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# HAS THE FREQUENCY OF DENTAL TRAUMA AND MOUTHGUARD USE IN ELITE HANDBALL PLAYERS CHANGED SINCE 2005?

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## ABSTRACT

**Background:** The study on the incidence of dental trauma and the use of mouthguards in 2005 revealed that handball players in Turkey do not use mouthguards. This current study evaluates the changes up to 2021 and evaluates today's athletes' attitudes toward using mouthguards.

**Methods:** The data were collected from 68 professional handball players through a questionnaire. The same questions of the 2005 study were asked concerning the incidence of dental trauma and mouthguard use. In addition, today's handball players' attitudes toward using mouthguards were also investigated. The data were analyzed with Minitab 17. Independent samples t-tests were used to compare quantitative data. Fisher's exact test was used for ratio comparisons (percentage), and the Pearson Chi-Square test was used to distribute categorical data. The statistical significance level was taken as $p<0.050$.

**Results:** This study shows that the athletes have experienced minor dental trauma since 2005. However, the difference is not statistically significant ($p=0.291$). Moreover, there was no statistically significant difference between the distribution of dental injury types in the avulsion, crown fracture, and dislocation between 2005 and 2021 ($p=0.431$). While 77.4% of the athletes were aware of mouthguards in 2005, this rate has increased to 100% in 2021 ($p<0.001$). No mouthguard use was reported in the 2005 study, while 29% of the participants in 2021 reported mouthguard usage ($p<0.001$). The main reason for not wearing a mouthguard for the 2005 participants was lack of information, while in 2021, it was fear of speaking or breathing difficulties ($p<0.001$)

**Conclusions:** Dental trauma remains a severe problem for handball players. It is pleasing that professional handball players in Turkey have started to use mouthguards. Dentists and sports managers should work together to reduce the frequency of dental trauma and prevent possible adverse effects.

**Keywords:** Dental Trauma, Mouthguard, Handball

## 1. INTRODUCTION

Contact sports are sports where players physically interact and prevent the opposing team's attack Kececi et al. (2005). Those involved in contact sports are at high risk of orofacial and dental trauma due to potential impacts during play. Orofacial injuries include dental trauma, tooth fracture, tooth displacement (avulsion), cutting of soft tissues (laceration), facial bone fractures (fracture), and temporomandibular joint injuries Bergman et al. (2017). In a systematic review and

meta-analysis study conducted in 2018 on the frequency of dentoalveolar trauma and mouthguard use in athletes, studies investigating the frequency of dentoalveolar trauma in athletes were examined, and rates ranged from 7.1% to 71.5% were reported Fernandes et al. (2019). Dental trauma is a public health problem that affects a large number of people in society and some cases, causes irreparable tooth loss not only at the time of the accident but also during or after treatment. Tooth loss may occur even a few years after the play due to sequelae such as root resorption Ferrari and De Medeiros (2002).

Dental professionals seek to provide appropriate treatment following such injuries to maximize the chances of recovery while preserving the function and aesthetics of the teeth Emerich and Kaczmarek (2010). The treatment of dental injuries is challenging and complex. The correct diagnosis, the time since the injury, and the procedures employed are essential factors for the treatment to be successful. The delay in the treatment can have aesthetic, functional, physical, psychological, and social effects Tuna and Ozel (2014). The type of sport played, the level of competition, the age, and the gender of the participant also directly affect the frequency of orofacial and dental injuries Ashley et al. (2015).

According to the International Dental Federation (FDI) classification, high-risk sports for dental trauma include American football, ice hockey, skating, skateboarding, lacrosse, rugby, mountain biking, basketball, football, handball, water polo, racquetball, and gymnastics, are classified as medium risk sports Federation Dentaire International (FDI). (1990). However, dental trauma is as common in basketball, football, handball, cycling, gymnastics, and other medium-risk sports as high-risk sports Maestrello et al. (1999). Dental injuries can be prevented by using mouthguards in athletes in high and medium-risk groups regarding dental trauma frequency Federation Dentaire International (FDI). (1990), Ferrari and De Medeiros (2002), Ranalli (2000).

