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Research Article / Araştırma Makalesi

Epidemiologic characteristics of anterior cruciate ligament injury in 10 consecutive seasons of Turkish Division-1 professional football league

Türkiye profesyonel birinci liginde 10 ardışık sezonda gerçekleşen ön çapraz bağ yaralanmalarının epidemiyolojik özellikleri

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ABSTRACT

Objective: Anterior cruciate ligament (ACL) rupture is a potentially career-threatening injury in professional athletes. This study aimed to evaluate the epidemiology and injury characteristics of ACL rupture of male football players participating in the Turkish Super League.

Materials and Methods: Epidemiologic characteristics of professional male football players participating in the professional first division Turkish Super League in 10 consecutive seasons were evaluated through a publicly available online soccer archive. Exposures in matches, as well as training, were calculated.

Results: A total of 100 ACL injuries were included (mean age at the time of injury: 25.2±3.9). Of these, 13% were re-rupture and 11% were contralateral rupture. The ACL incidence rate was 0.4060 per 1000 hours of play during Super League matches, 0.0801 per 1000 hours of training (rate ratio [RR], 5.06; 95% CI, 3.25-11.84; p<0.001), and 0.0622 per 1000 hours of total play. Although there was a regular number in other periods, the most frequent injury was in August. Also, training injuries peaked in July. A significantly higher incidence rate was found for the teams ranked from 1st to 5thplace compared with teams ranked 6th to 18th (0.0654 vs 0.0317 per 1000 hours of training; RR, 2.06; 95% CI, 1.44-3.65; p<0.05). A similar finding was found for total injury incidence proportion (2.17% vs 1.36%; p<0.05).

Conclusion: Epidemiologic data is important as a resource for athletes and those responsible for their health to develop appropriate training and preparation programs to reduce the risk of ACL injury.

Keywords: *Anterior cruciate ligament, injury, football, epidemiology, super league*

ÖZ

Amaç: Ön çapraz bağ (ÖÇB) rüptürü, profesyonel sporcularda potansiyel olarak kariyeri tehdit eden bir yaralanmadır. Bu çalışmada Türkiye Süper Liginde yer alan ÖÇB rüptürü olan erkek futbolcuların epidemiyoloji ve sakatlık özelliklerinin değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntemler: Türkiye Süper Liginin üst üste 10 sezonunda forma giyen profesyonel erkek futbolcuların epidemiyolojik özellikleri, halka açık bir çevrimiçi futbol arşivi aracılığıyla değerlendirildi. Maçlardaki ve antrenmanlardaki maruziyetler hesaplandı.

Bulgular: Toplam 100 ÖÇB yaralanması dahil edildi (Yaralanma anındaki ortalama yaş: 25.2±3.9). Bunların %13'ü yeniden rüptür ve %11'i karşı taraf rüptürü idi. ÖÇB rüptürü insidans oranı, Süper Lig maçları sırasında 1000 saatlik oyun başına 0.4060, 1000 saatlik antrenman başına 0.0801 (Risk oranı [RR], 5.06; %95 GA, 3.25-11.84; p<0.001) ve 1000 saatlik toplam oyun başına 0.0622 idi. Diğer dönemlerde düzenli bir sayı olsa da en sık yaralanma Ağustos ayında yaşandı. Ayrıca, antrenman yaralanmaları Temmuz ayında zirve yaptı. 6 ila 18. sıradaki takımlara kıyasla 1. ila 5. sıradaki takımlar için önemli ölçüde daha yüksek bir insidans oranı bulundu (1000 saatlik antrenman başına 0.0654'e karşı 0.0317; RO, 2.06; %95 GA, 1.44-3.65; p<0.05). Toplam yaralanma insidans için de benzer bir oran bulundu (%2.17'ye karşı %1.36; p<0.05).

Sonuç: Epidemiyolojik veriler, sporcular ve sağlıklarından sorumlu olanların ön çapraz bağ yaralanması riskini azaltmak için uygun antrenman ve hazırlık programları geliştirmeleri açısından önemli bir kaynak sağlamaktadır.

Anahtar Sözcükler: *Ön çapraz bağ, yaralanma, futbol, epidemiyoloji, süper lig*

INTRODUCTION

ACL injury risk is significantly increased in pivoting sports, like football (1). Especially sudden change of direction, rapid deceleration, landing or cutting tasks increase the combined axial and torsional loads during training or playing (2).

