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**Research Article / Araştırma Makalesi**

# Incidence of sports injuries and their association with training characteristics of football referees in Türkiye

## *Türkiye'de futbol hakemlerinde spor yaralanmaları insidansı ve antrenman özellikleri ile ilişkisi*

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**ABSTRACT**

**Objective:** There is an abundant number of studies that investigated injuries of football players. However, injuries of football referees remains under-researched. This cohort study aims to determine the sports injuries of Turkish football referees and also to investigate the relationship between the injury and demographic characteristics and the referees'training patterns.

**Materials and Methods:** At the onset of the season, a questionnaire involving personal characteristics, training content, and injury characteristics was administered to the referees. Then, the referees kept injury diaries throughout the season. Injury logs were analyzed at the end of the season.

**Results:** From 335 referees who were approached, a total of 286 completed the study. During the 2018-2019 football season, 134 injuries were reported from 94 (32.9%) referees, with more injuries during training than matches (n=114 vs 20; 85.1% vs 14.9%). Injuries were classified as acute injuries (n=36; 26.9%) and chronic/overuse injuries (n=86; 64.2%), while 12 (9%) injuries did not receive any clinical diagnosis. The most common injured body part was the lower leg (n=40, 29.9%). A significant difference was found between injured and non-injured referees for their ages, years of refereeing, the leagues they refereed, and the intensity of running training. Logistic regression analysis revealed that age groups affected the injury status with a variance of 12.4% with an odds ratio of 70.3% and %95 CI. The risk of injury for the referees in the 22-25 age group was 73% lower than those in the 30-year-old age group.

**Conclusions:** Our findings present the demographic profile and training characteristics of Turkish referees, and highlights the possible role of age, league level, years of refereeing and training planning in injury prevention.

**Keywords:** *Football, referee, injury, incidence, training*

**ÖZ**

**Amaç:** Futbolcuların yaralanmalarını araştıran çok sayıda çalışma bulunmaktadır. Ancak, futbol hakemlerinin yaralanmaları yeterince araştırılmamıştır. Bu kohort çalışması, Türk futbol hakemlerinin spor yaralanmalarını belirlemeyi ve ayrıca yaralanma özellikleri, tanımlayıcı özellikleri ve hakemlerin antrenman özellikleri arasındaki ilişkiyi araştırmayı amaçlamaktadır.

**Gereç ve Yöntem:** Hakemlere sezon başlangıcında kişisel özellikler, antrenman içeriği ve yaralanma özelliklerini sorgulayan bir anket uygulandı. Ardından hakemler sezon boyunca yaralanma günlükleri tuttular. Sezon sonunda yaralanma kayıtları analiz edildi.

**Bulgular:** Ulaşılan 335 hakemden toplam 286'sı çalışmayı tamamladı. 2018-2019 futbol sezonu boyunca 94 (%32.9) hakemde 134 yaralanma rapor edildi ve antrenman sırasında maçlardan daha fazla yaralanma oldu (n=114'e 20; %85.1'e %14.9). Yaralanmalar akut yaralanmalar (n=36; %26.9) ve kronik/aşırı kullanım yaralanmaları (n=86; %64.2) olarak sınıflandırılırken, 12 (%9) yaralanmaya herhangi bir klinik tanı konmadı. En sık yaralanan vücut bölgesi alt bacaktı (n=40, %29.9). Yaralanan ve yaralanmayan hakemler arasında yaşlarına, kaç yıldır hakemlik yaptıklarına, hakemlik yaptıkları liglere ve koşu antrenmanlarının yoğunluğuna göre anlamlı farklılık bulundu. Lojistik regresyon analizi, yaş gruplarının yaralanma durumunu %12.4 varyans ve %70.3 doğrulukla etkilediğini ortaya koydu. Yaralanma riski 22-25 yaş grubu hakemlerde 30 yaş grubuna göre %73.0 daha azdı.

**Sonuçlar:** Bulgularımız, Türk hakemlerin demografik profilini ve eğitim özelliklerini sunmakta ve kişisel özelliklerin ve eğitim planlamasının yaralanmayı önlemedeki olası rolünü vurgulamaktadır.

**Anahtar Sözcükler:** *Futbol, hakem, yaralanma, insidans, antrenman*

## INTRODUCTION

Football is considered to be one of the most popular sports worldwide (1). As such, football has its own special place in many societies and affects daily life. Football referees, also referred as "the 23rd man" in a football match, cover longer distances (2) in controlling the application of game rules and regulations with two assistant referees, and at least one side-line assistant referee (fourth referee), are most important and inseparable parts of the game. Referees have

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protective effects on players' injuries and maintain order during matches (3).