Mouthguards are flexible splints that extend up to the maxillary second molars, designed to fit over occlusal surfaces. A mouthguard is expected to cover the gums by separating the soft tissues in the oral cavity from the teeth, thus preventing laceration of the lips, cheeks, and tongue Bergman et al. (2017). Mouthguards protect the opposing teeth from damage by absorbing, limiting, and dispersing forces while minimizing the severity of trauma Sane (1988). In addition to preventing the cracking, breaking, displacement, and avulsion of the teeth, they can also prevent severe traumas such as concussion and hemorrhage, loss of consciousness, jaw fractures, and neck injuries by reducing the forceful movement of the mandible to the maxilla Barbic et al. (2005).

Mouthguards should be made of sturdy but comfortable material. There are three types of mouthguards generally available: (i) prefabricated (stock), (ii) boil and bite types that are made of a thermoplastic material and shaped in the mouth, (iii) custom-made mouthguard for the patient usually made from ethylene-vinyl acetate (EVA) and fabricated by the dentist Francis and Brasher (1991), Galic et al. (2018).

Wearing mouthguards is mandatory in many high-risk sports, and regulations have shown their beneficial effects on dental injuries. However, mouthguards are not widely accepted among athletes and are often criticized for causing breathing problems, disrupting communication during play, and creating aesthetic irregularities Using Mouthguards to Reduce the Incidence and Severity of Sports-Related Oral Injuries. (2006). The protective and positive results of mouthguard use have been proven in numerous epidemiological studies and tests Federation

Dentaire International (FDI). (1990), Newsome et al. (2001), Using Mouthguards to Reduce The Incidence and Severity of Sports-Related Oral Injuries. (2006).

Handball is a dynamic and fast sport with rapid direction changes and direct/indirect contact with opposing players. The American Dental Association has classified handball as a sport that requires the use of mouthguards. However, using mouthguards is not regular among handball players, so the risk of dental injury is high Barbic et al. (2005). Few published data evaluate the use of mouthguards by professional handball players. One of the first studies on the frequency of dental trauma and mouthguard use in handball players was published in 2005 Kececi et al. (2005). In the following years, many studies have been published on the frequency of dental trauma and mouthguard use for various sports branches Bergman et al. (2017), Ma (2008), Petrović et al. (2016). These studies were carried out observationally for the evaluation of the situation.

This cross-sectional study aims to measure the frequency of athlete-reported history of dental trauma, mouthguard knowledge and use, and athlete attitudes and concerns towards wearing a mouthguard since 2005 in elite handball players in Turkey. The study's null hypothesis is that no change has been observed in dental trauma incidence and the use of mouthguards in elite handball players in Turkey since 2005.

## 2. MATERIALS AND METHODS

The ethics committee approved the study of Süleyman Demirel University (21.03.2021: 50/13). As in the study carried out in 2005, a survey was applied to the men's handball super league players (April-May. 2021). The research questions conducted in 2005 regarding the incidence of dental trauma and mouthguards were taken as references Kececi et al. (2005) Table 1. The questions were shared with the players of 12 teams of the handball super league in 2020-21 via Google Forms connection. The questionnaire was a standard form with pre-defined response options completed by the athletes. The survey link was sent to twelve players of each team (Players in the ideal match squad reported by the team coach). The questionnaire was answered directly by each athlete who participated voluntarily in this study.

**Table 1**

| **Table 1 Questionnaire Form in 2005** |
|---|
| Age: |
| How long have you been practicing this sports activity? |
| Have you ever experienced a dental injury during training or competitions? |
| If yes, what kind of dental injury? (crown fracture, dislocation, avulsion) |
| Are you aware of mouthguards as a preventive measure against dental trauma? |
| Which types of mouthguards do you know ((i) stock, (ii) boil and bite, and (iii) custom made)? |
| Do you use a mouthguard during training and competitions? |
| If not, why? |

In addition to the questions of the study carried out in 2005, the questions about the attitudes of handball players toward mouthguard use were also included in the survey Galic et al. (2018) Table 2. The study included 68 participants, whose

average age was 26.5 (5.92 SD), who practiced handball for 10.0 years (4.85 SD), and who trained at least ten hours a week.

The data were analyzed with Minitab 17 (Minitab, LLC, Pennsylvania, USA). Independent samples t-tests were used to compare quantitative data. Fisher's exact test was used for ratio comparisons (percentage), and the Pearson Chi-Square test was used to distribute categorical data. The statistical significance level was taken as $p<0.050$.