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Anterior cruciate ligament (ACL) rupture is a potential career threatening injury in football players (3). Only one third of the professional football players can return to pre-injury level of sports competition after 12 months of rehabilitation (4). Only 65% of players can return to top-level sports competition 3-years after ACL injury (5). Time to return to sports is highly variable, between 9 to 12 months (6).

After a musculoskeletal injury, athletes may enter a vicious disability cycle known as continuum of disability (7). It has been associated with poor sensorimotor control and susceptibility to secondary injuries (8). The need for optimum preventive programs remains important. Accordingly, comprehensive epidemiologic data is important in the optimization of these programs.

Few studies investigated epidemiologic characteristics of ACL injuries through consecutive seasons in different countries using publicly available internet news and databases (3,9-11). To date, no epidemiologic studies investigating the epidemiologic characteristics of ACL injuries in Turkish Super League (professional first division football league). The Turkish Super League is an European league with a high concentration of international football players and one or more teams participating in all international cups organized by UEFA every year. Accordingly, ACL rupture epidemiological data and injury characteristics in the Turkish Super League would contain data that can be used in the international arena. Therefore, the aim of this study was to investigate the epidemiologic data and injury characteristics of ACL injury in 10 consecutive seasons of the Turkish Super League using a publicly available football database and a search engine.

We hypothesized that a-) injury incidence rate would be similar to that reported in the previous reports and the teams ranked higher and lower on final placement, and b-) the distribution of injuries is concentrated in certain time periods during the season and pre-season.

MATERIALS and METHODS

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Patient screening process

It was a cross-sectional, observational study. All professional football players participated in the Turkish Super League teams from 2010-2011 to 2019-2020 were screened to evaluate the epidemiologic characteristics of ACL injuries in the Turkish Super League.

Turkish Super League is consisted of 18 teams; all teams play each other 2 times within entire season (From August to May, total of 34 matches for every team). At the end of the season, the highest ranked 1 or 2 teams participate in the UEFA champions league (UCL), the most prestigious European football tournament including highest ranked teams of individual leagues, in the subsequent season. Subsequent 3 teams (3^{rd}, 4^{th} and 5^{th} ranked teams at the end of season) participate in UEFA Europa league (UEL). All teams are also involved in the national Turkey cup (NTC) in a knock-out format. Due to their progressive nature, the number of matches played in the UCL, UEL, and NTC varies. Also, limited number of players are involved in their national teams to participate in various competitions such as World Cup, Euro Cup, Asian Cup, African Cup, Copa America, or Confederation Cup.

Player data were accessed on a publicly available internet platform transfermarkt.com (Transfermarkt GmbH & Co KG) and the Google® search engine. An informed consent was not needed. Also, an ethical committee approval was not needed. Two investigators independently searched and systematically saved the detailed player, match, and injury data. The technique we used was previously validated by Leventer et al. (8) with more than 90% interobserver agreement and 0.82 kappa for cross-validation.

Ten consecutive seasons were progressively accessed. Eighteen teams were individually evaluated in each season regarding ACL injury reports. A further confirmation was performed on online search engine. Players were analyzed in more detailed fashion in the presence of ACL injury (ACL rupture).

Data Extraction

Anthropometric characteristics, injury characteristics, match characteristics, team characteristics, and timing of injury were extracted by each investigator individually. Injuries were classified based on the occurrence during Super league, Cup, national team, and training. Injuries occurred in the friendly matches were included in training category. Previous injuries such as ipsilateral or contralateral ACL injuries and concomitant injuries (if available) were recorded.

In the calculation of risk exposure while playing football, total number of matches played by each time in each season were calculated and subdivided in the different competition in which one or more teams participated. The risk exposure of each player during training was approximated considering the annual average exposure of a Turkish Super League middle-rank team that participated in more than half of the seasons analyzed. Finally, the number of players on each team in each season and the final place–

ment of each team in the seasonal rankings were obtained, as well. Since the first 1 or 2 teams in the final rank from the Turkish Super League are allowed to participate in the UCL, and subsequent 3 teams are allowed to participate in the UEL,

we defined high-ranked teams as those classified from 1st to 5th position, while low-rank teams were those classified from 6th to 18th position. Based on the data obtained, several epidemiological measures of ACL injuries were calculated, according to Knowles et al. (12) (Table 1 and 2). The incidence rates were defined as the number of injuries divided by the total person-time at risk (i.e., athlete-exposure during matches or training) (12). The incidence proportions were defined as the number of new injuries divided by the total number of athletes at risk during a specified time period (i.e., team-season or league-season) (12).