A comprehensive study by FIFA reported that there were more than 800.000 registered referees worldwide (4). However, in the literature, an abundant number of studies have investigated football injuries of the 22 players, but despite their important protective roles on injuries, there are very few publications on referees, which has remained under-researched. Although players and referees share the same pitch during the match, they have different physical characteristics, demands and movement patterns. Such that, referees are older than players, mainly do refereeing as a part-time job, do not have contact with other players or play with the ball, and are not substituted unless having a major injury (1,5). Additionally, given that referees do not have home games or get fan support like players (actually, they mostly hear complaints about their decisions), they are exposed not only to physical but also mental stress (6).

These high-performance demands and physical or mental stress factors may increase injury risk for the referees. Injury data from the 2006 FIFA World Cup in Germany revealed that 22% of the referees had an injury with the incidence of 20.8 injuries per 1000 match hours (7). While during the same event, players had an injury incidence of 68.7 per 1000 match hours. Considering that at least 22 players but only four referees participate in a football match, these results highlight the high incidence of injuries in referees, and display the significance of investigating these injuries.

Most previous studies only reported incidences of referees' injuries. However, identifying related risk factors is also required to provide information when planning prevention programs or in reducing the burden of injuries (8). When evaluating possible risk factors of injury, physiological aspects of refereeing performance would provide information. Unlike being common in players, contact injuries are less likely to occur in referees as they are not physically challenged by the opponents with tackles or jumps for headers (9).

Additionally, during a match, referees should follow players' actions closely, and be in the right place at the right time to observe and decide in critical positions (9). Moreover, they have to stay active during the 90 minutes, and only with short rest periods. Therefore, referees are expected to undergo overuse injuries more commonly than acute traumatic injuries (5). These physical aspects of refereeing make training sessions critical in meeting performance demands. Given that both high or low training loads have been associated with increased injuries (10), evaluating training loads, and their contents also will provide information for injury risks of referees. Therefore, we aimed to determine the incidence and pattern of injuries in football referees and determine factors associated with injuries such as socio-demographics and training routine.

## MATERIAL and METHODS

### Study Design and Setting

This study was designed as a prospective cohort study. To conduct it, consent was obtained from the Turkish National Football Federation and Central Referee Committee. When referees applied to sports medicine clinics for physical examination to obtain participation licensea, they were informed about the aims of this study, and asked for their consent for volunteer participation. Afterwards, participants were presented with questionnaire forms and asked personally to fill them in. During the season, participants kept injury diaries individually to report their injuries during matches and training sessions. Injury diaries were collected from the participants at the referee seminar at the end of the 2018-2019 season. Ethical approval was provided from the University's Clinical Research Ethics Committee.

Injury definition: Any physical complaint sustained by a player that results from a football match or training, irrespective of the need for medical attention or time loss from football activities (11). Reinjury definition: An injury of the same type and location of a previous injury that occurred within two months of the final rehabilitation day of the previous injury (12).

### Participants

There were 383 referees active in the city where the study was conducted (Izmir, Turkey). A total of 335 licensed referees active in the 2018-2019 football season volunteered to participate in this study. Eighteen participants were excluded from the present study (Thirteen participants were female, and five had chronic diseases). Referees were from Super League, First League, Second League, Third League and Regional Amateur Leagues in Turkey. None of the participants were full-time referees. All referees successfully passed the same physical fitness tests to be licensed and eligible to officiate a match in the 2018-19 season.

### Data Collection Tools

All participants completed a questionnaire in Turkish, their main language. The questionnaire had subdivisions as three sections: characteristics (age, part-time/full-time refereeing, experience in refereeing, professional/amateur league level, match/assistant referee), training status (frequency and duration of exercise sessions, warm-up routine, days spent for aerobic/strength training per week, rest days per week, preferred surface, running duration, how they determine training loads and running intensity), and injury cha-

ining injuries, personal thoughts on the reason for the injury, getting physical therapy/drug or no treatment, duration of the injury). According to the method they prefer to determine running intensity in their training programs, referees were categorized into two groups as i) referees using ratios of their calculated maximum heart rates, and ii) referees who modified their own running pace according to their target time to finish a certain distance. In injury diaries, referees self-reported their injury characteristics with the same subsections in the questionnaire. Injury data collection was conducted byline with previous definitions by FIFA (11) and UEFA (12).

