de Xalapa players of the Mexican professional basketball league

When calculating the Pearson correlation coefficient between the FMS score and the number of injuries in the Mexican professional basketball league players, a correlation of r=0.084, p=0.900 was found [Figure 7].

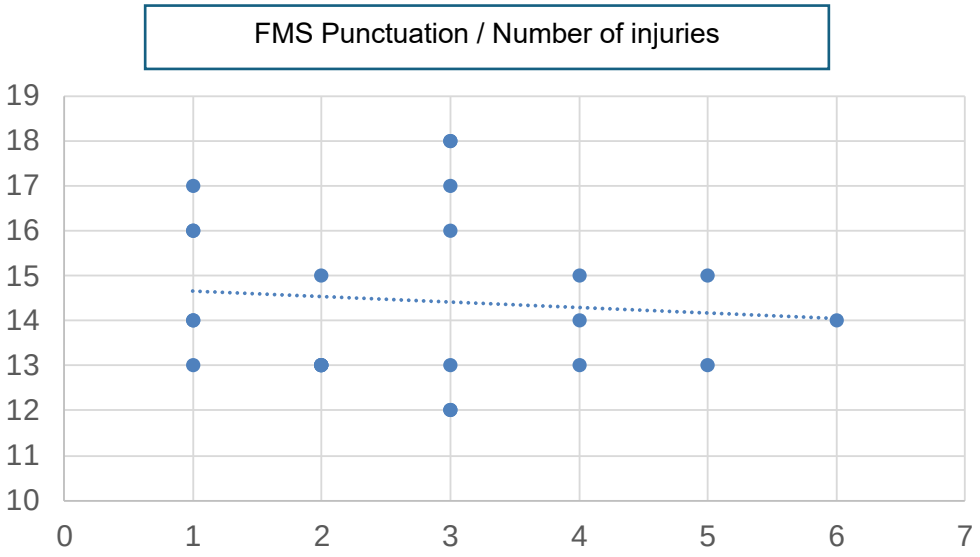

Figure 7. Pearson's correlation between the FMS score and the number of injuries in Mexican professional basketball league players.

Comparison of lost games, days off, and number of injuries among players with less and more than 14 points on the FMS scale

Lost games, days off, and several injuries among players with less and more than 14 points on the FMS scale were compared. Although no significant differences were found, there was a clear trend towards fewer lost matches, days of absence, and injuries among those with more than 14 points on the FMS scale [Table 3].

Table 3. Comparison of lost matches, days off and number of injuries among players with fewer and more than 14 points on the FMS scale

Parameter	>14 points FMS	<14 points FMS	p Value
Lost games	1.1±2.6	3.0±7.4	0.232
Days off	7.9±13.1	11.6±18.2	0.372
Number of injuries	2.1±1.1	2.3±1.4	0.604

Pearson's correlation of the FMS score with games and days off in players of the Mexican professional basketball league

Pearson's correlation of the FMS score with lost games and days off in Mexican professional basketball league players was not significant [Figures 8 and 9].

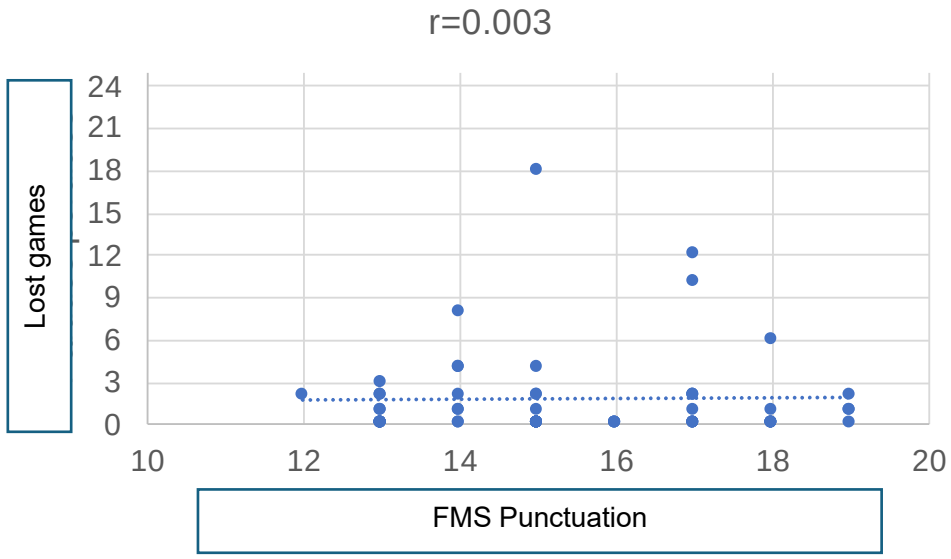

Figure 8. Pearson's correlation between the FMS score and the number of lost games in Mexican professional basketball league players.