ACL injury distribution and incidence rates across the 10 seasons according to different exposuresPhysical characteristics of the participants

Season	ACL injuries					Incidence rate of ACL injuries				
	Total	Super League	Cups	Training	National Team	Super League matches	Cup matches	Total matches	Training	Total play
10-11	15	6	2	7	0	0.5941	0.5411	0.5799	0.1059	0.0934
11-12	13	7	0	5	1	0.6932	0.0000	0.5074	0.0756	0.0809
12-13	10	1	0	8	1	0.0990	0.000	0.0724	0.1210	0.0622
13-14	11	1	1	9	0	0.0990	0.2705	0.1449	0.1361	0.0684
14-15	13	7	0	5	1	0.6932	0.0000	0.5074	0.0756	0.0809
15-16	7	5	0	2	0	0.4951	0.0000	0.3624	0.0302	0.0435
16-17	8	4	0	4	0	0.3961	0.0000	0.2899	0.0605	0.0498
17-18	10	4	0	6	0	0.3961	0.0000	0.2899	0.0907	0.0622
18-19	9	3	0	6	0	0.2970	0.0000	0.2174	0.0907	0.0560
19-20	4	3	0	1	0	0.2970	0.0000	0.2174	0.0151	0.0249
Total	100	41 (41%)	3 (3%)	53 (53%)	3 (3%)	0.4060	0.0811	0.3077	0.0801	0.0622

Match and injury characteristics of anterior cruciate ligament injuries based on team rank in the Super League

	Position in Super League		
	1 to 5	**6 to 18**	**P**
ACL injuries			
Total	38	62	NA
Super League	15	26	NA
Cups	1	2	NA
Training	20	33	NA
National team	2	1	NA
Matches played			
Total	2064	4582	NA
Super League	1700	4420	NA
Champions League	82	6	NA
Europa League	174	20	NA
National Cup	108	136	NA
Average per season	45	38	**0.038**
Incidence rate of ACL injuries (per 1000 hours)			
Total play	0.1115	0.0820	0.153
Super League	0.5347	0.3565	0.147
Cups	0.1665	0.7482	**<0.001**
Training	0.0654	0.0317	**0.020**
Total matches	0.4635	0.3288	0.096
Incidence proportion of ACL injuries (per 100 players)			
Total	2.17%	1.36%	**0.036**
Super League	0.85%	0.57%	0.216
Training	1.1%	0.72%	0.555
Cups	0.05%	0.04%	0.074
National team	0.11%	0.02%	**<0.001**
Incidence proportion of ACL injuries			
Team	0.7600	0.4770	0.115
Super League	0.0223	0.0058	**0.018**
Cups	0.0027	0.0123	**<0.001**
Total matches	0.0184	0.0135	0.488
Number of matches every ACL injury			
Super League	45	170	**0.002**
Cups	364	81	**<0.001**
Total matches	115	158	0.108

Statistical Analysis

Mean, standard deviation, range, raw number, and percentage were used in the presentation of descriptive statistics. The distribution of data was assessed using Shapiro-Wilk test. Independent samples t-test and analysis of variance were used in the comparison of continuous variables. Chi-square test was used in the comparison of categorical variables. A rate ratio (RR) and 95% confidence interval, and significance was tested using the z-statistics (5). A p value <0.05 was considered statistically significant. SPSS v24 (IBM, NY, USA) was used in the analyzes.

RESULTS

Player Characteristics

Of the 100 ACL injured athletes, the mean age at the time of injury was 25.2 ± 3.9 years and the mean BMI value was 23.0 ± 1.2 kg/m^2. According to the player position, an ACL injury occurred mostly in defenders (47/100) (Fig. 1). In 13 of 100 athletes (13%), ipsilateral re-rupture was observed. In addition, a contralateral primary ACL rupture developed in 11 athletes (11%) (Fig. 2). Concomitant knee injury was observed in 18 players (17.8%).

