




Injury rate in professional football: A systematic review

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DOI: <https://doi.org/10.34256/ijpefs2126>

Received: 03-05-2021, Revised: 28-05-2021; Accepted: 03-06-2021; Published: 06-06-2021



Abstract: The goal of this paper is to determine the injury frequency rate in professional football players in leagues and national competitions by analyzing existing papers. We have chosen 21 articles according to the PRISMA method from the Google Scholar, ResearchGate, Scopus, and Web of Science databases that fit both inclusion and exclusion criteria. We have discussed the following four segments based on the content of the selected papers: 1) An analysis of the injury frequency rate on the level of national teams, 2) An analysis of the injury frequency rate in club leagues, 3) A comparison of the injury frequency rate in matches and in practice, and 4) An analysis of the injury frequency rate in male versus female football players. The paper concludes that major national team tournaments have the highest injury frequency rate and that the probability of injury is four to five times higher in a match than in practice. The injury frequency rate in female players is lower than in male players regardless of the type of competition (national teams or leagues).

Keywords: Injuries in football, Injury frequency, Injury rate, Professional football players



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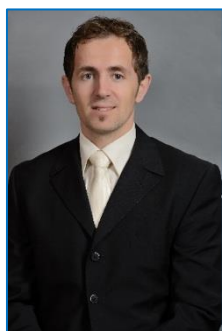
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1. Introduction

Football has been growing in popularity for decades, and it is higher than ever today, so it is rightfully called "the most important secondary thing in the world" [1, 2]. However, with the rise in popularity also came the increase in load on the players. Out of all the sports, football is the most common sport used as a recreational or professional activity [3]. According to its complexity, football fits in the category of complex sports, and its complexity is reflected in the requirements placed on male and female players in regards to the tactical, technical, and conditioning aspect. Football has been changing and developing for decades, and by extension, it has become increasingly physically demanding for the players [4, 5]. Modern players cover greater distances at a much higher pace during the match than ever before. As a result, the risk of injury in players has increased. The term "injury" is defined as any physical complaint in a player that has resulted from a football match or practice, regardless of the need for medical assistance or the time during which the player will not be able to perform football

activities [6]. A large number of injuries can directly impact the results of the team [7]. 82.9% of injuries in football players fall under the lower extremities, of which 68.5% are acute injuries, and the riskiest injuries in terms of missing time are knee injuries, while muscle and tendon injuries are the most common injuries of the lower extremities [8]. An interesting difference can be observed in Dutch football, where more injuries among amateurs occur in practice, while more injuries among professionals occur in matches [9]. A high degree of risk is present in professional [10], amateur [11], and youth [12] football. Strength and proprioception training have a significant influence on injury prevention in football [13-18], as do balance exercises, neuromuscular control, and posture control exercises [19]. Some of the most popular comprehensive prevention programs for football players are FIFA 11+ and HarmoKnee [20, 21]. The latest research has also shown that muscle injuries of the lower extremities are successfully prevented by additional eccentric strength exercises [22], and this type of exercise can also lead to an improvement in jumping ability and linear speed [23]. This type of training should be performed at the start of the week, given how eccentric exercises create ruptures in muscles, which can influence game performance [24]. Gender does not have a significant impact on injury prevention, even if anatomical differences between genders are the cause of different anatomical locations of injuries, as well as the specificity of injuries [25]. In general, the number of injuries in men and women is decreasing over time [26, 27].

The paper aims to analyze existing papers and determine the injury frequency rate in professional football players in leagues and national team competitions.

2. Methods

The paper is designed as a review according to the PRISMA method [28]. The following databases have been searched: Google Scholar, ResearchGate, Scopus, and Web of Science indexed journals. The following keywords have been used while searching for papers, „injuries in football,” „injury frequency in football,” and „epidemiology of injuries in football.” During the selection of the papers for analysis, only papers published in the last ten years (2010-2020) have been considered (21 total articles). Three criteria were used for the inclusion of papers: it is about football, it is about professional football players, and it discusses injury

frequency. The following exclusion criteria were used: amateur and youth football, not original papers, researching other aspects of injuries - not frequency, review articles.