### Statistical Analysis

Statistical Package for Social Sciences (SPSS) v25.0 software was used for statistical analysis of data. Pearson chi-square test was used to compare injury status of the referees based on their socio-demographic and training characteristics. Mann-Whitney U test was used to compare anthropometric measurements and training numbers of the referees according to injury status, since the data set did not reveal normal distribution. Logistic regression analysis was conducted to determine factors impacting injury status of the referees. The significance level was set a priori at $p<0.05$ for all analyses.

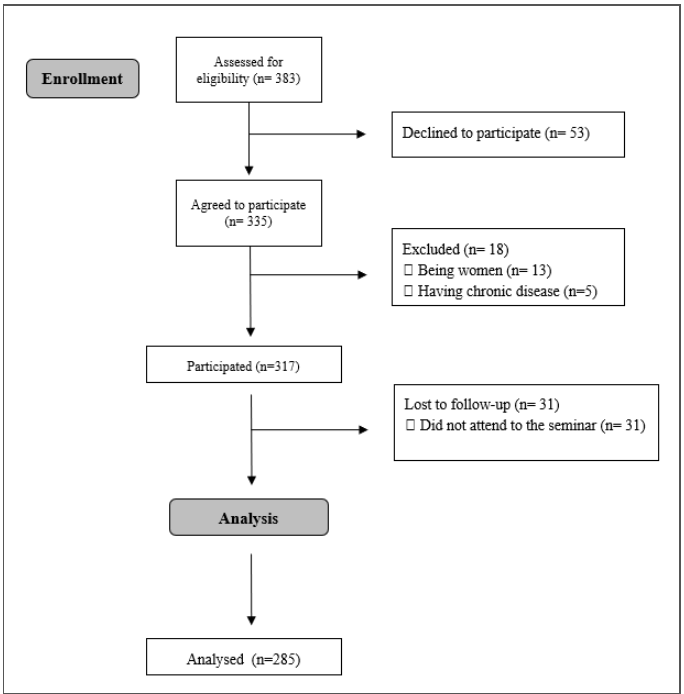


**Figure 1.** Flow diagram

## RESULTS

A total of 286 out of 317 referees (90.2%) completed this study. The flow diagram of the study is presented in Figure 1. Descriptive and training characteristics of the referees included in the present study are presented in Table 1.

**Table 1.** Descriptive and training characteristics of the referees

| Parameter | n | % |
|---|---|---|
| **Age** (Mean 24.9±6.1 yrs) | | |
| 18-21 yrs | 95 | 33.2 |
| 22-25 yrs | 97 | 33.9 |
| 26-29 yrs | 44 | 15.4 |
| ≥30 yrs | 50 | 17.5 |
| **Number of matches during the 2018-19 football season** (16.6±5.6) | | |
| **Experience in refereeing** | | |
| 0 to 3 yrs | 160 | 55.9 |
| 3 to 6 yrs | 49 | 17.1 |
| 6 to 9 yrs | 26 | 9.1 |
| 9 to 12 yrs | 15 | 5.3 |
| 12 to 15 yrs | 12 | 4.2 |
| ≥15 yrs | 24 | 8.4 |
| **League level** | | |
| Professional | 32 | 11.2 |
| Amateur | 254 | 88.8 |
| **Refereeing position** | | |
| Match referee | 132 | 46.1 |
| Assistant referee | 110 | 38.5 |
| Both | 44 | 15.4 |
| **Training routines** | | |
| Endurance training only | 52 | 18.2 |
| Resistance training only | 6 | 2.1 |
| Both | 228 | 79.7 |
| **Training duration** | | |
| 30 to 60 min | 120 | 42.0 |
| 60 to 90 min | 151 | 52.8 |
| 90 to 120 min | 15 | 5.2 |
| **Running surface** | | |
| Treadmill | 7 | 2.4 |
| Asphalt/concrete | 6 | 2.1 |
| Tartan | 133 | 46.5 |
| Grass | 12 | 4.2 |
| Soil | 4 | 1.4 |
| Artificial turf | 6 | 2.1 |
| Multiple surfaces | 118 | 41.3 |
| **Running duration** | | |
| 30 min and below | 22 | 7.7 |
| 30 to 60 min | 179 | 62.6 |
| 60 to 90 min | 85 | 29.7 |
| **Running intensity** | | |
| Ratio of maxHR | 76 | 26.6 |
| Time to complete a certain distance | 210 | 73.4 |
| **Total** | 286 | 100.0 |