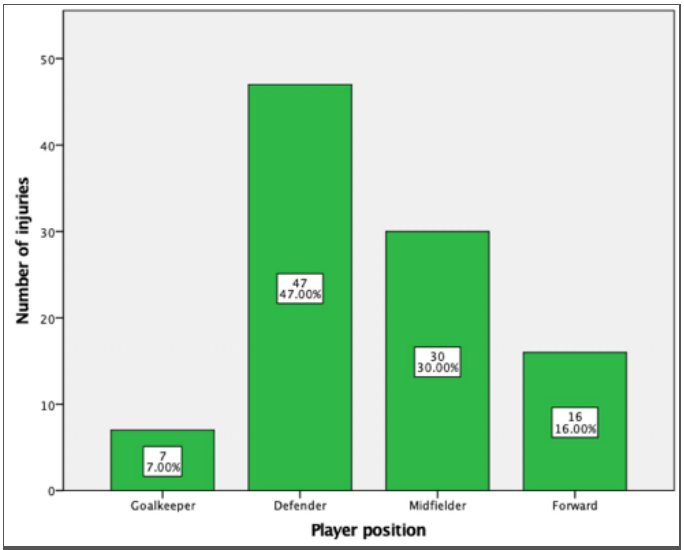

Figure 1. Distribution of ACL injuries according to player position.

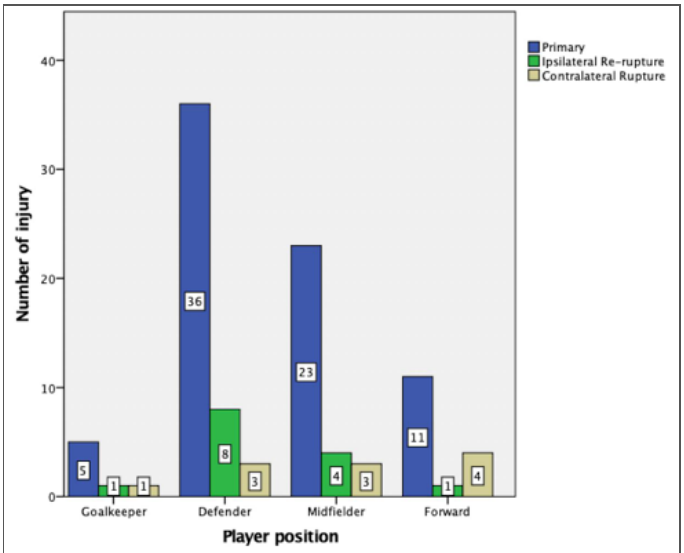

Figure 2. Distribution of primary rupture, ipsilateral re-rupture, and contralateral ACL ruptures

Incidence Rate

The overall injury rate per 1000 hours of play was 0.0622. The incidence rate of ACL rupture was 0.4060 per 1000 hours of play during Super League matches with no significant difference between 10 seasons. It was 0.0801 per 1000 hours of training (Table 1). The Super League injury rate was 5 times higher than the training injury rate ([RR]:5.06; 95% CI, 3.25-11.84; P < 0.001).

Incidence Proportion

The overall incidence proportion was 1.57% of the total players involved in the Super league with no significant differences between the 2010/2011 and 2018/2019 seasons (p>0.05). However, there was significantly lower incidence proportion in the 2019/2020 season than the previous 9 seasons (P<0.001) regarding incidence proportion. Total injuries per team was calculated 0.55 (1 injury every 2 seasons or 1 injury in every Super League matches).

Injury Distribution

The distribution of injuries according to season was similar (Summer:28%, Autumn:28%, Winter: 24%, and Spring: 20%; p>0.05) (Fig. 3). The distribution of injuries according to months was similar, except higher injury rate in August. However, the training injuries peaked in January and August (Fig. 4).

Team rank Distribution

Thirty-eight of the injuries were developed in teams ranked from 1st and 5th place compared to 6th to 18th positions (Table 2). The incidence rate per 1000 hours of training was 2.06 (p=0.020) times higher in higher-ranked teams. The injury incidence proportion per total number of players was 1.6-fold higher in the team ranked in the 1st to 5th positions (2.17% vs 1.36%, p=0.036). In addition, the injury incidence proportion per national team was 5.5-fold higher in the 1stto 5th positions (0.11% vs 0.02%, p<0.001) (Table 2).