**Table 2**

| **Table 2 Attitudes of Handball Players on Mouthguard Use in 2021** | |
|---|---|
| Have you been informed by a specialist (dentist) about the oral-dental injuries you may encounter while doing sports or using protective equipment for this? | |
| Do you think it would be beneficial for you to be informed about this issue? | |
| What is your perspective on the use of mouthguards while playing handball? | |
| Is the use of a mouthguard mandatory in the team you are an athlete? | |
| Do you support the mandatory use of mouthguards for handball players? | |
| If you are using a mouthguard, | • which type (stock, boil and bite, custom made)? |
| | • when do you wear it? |
| | • who recommended you use a mouthguard? |
| | • how many years has it been? |
| | • does it bother you? |
| | • has it impacted your performance on the field? |
| | • and feel discomfort while using it; how would you describe it? |

## 3. RESULTS

The current study results show that the athletes have experienced minor dental trauma incidence since 2005 (25.8% vs. 17.6%). However, the difference is not statistically significant (p=0.291) Table 3. Moreover, there was no statistically significant difference between the distribution of dental injury types in the avulsion, crown fracture, and dislocation between 2005 and 2021 (p=0.431) (Table3). While the rate of athletes reporting avulsion-type injuries among athletes with a history of dental trauma was 12.5% in 2005, no avulsion history was reported in this study. The crown fracture rate was 62.5% in 2005 and 66.7% in 2021. The dislocation-type injury rate was 25% in 2005 and 33.3% in this study.

**Table 3**

**Table 3 Descriptive Statistics of Elite Handball Players for the Incidence of Dental Trauma and Mouthguard Use 2005 Vs. 20021**

| **Questions** | **2005 (n=62)** | **2021 (n=68)** | **Test statistics** | **p** |
|---|---|---|---|---|
| **Age (Mean ± SD)** | 23.2 ± 4.68 | 26.5 ± 5.92 | -3.54 | 0,001[a] |
| **How long have you been practicing this activity? (Mean ± SD)** | 9.91 ± 4.80 | 10.0 ±4.85 | -0.11 | 0.916[a] |

| | | | | | |
|---|---|---|---|---|---|
| **Have you ever experienced a dental injury during training or competitions in the last 12 months?** | | 16 (25.8%) | 12 (17.6%) | 1.13 | 0.291[b] |
| **If yes, what kind of dental injury** | Avulsion | 2 (12.5%) | 0 | 1.685 | 0.431[c] |
| | Crown fracture | 10 (62.5%) | 8 (66.7%) | | |
| | Dislocation | 4 (25%) | 4 (33.3%) | | |
| **Are you aware of mouthguards as a preventive measure against dental trauma?** | | 48 (77.4%) | 68 (100%) | -4.25 | <0.001[b] |
| **Which types of mouthguards do you know** | Stock | 4 (6.5%) | 68 (100%) | -29.98 | <0,001[b] |
| | Boil and bite | 6 (9.7%) | 32 (47%) | -5.25 | <0.001[b] |
| | Custom made | 0 (0) | 16 (24%) | -4.57 | <0.001[b] |
| **Do you use a mouthguard during training and competitions?** | | 0 (0) | 20 (29.4%) | -4.57 | <0.001[b] |
| **If not, why?** | I was not informed | 55 (88%) | 16 (24%) | 9.98 | <0.001[b] |
| | Afraid of difficulty in breathing or speaking | 7 (11.3%) | 36 (52.3%) | -5.73 | <0.001[b] |

aTwo independent samples t-test; bFisher's exact test; cPearson's Chi-Square

In this study, 70% of the participants reported an onset period for mouthguard use in the last 1-3 years. Considering the participants' average active sports history of 10.0 (SD±4.85) years, this short duration of mouthguard use may have impacted the frequency of dental trauma.

The results show that from the 2005 study to the present (2021), athletes are more aware of mouthguards as protective equipment during training or matches, and the difference is statistically significant ($p<0.001$). While 77.4% of the athletes were aware of mouthguards in 2005, this rate has increased to 100% in 2021. A statistically significant difference was found among the distribution of those who knew stock-type mouthguards by years ($p<0.001$). While only 6.5% of the participants were aware of stock-type mouthguards in 2005, this rate has increased to 100% in 2021. A statistically significant difference was found between the distribution of those who knew boil and bite mouthguards by years ($p<0.001$). In the 2005 study, no participant was aware of the custom-made type of mouthguard. The data of this study (2021) show that 24% of the participants are aware of this type of protective equipment ($p<0.001$) Table 3.