3. Results and Discussion

Based on Figure 1, we can see that 21 papers have been used for results analysis (Table 1). All of them have fulfilled the inclusion criteria and were considered for the processing of results.

the injury frequency rate in male and female football players is the highest in major national team tournaments [29, 30, 32]. Multiple factors influence such a high number of injuries in national team competitions: fatigue based on studies by Gaulrapp [48] and Lehnert *et al.* [50]), quality of the field and of the officiating, especially in competitions in Africa based on studies by Akodu *et al.* [31], and the significance and the fatigue of players during those matches.

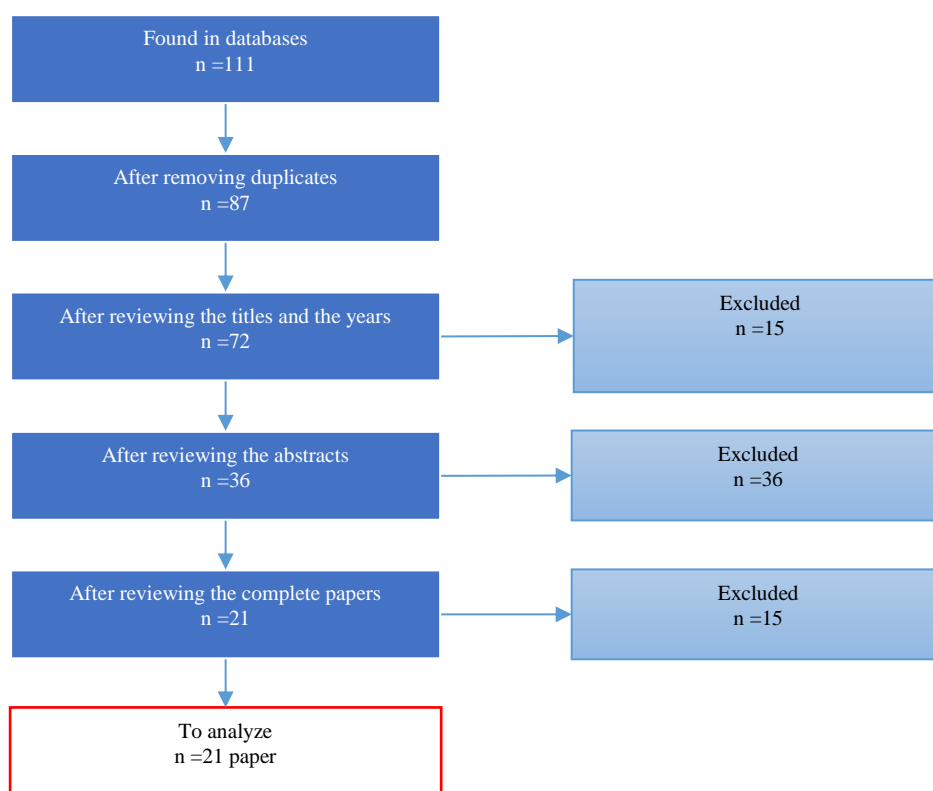


Figure 1 Study analysis

The papers have been published in various scientific magazines, and they can be found in indexed databases. By analyzing Table 2, we can conclude that the papers had similar goals, but they differ in the types of competitions and the countries where the competitions take place.

Injuries have been an integral and indispensable part of football since its inception, and they remain just that even today in modern football. They have a huge impact on team quality because they can knock players out of action for a longer or shorter period of time, depending on the severity of the injury, which directly affects the team's performance on the field and results [49]. By analyzing papers that have fulfilled the inclusion criteria, we have concluded that

A significantly lower number of injuries, as far as national team competitions go, was recorded in the 2016 European Championship in France [33]. On the other hand, club league competitions have a significantly lower injury frequency rate [34, 8, 47]. A somewhat higher injury frequency rate was recorded in the Italian Serie A [44].