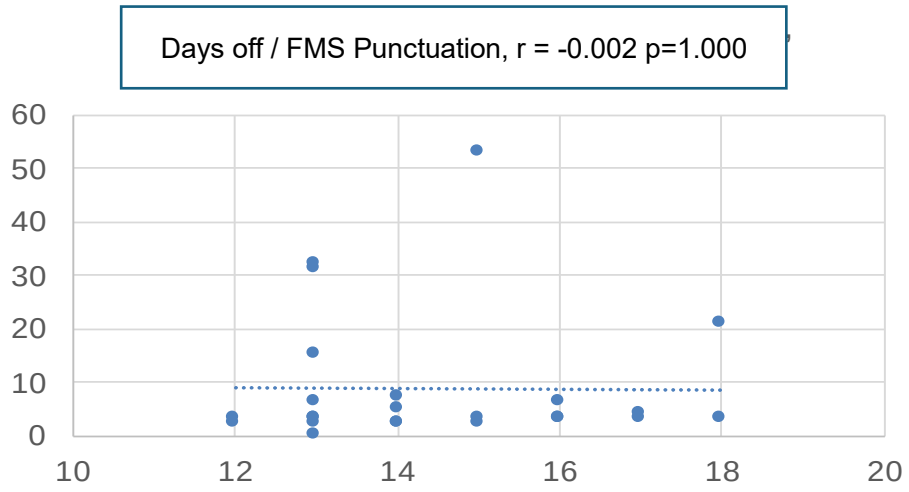

Figure 9. Pearson's correlation between the FMS score and days of absence in Mexican professional basketball league players.

Comparison of the FMS score for severity of injuries in Mexican professional basketball league players

The FMS score was compared for severity of injuries in players of the Mexican professional basketball league; however, no significant differences were found in the FMS score for severity of injuries (p=0.472, ANOVA test) in players of the Halcones de Xalapa team of the Mexican professional basketball league [Table 4].

Table 4. Comparison of the FMS score by severity of injuries in Mexican professional basketball league players

Parameter	Minor	Minor	Mild	Severe	p Value*
FMS	15.0±1.7	14.0±1.8	15.5±3.5	13.7±1.1	0.472

* ANOVA test

The area under the curve (AUC) ROC to predict moderate-severe musculoskeletal injuries based on FMS score in professional basketball players

The area under the ROC curve (AUC) was estimated to predict moderate-severe musculoskeletal lesions based on the FMS score in professional basketball players, finding that the AUC was 0.581 (0.419-0.742, p=0.359) [Figure 10].

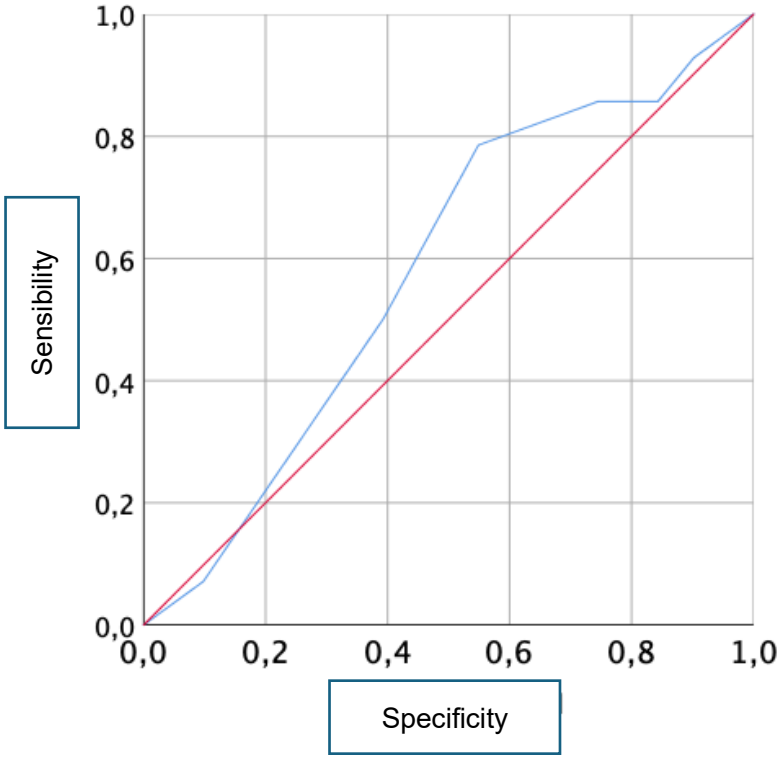

Figure 10. Area under the curve (AUC) to predict moderate-severe musculoskeletal injuries based on the FMS score in professional basketball players.