A total of 134 injuries were reported from 94 (32.9%) referees with an incidence rate of 2.81 injuries/1000 hours of match exposure, and 1.46 injuries/1000 hours of training. Sixty six (70.2%) referees reported a single injury, while 28 (29.8%) referees reported two or more injuries. A total of 86 (64.2%) injuries were classified as chronic/overuse injuries, 36 (26.9%) injuries as acute injuries, while 12 (9.0%) injuries did not receive any clinical diagnosis. Injury characteristics of referees are presented in Table 2, injury diagnoses based on their refereeing types are presented in Table 3, and as based on age groups in Table 4.

**Table 2.** Injury characteristics of the referees

| Feature | n | % | Feature | n | % |
|---|---|---|---|---|---|
| **Injured body part*** | | | **Match/training injuries** | | |
| Lower leg | 40 | 30.0 | Match | 14 | 14.9 |
| Ankle | 24 | 17.9 | Training | 80 | 85.1 |
| Knee | 18 | 13.5 | **Personal thoughts on the reason for the injury** | | |
| Thigh | 10 | 7.5 | Overloading | 16 | 17.0 |
| Groin | 9 | 6.7 | Improper posture | 9 | 9.6 |
| Foot | 7 | 5.2 | Fatigue | 28 | 29.8 |
| Shoulder | 5 | 3.7 | Trainer related | 2 | 2.1 |
| Neck | 4 | 3.0 | Reinjury | 8 | 8.5 |
| Hip | 3 | 2.2 | Other | 17 | 18.1 |
| Fingers | 3 | 2.2 | Multiple reasons | 14 | 14.9 |
| Lower back | 3 | 2.2 | **Reinjury** | | |
| Elbow | 2 | 1.5 | Yes | 16 | 17.0 |
| Wrist | 2 | 1.5 | No | 78 | 83.0 |
| Toes | 2 | 1.5 | **Received treatment** | | |
| Back | 1 | 0.7 | Yes (physical therapy and/or drugs) | 36 | 38.3 |
| Hand | 1 | 0.7 | No treatment | 58 | 61.7 |
| **Injury occurrence** | | | **Duration of injury** | | |
| Cannot remember | 10 | 10.6 | 1 to 3 days | 9 | 9.6 |
| Refereeing | 14 | 14.9 | 4 to 7 days | 37 | 39.4 |
| Warm-up | 2 | 2.1 | 8 to 28 days | 19 | 20.2 |
| Cool-down | 1 | 1.1 | >28 days | 29 | 30.8 |
| Resistance training | 8 | 8.5 | | | |
| Endurance training | 59 | 62.8 | | | |

**Table 3.** Injury diagnoses based on refereeing types, by occurrence and rate

| **Diagnosis** (n=122) | **Match refs** (n=67) | | **Assistant refs** (n=38) | | **Both types** (n=17) | |
|---|---|---|---|---|---|---|
| | **n** | **%** | **n** | **%** | **n** | **%** |
| Meniscus injury | 5 | 7.5 | 1 | 2.6 | 0 | - |
| Achilles tendinopathy | 7 | 10.5 | 4 | 10.6 | 3 | 17.6 |
| Gastrocnemius strain | 5 | 7.5 | 1 | 2.6 | 0 | - |
| Groin strain | 6 | 9.0 | 1 | 2.6 | 0 | - |
| Nonspecific pain | 15 | 22.5 | 15 | 39.5 | 6 | 35.3 |
| Knee ligament sprain | 0 | - | 1 | 2.6 | 0 | - |
| Nerve entrapment | 1 | 1.5 | 0 | - | 0 | - |
| Shoulder dislocation | 1 | 1.5 | 0 | - | 0 | - |
| Rotator cuff injury | 4 | 6.0 | 0 | - | 1 | 5.9 |
| Thigh strain | 6 | 7.5 | 3 | 7.9 | 0 | - |
| Medial tibial stress syndrome | 9 | 13.5 | 6 | 15.8 | 2 | 11.8 |
| Anterior cruciate ligament tear | 0 | - | 1 | 2.6 | 0 | - |
| Ankle sprain | 5 | 7.5 | 4 | 10.6 | 4 | 23.5 |
| Lumbar discopathy | 1 | 1.5 | 0 | - | 0 | - |
| Iliotibial band syndrome | 2 | 3.0 | 1 | 2.6 | 1 | 5.9 |