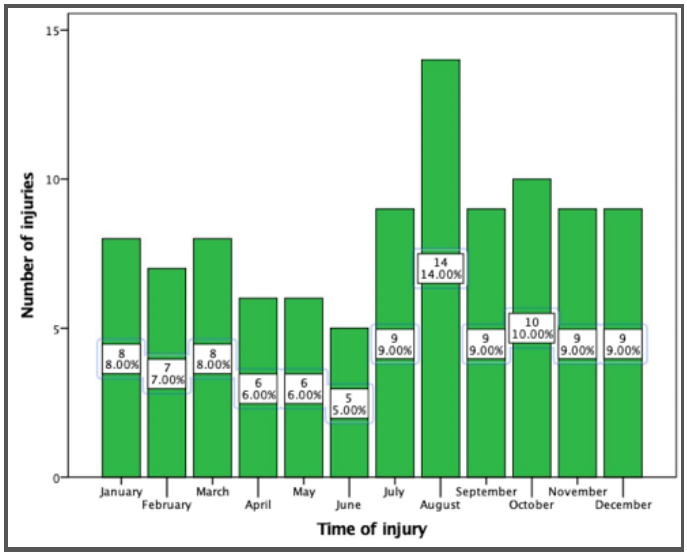

Figure 3. Distribution of ACL injuries according to months of the year

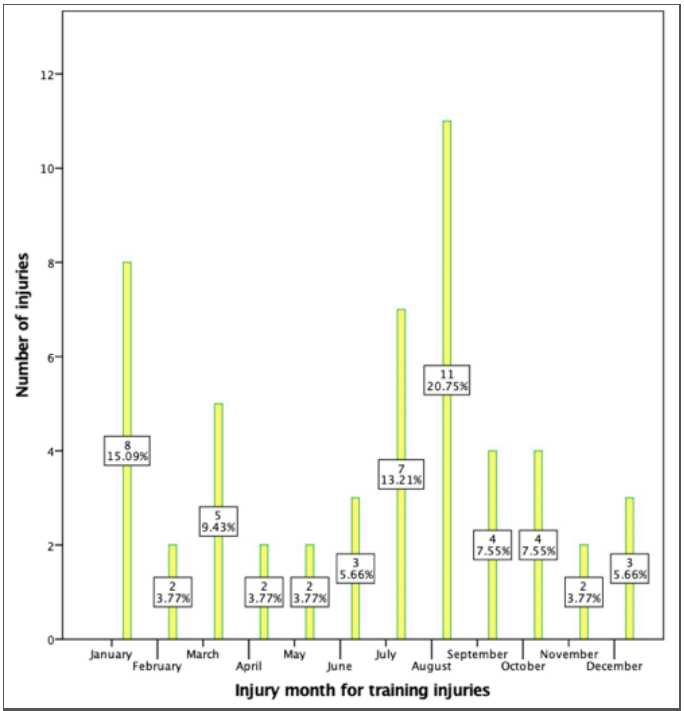

Figure 4. Distribution of ACL injuries during training according to months of the year. Injuries peaked in January and August.

DISCUSSION

The most important findings of this study are that the injury incidence rate of ACL rupture is similar to that reported in the previous studies including highest ranked players. The distribution of injuries is not concentrated in certain time periods during the season. However, a higher injury incidence is observed at the beginning of the season. It decreases towards the end of the season. Significant number of injuries occurred in July and August during preseason preparation period. Injury incidence rate per cups was found higher in the players of lower ranked teams. However, injury incidence rate per training was found higher in the players of higher ranked teams.

Previously, the mean age at the time of ACL injury was reported between 25.0 and 25.3 years (3,9,11,13). Similarly, we found the mean age of injured players as 25.2. The most common player position that is associated with ACL injury was reported as defender (3,14). Grassi et al. (3) reported 47% rate of ACL injury in defenders played in Italian Serie A. In our study, 47 of 100 ACL injuries (47%) were defenders. It may be associated with more pressing in defending position than other positions.