Factors significantly associated with the FMS score.

Factors significantly associated with the FMS score were sought, however, only in people over 30 years of age was a significant correlation found between the FMS score and age (r=-0.406), but not in children under 30 years of age [Figure 11].

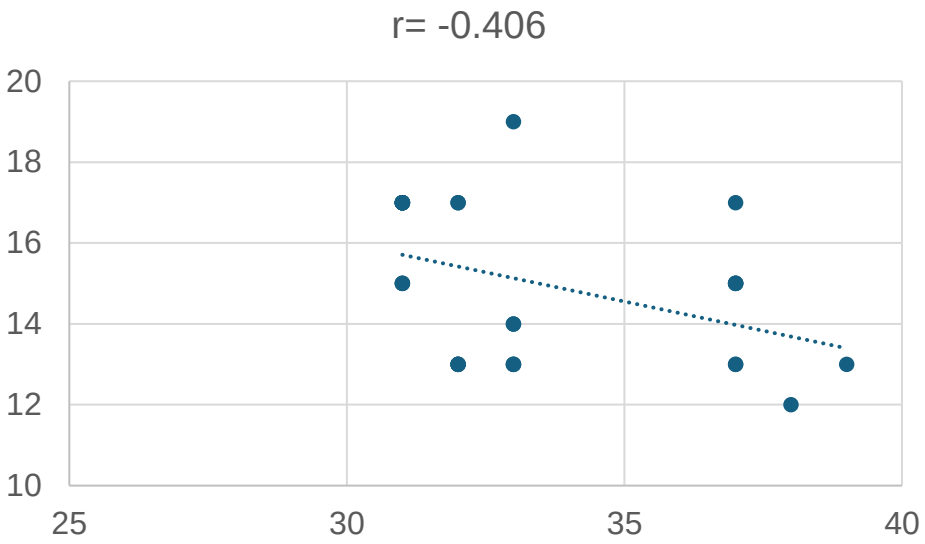

Figure 11. Correlation of the FMS score with age over 30 years.

DISCUSSION

The risk of musculoskeletal injuries in professional basketball players is a major concern due to this sport's physical and demanding nature. With rapid movements, sudden changes in direction, repetitive jumps, and physical contact with other players, basketball players are exposed to various risk factors that increase the likelihood of musculoskeletal injury (34,35). In recent years there has been interest in identifying factors or tools capable of predicting skeletal muscle injury, and potential factors include the FMS (Functional Movement Screen) score, a tool designed to evaluate the quality of movement and functional stability in athletes, identifying possible biomechanical dysfunctions that could predispose to injuries (36). Therefore, in this study, we evaluated whether there is a correlation between the score obtained by applying the FMS test and the incidence of musculoskeletal lesions throughout the 2023 season in the " Halcones de Xalapa " team of the LNBP. The main findings of this study are discussed below.

First, the average age of the players was 29, although the range was between 27 and 39 years. This average age is higher than that reported by Ochoa et al. in Mexicali Soles players of the 2012 season who reported an average age of 24.8 2.1 years in these players (37). In another study by Cunha et al. on professional basketball players from Brazil in 2014/2015, the average age of professional basketball players was 25.9 years (38). Also, the average age of our players was higher than that reported by professional basketball players of the NBA who had an average age of 26 years (39).

Second, regarding the incidence of skeletal muscle injuries, we found that 88.9% of players had any injuries throughout the season, and only 3 players (11.1%) had no injuries throughout the season. This incidence of musculoskeletal lesions is higher than that reported by Crespo et al. who reported a 60.6% incidence of musculoskeletal injuries over two seasons on an Argentine professional basketball team (40). In Spanish professional basketball teams during the 2004-2007 season, the incidence of musculoskeletal injuries was 78.7% (41). Another study, which included a total of 217 professional basketball players, found that a total of 282 injuries were reported, meaning that almost 100% of players had a musculoskeletal injury throughout the season (42), which coincides with the frequency of musculoskeletal injuries in the " Halcones de Xalapa" team of the LNBP. Therefore, the incidence of musculoskeletal injuries of professional basketball players of the " Halcones de Xalapa " team of the LNBP is among the highest reported in the literature.