**Table 4.** Injury diagnoses based on age groups, by occurrence and rate

| | **18 to 21 yrs** | | **22 to 25 yrs** | | **26 to 29 yrs** | | **≥30 yrs** | |
|---|---|---|---|---|---|---|---|---|
| **Diagnosis** (n=122) | **n** | **%** | **n** | **%** | **n** | **%** | **n** | **%** |
| Meniscus injury | 2 | 4.3 | 3 | 11.5 | 0 | 0 | 1 | 3.3 |
| Groin strain | 2 | 4.3 | 1 | 3.9 | 1 | 5.3 | 3 | 10.0 |
| Nonspecific pain | 17 | 36.1 | 7 | 26.8 | 4 | 21.1 | 8 | 26.7 |
| Knee ligament sprain | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3.3 |
| Nerve entrapment | 1 | 2.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Shoulder dislocation | 0 | 0 | 1 | 3.9 | 0 | 0 | 0 | 0 |
| Rotator cuff injury | 4 | 8.5 | 0 | 0 | 1 | 5.3 | 0 | 0 |
| Achilles tendinopathy | 4 | 8.5 | 3 | 11.5 | 3 | 15.7 | 4 | 13.3 |
| Thigh strain | 1 | 2.1 | 0 | 0 | 3 | 15.7 | 5 | 16.8 |
| Gastrocnemius strain | 1 | 2.1 | 1 | 3.9 | 0 | 0 | 4 | 13.3 |
| MTSS | 6 | 12.8 | 5 | 19.2 | 4 | 21.1 | 2 | 6.7 |
| ACL tear | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3.3 |
| Ankle sprain | 7 | 14.9 | 3 | 11.5 | 2 | 10.5 | 1 | 3.3 |
| Lumbar discopathy | 0 | 0 | 1 | 3.9 | 0 | 0 | 0 | 0 |
| Iliotibial band syndrome | 2 | 4.3 | 1 | 3.9 | 1 | 5.3 | 0 | 0 |

MTSS: medial tibial stress syndrome

The comparison of injury status of the referees based on their descriptive characteristics is given in Table 5. Accordingly, a significant difference was determined between the injury status of the referees concerning their age (p=0.025), the duration of refereeing (p=0.011), the league they refereed (p=0.003), and the way of determining the running intensity (p=0.045). There were no significant differences between the referees concerning injury status, for height (p=0.943) and body weight (0.201), BMI values (p=0.198)

from the anthropometric measurements, and the type of refereeing (p= 0.094) from the descriptive characteristics.

The comparison of the referees regarding their training characteristics is also displayed in Table 5. The injury rate of those who regulated their running training intensity according to the maximal heart rate in accordance with age was higher than those who determined running training intensity according to the time to finish a certain distance (p=0.045). No significant differences were determined between the injury rates of other training characteristics variables (p>0.05).