A statistically significant difference was found between the number of handball players using mouthguards by years ($p<0.001$). No mouthguard use was reported in the 2005 study, while 29.4% of the participants in 2021 reported mouthguard usage. While the lack of information was the main reason for not using a mouthguard by 88% of players in 2005, this rate decreased to 24% in 20021

(p<0.001). The main reason for not wearing a mouthguard for the 2021 participants was fear of speech or breathing difficulties (p<0.001) Table 3.

When the questions about the athletes' attitudes toward mouthguards were evaluated, only 26.5% of the participants declared that a specialist (dentist) informed them about oral-dental injuries they may encounter while playing. In addition, 73.5% of the participants reported that the information on this subject would benefit them, and 64.7% emphasized the importance of wearing mouthguards. No participants reported that the team made the use of mouthguards mandatory, and only 11.8% reported that mouthguard use is recommended but not required by the team. Moreover, 23.5% of the participants reported that they could support the mandatory use of mouthguards.

Mouthguard users (n=20, 29.4%) among the participants (n=68) reported using mostly boil and bite type (n=12, 60%). Stock type and custom-made mouthguard usage rates were similar (n=4, 20%). The users reported that they mainly used mouthguards during the match (80%), while no athlete declared mouthguard use for both training and matches. Half of those who wear mouthguards report being impressed by other athletes (%50). The rate of those who use a mouthguard with the recommendation of a dentist is 40%. The recommendation of family members was effective for only 10% of mouthguard users.

The data of this current study show that the use of mouthguards among handball players in Turkey can be considered relatively new. Fourteen mouthguard users (70%) reported an onset period in the last 1-3 years. While 20% of the athletes using mouthguards reported a usage period of 4-5 years (n=4), 10% reported a usage period of 6-10 (n=2) years. While 60% of mouthguard users did not report any complaints, 80% (n=16) reported that mouthguards did not positively or negatively affect their performance. The percentage of participants reporting that using mouthguards increases or decreases performance is the same (n=2, 10%). In this study, speech difficulties were the most frequently reported complaint among individuals who reported using mouthguards (n=6, %60). Complaints of difficulty in breathing and poor mouth fit were also reported by users, respectively (30% and 10%).

Sixty-eight out of 144 players in the 2020-2021 handball super league responded to the current study. In the participation of 68 people, there is an acceptable error of 8.66% in the 95% confidence interval. When compared with the study conducted with 62 handball players in 2005, a statistically significant difference was found between the age of the athletes according to the years (p<0,001). Over the years, the average age has increased from 23.2 to 26.4, and the difference is statistically significant. The sports history of the study participants has also increased over the years. However, the difference is not statistically significant Table 3.

## 4. DISCUSSION

Sports-related dental trauma can create lifelong problems Lang et al. (2002). Handball is one of the sports with a medium-high risk of causing dental trauma Federation Dentaire International (FDI). (1990). Dental injuries are mainly caused by impacts to the face with hands or elbows or collisions with another player at high speed. In addition, such injuries can also occur if the ball hits the face during a close-range shot Sane and Ylipaavalniemi (1988). The impact force often causes a crown fracture. Even though the most common damage observed among handball players

is crown fractures, severe periodontal damage, ankylosis, or resorption due to infection may also occur after tooth dislocation (avulsion). These traumas may cause the loss of the tooth in question in the long term Lang et al. (2002).

Studies show that handball players' frequency of dental trauma varies between 11% and 19.7%. However, Ferrari et al. reported a significantly higher injury rate due to more competitive and aggressive participation in their study of professional and semi-professional players Ashley et al. (2015), Ozbay et al. (2013), Petrović et al. (2016). Lang et al. revealed that 17.9% of amateur and semi-professional Swiss handball players experience dental trauma Lang et al. (2002). The results of this current study, conducted at Süleyman Demirel University in 2021, show that 17.6% of players experience some form of dental trauma during play or training. In this sense, the data are similar to the study by Lang et al.

The present study reports crown fracture (n=8, 66.7%) and dislocation (n=4, 33.3%) as the most common dental injuries among (n=12 17.9%) handball players with a history of dental trauma. In the study conducted in 2005, the dental trauma rate was 25.81% (n=68). Although today's dental trauma data in Turkish handball players show a decrease, it is not statistically significant. These results support the first null hypothesis of this current study that "the incidence of dental trauma in Turkish handball players did not change between 2005 and 2021 years."