This data is not surprising if we consider that this league has a decades-long reputation for being rougher than the rest and that the defensive aspect is a key part of the strategy. The importance of officiating in matches is once again highlighted as an important indicator of the frequency of injury.

Table 1 Basic information on the papers taken into account for the analysis of results

No	Title	Year	Authors	Journal
1	Injury surveillance in the world football tournaments 1998-2012	2013	Junge and Dvorak	British Journal of Sports Medicine
2	Epidemiological study on professional football injuries during the 2011 Copa America	2013	Pedrinelli <i>et al.</i>	Revista Brasileira de ortopedia
3	Incidence and characteristics of injuries during the 2011 West Africa Football Union (WAFU) Nations Cup	2012	Akodu <i>et al.</i>	African Journal of Medical and Health Sciences
4	Football injuries during the 2014 FIFA World Cup	2015	Junge and Dvorak	British Journal of Sports Medicine
5	Injury study report-EURO 2016 France	2016	Ekstrand	UEFA
6	Epidemiology of injury in English professional football players: a cohort study	2018	Jones <i>et al.</i>	Physical Therapy in Sport
7	Injuries in professional male soccer players in the Netherlands: a prospective cohort study	2015	Stubbe <i>et al.</i>	Journal of Athletic Training
8	Injury incidence of a Spanish elite female Soccer team during a competitive season: A case study	2014	Mallo	JMED Research
9	UEFA elite club injury study Season 2012/2013 report	2013	Ekstrand	UEFA
10	UEFA elite club injury study Season 2013/2014 report	2014	Ekstrand	UEFA
11	UEFA elite club injury study Season 2014/2015 report	2015	Ekstrand	UEFA
12	UEFA elite club injury study Season 2016/2017 report	2017	Ekstrand	UEDA
13	Injury profile of a professional soccer team in the premier league of Iran	2010	Hassabi <i>et al.</i>	Asian Journal of Sports Medicine
14	The incidence of injuries and exposure time of professional football club players in the Premier Soccer League during football season	2016	Calligeris <i>et al.</i>	South African Journal of Sports Medicine
15	Epidemiology of football injuries in Asia: A prospective study in Qatar	2012	Eirale <i>et al.</i>	Journal of Science and Medicine in Sport
16	Injuries in professional male football players in Kosovo: a descriptive epidemiological study	2016	Shalay <i>et al.</i>	BMC Musculoskeletal Disorders
17	Epidemiology of football(soccer) injuries in the 2012/2013 and 2013/2014 seasons of the Italian Serie A	2016	Falase <i>et al.</i>	Research in Sports Medicine: An International Journal
18	An examination of injuries in Spanish Professional Soccer League	2014	Salces <i>et al.</i>	The Journal of Sports Medicine and Physical Fitness
19	Incidence of injuries among professional football players in Spain during three consecutive seasons: A longitudinal, retrospective study	2019	Gijon-Nogueron <i>et al.</i>	Physical Therapy in Sport
20	Incidence of Injuries in French Professional Soccer Players	2011	Dauty and Collon	International Journal of Sports Medicine
21	Injuries in Women's Soccer: A 1-Year All Players Prospective Field Study of the Women's Bundesliga (German Premier League)	2010	Gaulrapp <i>et al.</i>	Clinical journal of sports medicine: official journal of the Canadian Academy of Sports Medicine