**Table 5.** The comparison of the injury status of the referees based on their descriptive characteristics

| | Non-injured | | | Injured | | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameters** | **n** | **x̄** | **s** | **n** | **x̄** | **s** | **Z** | **p** |
| **Height** (cm)[a] | 192 | 180.3 | 5.3 | 94 | 180.4 | 5.2 | -0.072 | 0.943 |
| **Weight** (kg)[a] | 192 | 73.4 | 7.7 | 94 | 74.5 | 6.4 | -1.280 | 0.201 |
| **BMI** (kg/m²)[a] | 192 | 22.6 | 2.0 | 94 | 22.9 | 1.9 | -1.287 | 0.198 |
| **Training sessions in a week** (days)[a] | 192 | 4.0 | 1.4 | 94 | 4.0 | 1.4 | -0.843 | 0.399 |
| **Endurance training sessions/wk** (days)[a] | 192 | 2.7 | 1.0 | 94 | 2.7 | 1.0 | -0.742 | 0.458 |
| **Resistance training sessions/wk** (days)[a] | 192 | 1.4 | 1.0 | 94 | 1.4 | 0.9 | -0.344 | 0.731 |
| **Rest days in a week** | 192 | 3.0 | 1.4 | 94 | 3.0 | 1.4 | -0.843 | 0.399 |
| | **n** | **%** | | **n** | **%** | | **X²** | **p** |
| **Age** [b] | | | | | | | | |
| 18 to 21 yrs | 61 | 64.2 | | 34 | 35.8 | | 9.372 | 0.025* |
| 22 to 25 yrs | 76 | 78.4 | | 21 | 21.6 | | | |
| 26 to 29 yrs | 27 | 61.4 | | 17 | 38.6 | | | |
| ≥30 yrs | 28 | 56.0 | | 22 | 44.0 | | | |
| **Experience in refereeing** [b] | | | | | | | | |
| 0 to 3 yrs | 112 | 70.0 | | 48 | 30.0 | | 14.749 | 0.011* |
| 3 to 6 yrs | 30 | 61.2 | | 19 | 38.8 | | | |
| 6 to 9 yrs | 22 | 84.6 | | 4 | 15.4 | | | |
| 9 to 12 yrs | 12 | 80.0 | | 3 | 20.0 | | | |
| 12 to 15 yrs | 6 | 50.0 | | 6 | 50.0 | | | |
| ≥15 yrs | 10 | 41.7 | | 14 | 58.3 | | | |
| **League level** [b] | | | | | | | | |
| Professional | 14 | 43.8 | | 18 | 56.2 | | 8.929 | 0.003* |
| Amateur | 178 | 70.1 | | 76 | 29.9 | | | |
| **Refereeing position** [b] | | | | | | | | |
| Match referee | 80 | 60.6 | | 52 | 39.4 | | 4.733 | 0.094 |
| Assistant referee | 80 | 72.7 | | 30 | 27.3 | | | |
| Both | 32 | 72.7 | | 12 | 27.3 | | | |
| **Running intensity** [b] | | | | | | | | |
| Ratio of maxHR | 44 | 57.9 | | 32 | 42.1 | | 4.003 | 0.045* |
| Time to complete a certain distance | 148 | 70.5 | | 62 | 29.5 | | | |

*: p<0.05; [a]: analyzed with Mann-Whitney U test; [b]: analyzed with Pearson Chi square test

The results of the logistic regression analysis regarding the determination of the factors impacting the injury status of the referees are presented in Table 6. The variance explained by the model was 12.4%, and the accuracy of the prediction was 70.3%. It was found that the age groups of the referees impacted the injury status (p<0.05). The risk of injury for the referees in the 22-25 age group was 73.0% lower than those in the 30-year-old age group. The referees' duration of refereeing, the league they refereed, and the way of determining the running intensity did not impact the risk of injury (p>0.05).

## DISCUSSION

The incidence of match injuries detected in our study, which was 2.81/1000 h of match, was consistent with that of Bizzini et al., who investigated similar level referees (2.06/1000 h of match) (13). It was lower than the referees (6.8/1000 h) in the study of Gabrilo et al. (14), and Bizzini et al.'s study in which "top-level" referees were analyzed (5.0/1000 h) but higher than their assistant referees (1.7/1000 h) (5). When training injuries, at 1.46/1000 h in our study were evaluated, it was higher than injury incidences (0.09-0.5/h) obtained by Bizzini et al. (5,13). All of these studies had a retrospective design. In retrospective studies analyzing the previous 12-month period, and in studies analyzing data loss due to recall in prospective studies, it has been demonstrated that 80% of the participants could remember the location and number of their injuries accurately, and only 61% could remember the diagnosis (15). On the other hand, Junge and Dvorak reported lower rates, and suggested that 30% of moderate injuries and only 10% of mild injuries were reported in retrospective studies (16).

**Table 6.** Factors impacting the injury status of the referees as tested with logistic regression analysis

| Factors | B | SE | Exp (B) OR | %95 CI lower | p |
|---|---|---|---|---|---|
| **Age** | | | | | |
| 18 to 21 years | -0.52 | 0.65 | 0.60 | 0.167 | 0.423 |
| 22 to 25 years | -1.29 | 0.64 | 0.27 | 0.079 | 0.043* |
| 26 to 29 years | 0.05 | 0.56 | 1.05 | 0.353 | 0.929 |
| 30 years and above | | | 1.0[a] | | |
| **Experience in refereeing** | | | | | |
| 0 to 3 years | 0.74 | 0.67 | 2.10 | 0.561 | 0.271 |
| 3 to 6 years | 1.22 | 0.68 | 3.39 | 0.903 | 0.071 |
| 6 to 9 years | -0.87 | 0.72 | 0.42 | 0.102 | 0.229 |
| 10 years and above | | | 1.0[a] | | |
| **League** | | | | | |
| Professional | 1.03 | 0.54 | 2.79 | 0.965 | 0.058 |
| Amateur | | | 1.0[a] | | |
| **Running intensity** | | | | | |
| Ratio of maxHR | 0.47 | 0.30 | 1.61 | 0.885 | 0.119 |
| Time to complete a certain distance | | | 1.0[a] | | |
| **Constant** | **-0.97** | **0.47** | **0.38** | | 0.039* |