When the use of mouthguards in elite handball players is evaluated, the current study's data show that there has been a statistically significant improvement since 2005. It has been observed that the knowledge and usage habits of the players on mouthguards have changed positively since the first study. While 77.4% of the players were aware of mouthguards in 2005, this rate has increased to 100% in 2021. It is a highly positive development that all participants in 2021 know at least one type of mouthguard. Handball teams in Turkey have been participating regularly in the champions league and other cups organized by the European Handball Federation since 2011, which require teams to play against each other regularly throughout the year. As of now, eight teams for women and men play in these cups (https://www.eurohandball.com/en/who-we-are/ehf-federations/details/tur/turkey/). It can be thought that this mutual relationship established with other teams and players in Europe over the years and the increasing number of athletes from other countries in Turkish handball teams have increased awareness and the use of mouthguards. In addition, due to the general internet service, it has become a part of daily life for players to follow international matches and players instantly.

The familiarity of all participants with a mouthguard indicates that they appreciate the importance of mouthguards in handball. All of the participants in this study are familiar with the stock-type mouthguard. While the players' awareness of the boil and bite type mouthguard was 9.7% in 2015, it reached 47% in this study. In addition, while the number of players who knew custom-made mouthguards was zero in 2015, this rate was 68% in the current study Kececi et al. (2005). It has been reported that players who use mouthguards regularly have 5.55 times less risk of dental injury than those who do not Bergman et al. (2017). Levin et al. found that injury rates were significantly higher among athletes who did not use mouthguards Levin et al. (2003). However, research has shown that up to 25% of dental injuries can also occur with a mouthguard Onyeaso and Adegbesan (2003). In this current study, 24% of the participants reported using mouthguards. Participants reported using the mouthguard only during the match or training (80% - 20%, respectively).

It is reported that mouthguards contribute to a lower prevalence of dentoalveolar trauma among contact sports athletes Fernandes et al. (2019).

However, the current study results do not show a statistically significant reduction due to mouthguard use. Most of the athletes participating in this study (80%) reported that they only used the mouthguard during the competition, and none of the participants reported the use of mouthguards in both match and training. The fact that it was not used in all risky situations may be a reason why the use of mouthguards did not show the expected effect in terms of protection. In addition, only 20% of the athletes who reported using mouthguards in this study stated that they used personal-type mouthguards. Compared to custom-made mouthguards, the high rate of use of boil and bite type (50%) and stock type (20%) may have prevented the decrease in dental trauma frequency as expected.

Disruption of communication during the game, breathing difficulties, and unpleasant aesthetic features are why athletes do not wear mouthguards Bemelmanns and Pfeiffer (2000), Francis and Brasher (1991), Seals et al. (1985). Bergman et al. stated that 29% of the participants did not wear mouthguards as no one recommended them, and 24% of the athletes did not use them because they felt uncomfortable Bergman et al. (2017). Lip closure, inability to breathe, swallowing, and dislocation were reported as problems for mouthguard use among rugby players Boffano et al. (2012). In this current study, speech and breathing difficulty came first with a rate of 52.3% among the reasons for not using mouthguards, while lack of information followed these with a rate of 24%.

It is shown that mouthguards do not significantly affect primary stomatognathic system functions and the reported problems are subjective Gawlak et al. (2016). A possible solution to comfort issues could be the use of custom-made mouthguards, which cause less difficulty in breathing and speaking, while also providing better protection than stock mouthguards Amis et al. (2000), Duarte-Pereira et al. (2008), Kececi et al. (2005) Athletes can often associate the minor distressing factors with a negative impact on their athletic performance Bemelmanns and Pfeiffer (2000). However, the evidence shows that wearing a good mouthguard causes negligible respiratory impairment and thus does not impair the athlete's performance Amis et al. (2000). In this current study, 63% of the participants evaluated the effects of mouthguards on their performance as ineffective, while it was positive for 18.2% and negative for 18.2% of athletes.