Third, the average injury of the players was 2.7 and most had between 1 and 3 injuries. Other reports reported an average of 2.1 injuries per player over a season in basketball players from a league in southern Portugal: a lower average than our study (43). Crespo et al. on the other hand reported an average of injuries per player of 1.9, a figure also lower than that of the players of the team " Halcones de Xalapa" of the LNBP (40). Jover and Conesa reported an average injury per player of 2.3 (41). Meanwhile, Manonelles and Tárrera reported 1.5 injuries per player per season, a lower figure than found in our players (42). In this way, the average number of lesions, in our patients, is higher than the reported in the literature.

Fourth, 70% of injuries were first-time injuries and the remaining 30% were recurrent. This number of recurrent lesions is higher than that reported in other studies such as Chiao et al. where 19-22% of lesions have been reported to be recurrent (44). Roos et al. reported that 21.1% of anterior cruciate ligament injuries in basketball players were recurrent (45). Pasanen et al. that 28% of lesions were recurrent (46). In some types of injuries such as the ankle, recurrent injuries account for up to 60% as reported by Attenborough et al. (47).

Therefore, the recurrent injuries in the players of the "Halcones de Xalapa" team of the LNBP are similar to that reported in the literature.

Fifth, the segments most frequently affected were the lower limb, followed by the upper, which coincides with reports such as Minghelli et al. found that the most frequent lesions were of lower and upper extremities (43). Crespo et al. reported that 25.4% of the injuries were to the thigh, 20.6% to the ankle, and 14.3% to the leg, i.e., lower extremity injuries were more frequent (40). Manonelles et al. reported that lower limb injuries were the most frequent, followed by upper limb injuries (42). So the affected area in our patients is similar to that reported in the literature.

Sixth, the most common injuries were sprains, strains, tendinopathies, and tears accounting for about 80% of injuries. Which partially matches other reports like Minghelli and Cols. who found that tendinopathies, muscle injuries, and fractures accounted for 43.8%, 15.7%, and 10.7% of injuries, respectively (43). For their part, Crespo et al. found that the most common injuries among basketball players were sprains, contractures, and tears (40). For their part, Jover and Conesa reported that ankle, finger, and knee corners were the most common injuries in professional basketball players (41). Manonelles et al. found that ankle sprain and tendinitis were the most common musculoskeletal lesions (42). Which partially matches our findings.

Seventh, the average FMS score was 14.5 points out of a maximum of 21 points. Since the FMS usually uses a scale of 0 to 21 points, a score of 14.5 is within the moderate range, suggesting that players present competition in some movement patterns, but may also have areas of weakness or dysfunction that require attention and improvement. This score is lower than reported by Keil et al. who found an average score of 16.2 points and 17.1 points in high school basketball players (48). Another study by Hoover et al. reported average scores of 15.1 in professional basketball players (49). Therefore, the lower scores in the team players "Halcones de Xalapa" of the LNBP indicate a slightly greater dysfunction of movement and a higher risk of injury than that of players in the other reports in the literature, which could be related to our older players. When looking for factors associated with the FMS score, we only found that in people over 30 years old, the FMS correlated inversely with age with an r: -0.406, indicating that the older the FMS score is the greater the risk of injury. This finding coincides with previous reports such as Minghelli et al. who found that at older age is the incidence of musculoskeletal lesions (43). Mitchell et al. also found that FMS scores decreased as age increased (50). Similarly, Kuzuhara et al. reported that the FMS correlated with age in basketball players (51). Therefore, our findings are consistent with what is expected and reported in the literature.

Finally, we found no significant differences in the FMS score between players with and without injuries, nor association between these, and the FMS score did not predict the severity of musculoskeletal injuries. We only found a trend towards a higher number of lost matches and days off for injuries in players with lower FMS scores, thus demonstrating a potential utility of the FMS score for musculoskeletal injuries. However, more and larger studies are required to confirm or rule out the usefulness of the FMS score for predicting musculoskeletal injuries during the professional basketball season.

CONCLUSION

The incidence of musculoskeletal lesions was elevated throughout the 2023 season in the "Halcones de Xalapa" team of the LNBP compared to statistics from other leagues, this can be largely due to the lack of medical evaluations as part of a choice filter for players, who are hired without having a medical summary of origin, as well as the large number of games played in a short time that lasts the season.

Although the FMS score did not prove to be a determinant predictor of musculoskeletal lesions in this study, our study suggests its potential usefulness to identify players with a higher risk of more severe injuries, especially in individuals over 30. Further research with a larger sample size is required to confirm or rule out the usefulness of FMS in predicting injuries in professional basketball players.

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