Table 2 A list of papers with their goals, results, and conclusions

No	Authors	The goal of the paper	Results	The conclusion of the paper
1	Junge and Dvorak, 2013 [29]	Analyzing the frequency, characteristics, and changes in injuries in football players in World Cups since 1998	A total of 3944 injuries have been reported in 1546 matches, which means 77.3 injuries in 1000 h of play, or 2.6 injuries per match. The frequency of injuries was lower in women's tournaments compared to men's.	The frequency of injuries in FIFA World Cups had a different trend between 1998 and 2002. The change could have been influenced by the style of play, officiating, and the scope and intensity of play. A strict application of the rules of the match is essential in injury prevention.
2	Pedrinelli <i>et al.</i> , 2013 [30]	To develop a study of injuries in male football players at the 2011 Copa America competition in Argentina	A total of 26 matches have been played over a period of 17 days. Twenty-three matches lasted for 90 minutes, and three have lasted for 120 minutes for a total of 2430 minutes. A total of 26 players were injured for a total of 63 injuries. The result is 2.4 injuries per match.	The vast majority of the results from this study are consistent with the data from other studies on football injuries. The largest number of injuries was related to the lower extremities, and the most common diagnosis was a muscle injury. Most of the injuries were of a milder degree of severity.
3	Akodu <i>et al.</i> , 2012 [31]	An estimate of the frequency and the characteristics of injuries during the 2011 WAFU Cup	Eighteen injury reports for nine matches have been completed and delivered to the research supervisor by physical therapists. Eighty-nine injuries (9.9 injuries per match) have been recorded, which means 289 injuries per 1000 hours of play.	The incidence of injuries during the WAFU Cup was much higher than ever documented in other tournaments, but the injury characteristics were similar. Additional records and analyses of injuries in African football players are needed to fully understand the nature of injuries and implement a prevention strategy in this part of the world.
4	Junge and Dvorak, 2015 [32]	An estimate of the frequency and the characteristics of injuries during the 2014 World Cup	A total of 104 injuries (1.68 per match) were recorded, i.e. 50.8 injuries per 1000 hours of play. Almost two-thirds of injuries were caused by contact. The most common were the injuries of the lower extremities (68%), followed by head/neck (19%), upper extremities (10%), and stomach (7%).	The overall injury rate decreased by 37% from 2002 to the 2014 FIFA World Cup. While the frequency of non-contact injuries has not changed significantly, injuries caused by contact or fouls have drastically decreased during that period. This may be the result of stricter officiating, as well as a better approach of the players towards fair play.
5	Ekstrand, 2016 [33]	To analyze the frequency and the types of injuries during the 2016 European Championship in France	Forty-six players have suffered a total of 49 injuries during the tournament. Thirty-nine injuries occurred during matches (80%), and ten injuries have occurred in practice (20%). The injury frequency in practice was 1.6 injuries/1000 h, and the injury frequency in matches was 22.6 injuries/1000 h.	A total of 8500 hours of player exposure was recorded during the tournament, approximately 6800 hours of practice (80%), and 1700 hours of matches, including overtime (20%). The largest number of injuries has been recorded in the group stage of the tournament, 24.1 injuries/1000 h of player exposure.
6	Jones <i>et al.</i> , 2018 [34]	To estimate the current frequency and location of injuries in English professional football	By following 243 players from 10 teams during the 2015/2016 season, a total of 473 injuries have been recorded. That equates to 9.11 injuries/1000 h of football activity. The injury frequency is higher during	The frequency of injuries is significantly higher in matches compared to practice. Also, in the last 16 years, there has been an increase in injuries, and muscle strains are the most common injury. The hamstring is the most commonly injured muscle group.