Significant number of ACL ruptures (both re-rupture in the ipsilateral side and primary rupture in the contralateral side) occur in patients with a previous ACL reconstruction (15,16). In their series, Grassi et al. (3) reported that 25% of ACL ruptures in 84 Italian Serie A players had a previous ACL rupture and reconstruction history. They also reported 15% rate of reinjury and 10% of contralateral injury. In a meta-analysis including various sports and levels performed by Wiggins et al. (16), 23% rate of second ACL injury was reported in players younger than 25 years of age. In our study, 24 of 100 players (24%) had a previous ACL injury and reconstruction. Of these, 13% were ipsilateral re-rupture and 11% were contralateral injury. According to previous reports and our findings, preventive strategies including anatomical risk factors and rehabilitation techniques responsible for the ipsilateral or contralateral injuries should be taken into consideration in professional male football players to decrease injury rate.

The overall incidence rate of ACL injuries per 1000 hours was reported between 0.058 and 0.076 (5,11). These studies included European and Middle Eastern clubs including high rate of international players. Also, Grassi et al. (3) reported 14-fold higher incidence rate during matches than training. However, in an UEFA report conducted by Walden et al. (5), it was reported that the incidence rate during matches was 20-fold higher than training. In our study, we observed that the overall injury rate per 1000 hours of play was 0.062 which is in line with previous reports. The incidence rate during matches was 3.8-fold higher than training. This is slightly lower than previous reports. It may be associated with different training approaches.

Grassi et al. (3) and Rekik et al. (11) reported 40% (34/84 and 15/37 players, respectively) of injuries during training. However, Walden et al. (5) proposed 20% (28/140) rate during training. In our study, we found 48% of injuries during training. The approximated exposure training time and injuries in friendly matches could be responsible for the difference between studies. High percentage of training injuries should be carefully investigated regarding responsible factors for injury prevention.

In their study, Grassi et al. (3) reported 10% of ACL injury rate during the national representative matches. In our study, we found only 3 (3%) ACL injuries during the national representative matches. The lower rate found in our study might be associated with lower number players involved in national representative teams.

Previously, a bimodal peak was reported regarding the distribution of ACL injuries (3). In Italian Serie A, clear peaks were identified in October and March (17). Similarly, in French League 1, bimodal peak was identified in November and March (18). In contrast, one peak in August was found in Turkish Super League. Also, January and August were the most common time for ACL injury during preparation. The relevant number of injuries during pre- and mid-season

preparation and at the beginning of the season may be associated with lack of physical readiness and stress for multiple competitions. Working on pre- and mid-season preparation programs and readiness tests that will ensure optimal physical and mental preparation of players will help reduce the risk of ACL injury.

An increased incidence rate and proportion have been associated with higher rank teams (3). It may be associated with higher number of matches that are played by higher ranked teams in international competitions. In their study, Grassi et al. (3) reported that higher ranked teams had 1 injury every season. However, in lower ranked teams, one injury in every 2 seasons was found. In our study, we found that higher ranked teams had 0.76 injury in every season. On the other hand, in lower ranked teams, one injury in every two seasons was found. Also, a higher risk of overall injuries has been reported when 2 matches per week, a common condition for high ranked teams, are played (19). It was associated with the change in the style of play which has been correlated with ACL injury.

There are several limitations that should be acknowledged. First, the data was recruited from a publicly available database. Having the direct injury reports would give more objective results regarding the injury risk during training. Second, the exposure time was calculated as an estimation. Direct data including the training details could affect calculations. Third, individual injury videos were not watched. Injury mechanism and possible factors associated with increased ACL injury risk would be identified using video analysis. Finally, the data obtained from publicly available database are not confirmed with hospital records and Turkish Football Association records.

CONCLUSION

Epidemiological data is important as a resource for athletes and those responsible for their health to develop appropriate training and preparation programs to reduce the risk of ACL injury.

Ethics Committee Approval / Etik Komite Onayı

Ethics committee approval is not needed due to publicly accessible data interpretation.

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: AM; Design: AM and KA; Supervision: AM; Data Collections and Processing: KA and MBK; Analysis and Interpretation: AM, KA, and MBK; Literature Review: AM, KA, and MBK; Writing Manuscript: AM; Critical Reviews: KA and MBK.

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