B: unstandardized regression weight; SE: standard error; Exp (B) OR: exponentiated coefficient odds ratio; CI: confidence interval; *: p<0.05; Nagelkerke $R^2$=0.124, accuracy of the prediction =70.3%; [a]: reference group

Based on these studies, the higher incidence rates of training injuries in our study may be due to the prospective design of our study. When previous prospective studies are reviewed, it is noticed that match injury incidence rates ranged between 4.6-8.8/1000 h and training injury incidence rates ranged between 16.4-19.6/1000 h (17,18). Based on these data, it is clear that that the difference in training injuries is greater than that in match injuries in retrospective and prospective studies. Albeit our study was designed as a prospective study, the self-reported injury data was collected from the referees at the end-of-year seminars. It is likely that referees may want to increase their chances of getting more matches and/or promotion in the league by not stating their injuries in this meeting, which was attended by their superiors who assign them matches. Hence, training injuries may be underreported. It is likely that match injuries were reported at the time of incidence, as there is a federation observer in the stadium during official matches.

The fact that the number of match injuries is lower compared with published data may be due to the younger age of our participants. In the study of Gabrilo et al., it was stated that participants were younger than average, which was supported by UEFA's recommendations for reducing the age of referees (14). Moreover, given that referees in our study are younger may also be due to the level of the league they serve: 55.9% of those in our study consisted of referees who were within the first three years of their careers. Those who have been referees for ≥10 years made up the 17.8% of the referees. Referees working in professional leagues made up 11.2% of the referees. Referees can only officiate matches at higher levels when they become older since they need to be experienced to rise to elite levels (1,19). Therefore, the age difference supports the reason for the difference with previous studies.

Differences in the number of matches played by referees might have affected the incidence of injuries. In our study, referees officiated lower number of matches per year than in previous studies (5,13,18). Given that injuries (20) increase among football players due to the increase in the ratio of acute workload to chronic workload, the addition of acute workloads exposure to chronic workloads in their regular training may have changed this ratio in a way that increases susceptibility to injury. This may help account for why our incidence rates of match injury are less prevalent than in the literature.

In our study, most common injuries were in the lower leg, ankle, knee and thigh regions. Incidences were consistent with some previous studies (14,17). The incidence was lower than that in Bizzini et al. (15.5% vs. 29.9%) (13). The reason for this may be that conditions, such as stress syndromes, which may frequently occur in the lower leg, are interpreted as complaints and are not included in the injury classification. Given that the diagnosis of these common conditions was made by clinical examination (21), and 38.1% of the referees in this study did not receive medical assistance and were not examined (13), this might have led to lower diagnosis of lower leg injuries. Another potential factor is that although such stress syndromes adversely impact activity, as they do not completely prevent participation in sports, athletes may consider these pains a natural outcome of training. Hence, athletes may prefer reducing their activity levels to a level they can tolerate the pain or continue training even if the pain develops. Therefore, athletes might not have stated these as injuries.

In our study, thigh injuries were observed less frequently (7.5%) compared with other studies. Young age, less frequent matches, different training content, or the differences between study designs may have affected this result. In the

previous studies, training was reported only as the time spent in training, but the training contents were not mentioned. This issue was only mentioned in the study of Wilson et al., and the weekly training duration was reported as being similar to our study (18). However, approximately 14% of the training is allocated for strength training. In our study, this rate was 33.5%. This ratio may yield fewer injuries by providing muscle strength. It is expected that more time is allocated to aerobic endurance in training for referees to achieve the high cardiovascular endurance required in matches (1,19). Therefore, referees may allocate more time to endurance training, focusing on performance (22), resulting in less time allotment to strength training, especially due to aging and regression of endurance performance, causing a higher incidence of injury.

Given the high rate of strength training in our study, and the lower incidence of all injuries, especially muscle injuries, concentrating on protective factors, not only as time spent by the referees in training, but also by its content may have been beneficial in preventing future injuries. As another point of view, it was stated that muscle injuries of referees mostly occurred during the fitness test (14). Since referees who were active during the season were assessed in our study, referees who experienced performance affecting injuries, might not have passed the fitness tests. In the same study, apart the fitness test, injury incidence rates were similar to our study.