			matches (24.29/1000h) compared to practice (6.84/1000h)	
7	Stubbe <i>et al.</i> , 2015 [8]	To study the frequency and the characteristics of injuries in the Dutch premier football league	Two hundred and seventeen players from eight teams took part in the study. The exposure time was 46.194 hours. A total of 286 injuries were recorded. The total injury frequency was 6.2/1000 h. The injury frequency in practice was 2.8/1000 h and 32.8/1000 h in matches	The risk of injury in the Dutch Football League is high, especially during matches. Preventive measures should focus on the most common diagnoses, i.e., the injuries of muscles and tendons of the lower extremities.
8	Mallo, 2014 [35]	To study the frequency and characteristics of injuries in elite Spanish female football players during a single competitive season	A total of 39 injuries were recorded during 7695 hours of exposure. The total injury frequency is 5.1/1000 h. The injury frequency in practice is 3.9/1000 h, and it is 14.4/1000 h	This study has shown the frequency and characteristics of injuries of elite Spanish female football players during one competitive season. The highest risk of injury was recorded at the beginning and the end of the season. Injuries to the joint, knee, and thigh were most commonly reported.
9	Ekstrand, 2013 [36]	The goal is to analyze the frequency of injuries in elite European clubs in the 2012/2013 season	The injury frequency was 3.4/1000 h in practice, and it was 22/1000 h in matches	The exposure of players during this season was 139.939 h (84% practice - 117.578 h, 16% matches - 22.361 h). The injury frequency in matches was almost seven times higher than in practice.
10	Ekstrand, 2014 [37]	The goal is to analyze the frequency of injuries in elite European clubs in the 2013/2014 season	The injury frequency was 3.4/1000 h in practice, and it was 23.2/1000 h in matches.	The exposure of players during this season was 200.000 h (85% practice - 170.000 h, 15% matches - 30.000 h). The injury frequency in practice has remained consistent, while it has increased in matches.
11	Ekstrand, 2015 [38]	The goal is to analyze the frequency of injuries in elite European clubs in the 2014/2015 season	The injury frequency was 2.7/1000 h in practice, and it was 20.5/1000 h in matches.	The exposure of players during this season was 175.000 h (86% practice - 150.000 h, 14% matches - 25.000 h). There was a decrease in injury frequency this season, both in practice and in matches.
12	Ekstrand, 2017 [39]	The goal is to analyze the frequency of injuries in elite European clubs in the 2016/2017 season	The injury frequency was 2.3/1000 h in practice, and it was 19.8/1000 h in matches.	The exposure of players during this season was 170.000 h (85% practice - 145.000 h, 15% matches - 25.000 h). The trend of injury frequency decrease has continued from the season prior.
13	Hassabi <i>et al.</i> , 2010 [40]	The goal of the paper is to determine the frequency of physical injuries in football players in the Iranian league	The players in this study were exposed to 2352 playing hours in practice and 258 playing hours in matches. Forty-three acute injuries were recorded with a total frequency of 16.5/1000 h. The injury frequency was 11.5/1000 h in practice and 62/1000 h in matches.	Data on the frequency of injuries in this paper is within the numbers recorded in international tournaments, but the number of injuries during practice is higher than in other studies. So it can be concluded that it is a priority to find methods to reduce injuries in practice.
14	Calligeris <i>et al.</i> , 2016 [41]	To calculate the injury frequency and time of exposure of players from a South African league team during one entire season	The total injury frequency was 14.4/1000 h. The number was lower in practice (6.6/1000 h) than in matches (88.9/1000 h). The nature of the injuries varies.	The importance of estimating injury frequency and exposure of players playing in a club must not be disregarded. It is necessary to promote a better understanding of risk factors, injury exposure, and