In boxing, wearing mouthguards is partially regulated by regulations; however, although handball is a medium-high risk sport, no recommendation has been made yet Federation Dentaire International (FDI). (1990). In this respect, handball still requires more knowledge and training. The use of mouthguards should be demanded in all sports where the risk of orofacial injury is high Flanders and Bhat (1995), Lang et al. (2002). In this current study, 76.5% of professional handball players do not recommend whether mouthguards should be mandatory, while 23.5% recommend making it mandatory.

Studies examining the incidence of mouthguard use by handball players have reported rates such as 5.7% to 14.5% Galic et al. (2018), Petrović et al. (2016). This current study shows that the rate of using mouthguards among professional handball players in Turkey has increased from zero to 29.4% since 2005 Kececi et al. (2005). It has been reported that 67% of handball players are well aware of the positive effects of wearing mouthguards, but despite this, only 28% wear them regularly, and 16% think them to be unnecessary Bergman et al. (2017). This study shows that although 100% of professional handball players are aware of mouthguards, only 29.4% use them. Although the number of users is still relatively low, it can be said that awareness about the use of mouthguards in preventing the risk of dental injury in contact sports has increased. It has been reported that a

dentist's recommendation is an essential factor in using mouthguards by athletes Bergman et al. (2017). In this current study, 50% of the participants got knowledge of mouthguards for the first time from their teammates, 40% from a dentist, and 10% from their family members.

As a result of dental trauma, restorative, endodontic, or prosthetic treatments may be required. Such preventable health problems can lead to significant professional losses for an elite athlete. Moreover, these treatments are costly and must be renewed regularly. It is possible to prevent injuries that require costly and complicated treatments with relatively more economical and easily applied mouthguards. Dentistry organizations can contribute to increasing the number of athletes using mouthguards. While taking anamnesis from their patients, dentists may question whether they are engaged in any sport. They can raise awareness of athletes and their families about sports traumas, consequences, and the use of mouthguards Tiryaki and Saygı (2013). In addition, it would be advantageous for sports health teams to have a sports dentist responsible for preventing dental traumas and implementing emergency protocols whenever they occur Newsome et al. (2001). Sports-related orofacial and dental injuries can permanently impair stomatognathic function, especially in young athletes Pieter et al. (2012). Although there is no obligation to wear mouthguards, handball is one of the 29 sports in which the American Dental Association recommends their use. A recent study suggests that athletes at all levels should continue to be advised to use custom-made mouthguards fabricated by a dentist to prevent orofacial injuries. In addition, the researchers proposed mandatory mouthguard use for athletes under 16 in high-risk sports (among handball) Ahmed and Fine (2021). Educating, informing, and encouraging the use of this protective equipment at an early age can significantly reduce the concerns of the athletes about breathing or speaking difficulties, reduce the frequency of dental trauma, and prevent possible injuries.

The acceptable error rate, an essential criterion for the representation of the population, was determined as 8.66% due to participation in the current study (68/144). Due to this rate, which is slightly more than 5%, the results of this study may pose a question mark regarding the representation of all players in the handball super league.

## 5. CONCLUSIONS

This study shows that mouthguard use by professional handball players has increased significantly in Turkey since 2005. In addition, positive developments were observed in the knowledge and attitudes of the athletes regarding this protective equipment. Despite the development in the use of mouthguards, dental trauma among these athletes continues to be an actual problem. The dentists and club management should cooperate to prevent dental trauma and related complications.

## DECLARATIONS

### Ethics approval and consent to participate

The patients were informed about the study and were guaranteed that they would not be advantaged/disadvantaged by accepting/refusing to participate. The Ethics Committee of Süleyman Demirel University Faculty of Medicine approved the study, and each participant signed an informed Consent form according to the World Medical Association's Helsinki Declaration (2018:189).

**Consent for publication**

The authors of this study declare that they self- funded the current study.

**Availability of data and materials**

All of the material is owned by the authors and/or no permissions are required.

## AUTHORS CONTRIBUTION

- **Mehmet Guven:** Project administration, Software, Writing-original draft, Writing-review, and editing
- **Zeynep Basagaoglu Demirekin:** Project administration, Resources, Writing-original draft, Writing-review, and editing
- **Hatice Sevinç Akca:** Project administration, Software, Writing-original draft, Writing-review, and editing
- **Erdal Eroglu:** Conceptualization, Data curation, Formal analysis, Project administration, Resources, Writing-original draft, Writing-review, and editing

## CONFLICT OF INTERESTS

None.

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