When characteristics of the injured and non-injured referees were compared in our study, significant differences were determined for age, years of refereeing, refereeing league levels, and the method of determining running intensity. It was observed that the age range with the lowest incidence of injury was that of 22-25, and a refereeing period of 6-9 years. Furthermore, fewer injuries were observed in amateur referees than in professionals, consistent with findings of previous studies (13,14). Following logistic regression analysis, only the age factor impacted the injuries significantly, and the injury risk of referees in the 22-25 age group was 73% lower than the referees in the ≥30 age group. Based on these data, it can be suggested that other significant factors are affected by the age factor. Aerobic and anaerobic endurance, and strength, which are performance determinants, decrease with advancing age (1,22). In addition to this expected decline in age-related performance, the incidence of injuries may increase due to increased physical demands with increasing league levels. Therefore, it can be recommended that in particular, aging referees should also practiceprotective training from injuries along with performance-oriented endurance exercises.

In our study, a significant difference was found between the injured and non-injured referees in terms of the running training. Referees who determined their running intensity according to the age-related maximal heart rate were more frequently injured than those who determined running intensity according to the time to finish the run for a certain distance. Albeit determining the age-related maximal heart rate and performing endurance training accordingly is one of the methods recommended by the ACSM (23), findings in our study may be unexpected. However, the individual characteristics of the referees can be affected not only by their age but also by other independent factors. Thus, determining training intensity only by considering age may increase the incidence rate of injury in susceptible individuals. It has been suggested that when determining training intensity based on the heart rate, the age-related maximal heart rate may cause over- or underestimation. Hence, training intensity should be determined by variables such as the heart rate reserve, which is computed on a more individual basis (23).

This customized approach may also be preferable for injury prevention. Gabrilo et al. found that injuries experienced by referees in fitness tests were higher than those experienced in matches (14). They pointed out that although the referees could determine the rhythm during the match using their own methods, they had to follow the rhythm of the test to successfully pass the fitness test. In our study, referees who were able to determine intensity based on the completion time of the running training were able to adjust their performance. Thus, they might have been injured less. Hence, our findings support the significance of individual approaches in determining the intensity of running training in injury prevention.

This study has several limitations that should be considered. Firstly, the fact that the number of professional referees is significantly lower than the number of amateur referees is a limitation. However, this outcome is because the number of registered professional referees in the region where the study was performed is much less than that of amateur referees. Still, given that the number of top-level referees is less than the number of lower-level referees in previous studies (13,14), our results are comparable to previous studies. Secondly, the fact that injury data were collected from referees' self-reports, it may have created a recall bias, although our study was of a prospective design. However, informing the referees that their injuries will be followed-up, and obtaining their consent and approval before the present study would reduce the recall bias. Also, misreporting might have occurred since injuries were self-reported. However, the fact that 91% of the injuries were diagnosed by a medical staff reduced misreporting. Additi–

onally, self-reported collection of injuries might have affected the number of reported injuries by causing the referees to want these injuries not to be known by their superiors who evaluated their performance due to economic or promotion concerns.

## CONCLUSION

The demographic profile and training characteristics of Turkish referees were addressed for the first time in literature, and the effects of these characteristics on injuries experienced during a football season were presented. Older age (≥30 years), among the characteristics of the referee, is one of the effective factors in experiencing an injury. Moreover, how the running intensity is determined in training programs to meet the performance needs of refereeing can have an impact on the injury. Future studies are required to evaluate which methods of determining running intensity in their training would affect referees' injuries. On the other hand, since injuries during a fitness test was not investigated in this study, muscle injuries were detected less frequently than in previous studies. This information could serve as a basis in stressing the significance of considering different personal characteristics, such as age, which would help referees protect themselves from sports injuries when planning their training.

***Ethics Committee Approval / Etik Komite Onayı***

Approval for this study was obtained from the Institutional Ethics Committee of Ege University, İzmir, Türkiye (Decision No:19-8.1T/5 Date:21.08.2019).

***Conflict of Interest / Çıkar Çatışması***

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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***Author Contributions / Yazar Katkıları***

Concept SŞ,OK,ND; Design SŞ,OK,ND; Supervision SŞ; Materials SŞ,OK,YEM; Data Collection and/or Processing SŞ,OK,YEM; Analysis and Interpretation ND,OK,YEM; Literature Review SŞ,OK; Writing Manuscript OK; Critical Reviews SŞ,ND.

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