			The thighs and the ankles were most frequently injured.	injury mechanisms of South African football players.
15	Eirale <i>et al.</i> , 2012 [42]	The goal is to study the frequency, characteristics, and patterns of injuries on the club level in Qatar	A total of 217 injuries have been recorded, a frequency of 6/1000 h. One hundred thirty-three injuries have been recorded in practice and 85 in matches. The injury frequency is 4.4/1000 h in practice, and 14.5/1000 h in matches.	This research in a professional football club in Asia shows relatively high injury rates and a high rate of thigh muscle injuries. This study, when compared to European studies, shows that there are no regional specifics in football injuries in this part of Asia.
16	Shalay <i>et al.</i> , 2016 [43]	The goal is to record the frequency, types, and severity of injuries in football players in Kosovo	A total sample of 143 players had an exposure of 36.833 h. A total of 272 injuries were recorded. The total injury frequency rate was 7.38/1000 h - 35.37/1000 h in matches and 3.16/1000 h in practice.	The overall injury frequency among football players in Kosovo is slightly below the European league average. This may be because players from Kosovo participate in fewer matches than teams that play internationally. As with other research on injuries in football, this one has also shown that the frequency of injuries in matches is ten times higher than in practice.
17	Falase <i>et al.</i> , 2016 [44]	The goal is to describe the epidemiology of football injuries in the 2012/2013 and 2013/2014 seasons of Italian Serie A	There were 363 total injuries during the two seasons. The number of players who suffered at least one injury was 286. The most common injuries were to the lower extremities. The total injury frequency rate was 15.2/1000 h. The injury frequency rate has increased with the age of the players.	Epidemiological studies on the occurrence of injuries are crucial to highlight the risk factors for injury and for guiding coaches towards better programming of their activities. Our study found that the largest number of injuries were thigh and knee injuries, and that they occurred at the beginning of the season. Injury prevention strategies should be implemented at the beginning of the season to reduce the risk of injury.
18	Salces <i>et al.</i> , 2014 [45]	The goal of the study was to study the frequency of injuries in the Spanish professional football league and analyze the differences between practice and matches	Eight hundred thirty-one total injuries were recorded among 301 analyzed players. The exposure time was 161.602 h. The injury frequency rate was 38.8/1000 h in matches and 3.8/1000 h in practice.	Our analyses indicate that Spanish footballers are more susceptible to injuries in matches compared to practice. The results also show that the frequency of injuries in practice decreases during the season and that it increases in matches. Strategies such as designing individual training programs, rotating football players, and optimizing recovery protocols can help reduce the high frequency of injuries.
19	Gijon-Nogueron <i>et al.</i> , 2019 [46]	The goal is to identify risk factors that may be associated with a higher frequency of injuries among elite football players in Spain over a period of three years.	The team was tracked for 18 seasons, and 71 players have fulfilled the criteria of playing for at least three seasons. Three hundred fifty-six total injuries were recorded. The injury frequency rate was 6.9/1000 h in matches and 0.23/1000 h in practice.	Our results show differences in the frequency and severity of injuries depending on the position of the players, where attackers have the highest injury rate. The thigh is the most common location of the injury, and the muscle tissue is most commonly injured. Exposure time is inversely proportional to the total number of injuries in practice.
20	Dauty and Collon, 2011 [47]	The goal was to investigate the frequency of injuries in	Nine hundred three injuries in 173 professional players	In professional football players, the injury frequency rate did not vary significantly over the 15-season

		French football players over a period of 15 seasons	were recorded over 15 seasons. The total injury rate was 4.7/1000 h. The injury frequency rate has doubled over 15 years.	period, except for the muscle injury rate, which grew from season to season regardless of player position, the number of matches played in Europe, or the final position in the French national championship.
21	Gaulrapp <i>et al.</i> , 2010 [48]	To get precise information on injuries in the German women's football league	Two hundred fifty-four female football players took part in the study. The total exposure time was 75.438 h. One hundred forty-four players suffered injuries. The total injury frequency rate was 3.3/1000 h. The injury rate was 18.5/1000 h in matches and 1.4/1000 h in practice.	In women's elite football, one injury per year per player is to be expected. Matches are eight times riskier than practice. The players suffer a large number of head injuries and serious injuries to their knees and joints. The most common individual injury is a sprained joint. The most common injury that requires a long recovery is a torn ligament of the joints and knees. Almost a quarter of all injuries consist of fatigue syndrome.

A higher rate of injuries in club competition is noticeable in leagues outside of Europe, in the South African Republic [41], and in Iran [40]. In this case, one previously mentioned cause of injury is confirmed, and that is infrastructure, but the financial power of clubs in those countries is also connected given how the budgets and investments of European clubs are by far the highest in the world [51]. A lower injury rate, compared to men, was determined in women's leagues [48, 35]. This occurrence can be explained by anatomical and structural differences between men and women, but also differences in the volume and intensity of work, which is stated in the research by Ristolainen *et al.*, [25]. Still, just because of the anatomical difference, women have a two to three times higher risk of an ACL injury [52].

In all studies, many times more injuries occurred in matches compared to injuries that occurred in practice [8, 33-43, 45-48]. What is very important in the analysis of these papers is that they were done on a different sample and in different parts of the world, so the results can be generalized. One of the biggest causes of the difference in the rates of injury in matches and practice is the level of intensity that is applied. Practice usually has a lower intensity, recovery practice with players from the same team, so there's a much higher level of fair play. Also, in the period of a dense schedule when players play 6-7 matches in 20 days, load distribution in practice is considered a prevention factor, as is the application of post-practice recovery methods (cold and hot water) [53]. In the

study by Rechel *et al.*, they recommended that protective equipment (shin pads) be used both in matches and in practice [54]. Unlike practice, matches have a much higher intensity, tempo, and charge. Players have much more motivation, they give their all and enter duels without compromise. All of that increases the risk of injury, and when you add a dense schedule of matches that players are commonly exposed to, this piece of data on the difference in injury frequency in matches and in practice becomes much clearer. It is recommended to pay attention to risky muscle regions in warm-up [54], because warm-up is also considered a prevention strategy [55], given that it has been proven that specific warm-up and cooling lower the probability of injury, especially in players with an unstable ankle [56]. What is also significant for injury prevention is the implementation of a targeted prevention program [45], given how implementing a prevention program just twice a week during the season (58 prevention practices) leads to a significant decrease in the probability of injury [57]. In general, during the preparation period, more attention should be paid to knee and ankle proprioception, eccentric strength exercises, stabilization, and stretching, while attention during the competitive period should be paid to the prevention of muscle strains through a specific team preventive program [58].

Another factor that affects injury frequency that was isolated from the analyzed scientific papers is player age, i.e. the fact that older players are more prone to injuries [44]. This piece of information points

to a necessity for volume individualization of load for older players.

A suggestion for future studies is a comparison of load in practice and in matches, and to study the significance of applying situational (integral) practice as a means of injury prevention.

4. Conclusion

Investigating the injury frequency is a complex and extensive process, but also a very important indicator in modern football. Its importance is reflected in the fact that these results show in which direction further research should go in terms of creating strategies for injury prevention. The highest injury rate was recorded in national team tournaments. Factors that affect such results are the timing of the national team tournaments, the number of matches, the infrastructure, and the officiating criteria. Unlike the national team level, the injury frequency rate in club league competitions is lower but varies depending on the quality of the league, the level of infrastructure, and the financial capabilities of the clubs. Because of the aforementioned reasons, the injury rate in elite European leagues is much lower compared to leagues in countries outside Europe, i.e. in countries where less money is invested in football. The results of these studies have shown that the style of play practiced can also affect the injury rate regardless of the conditions. An example of this is the Italian Serie A, which has a higher injury rate than other top European leagues but does not lag behind those leagues in terms of organization and infrastructure. Injuries in matches are 4 to 5 times more common in all studies compared to injuries that occurred in the training process, which is a result of work intensity, as one of the significant injury factors. Also, age significantly affects the risk of injury, where older players have a higher chance of injury.

According to the above, it is necessary to implement preventive strength and balance training. Also, the organization of matches and paying attention to the number of days between matches is very important and creating a practice environment that will be close to the ambiance and the intensity of the match, so that players create adaptation, thereby significantly reducing the risk of injury in matches. All the above conclusions are based on the results of the analyzed studies, but a detailed scientific analysis of each one is necessary for their concretization, which is a recommendation for future research.

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Funding

No funding was received to carry out this study.

Ethics approval

This study was approved by Institutional ethics committee.

Authors Contribution

All the authors equally contributed to this work and approved of the final version of this manuscript.

Does this article screened for similarity?

Yes.

Conflict of interest

The authors have no conflicts of interest to declare that they are relevant to the content of this article.

Informed consent

Written consent was obtained from the participants.

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