ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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Density Mapping of Nasal Fracture: A New Epidemiological Perspective of Nasal Fractures in a Pilot City

Burun Kırığının Yoğunluk Haritalaması: Pilot Şehirdeki Burun Kırıklarının Yeni Epidemiyolojik Perspektifi

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ABSTRACT Objective: Nasal fracture is the most common form of fracture due to maxillofacial trauma. The most common mechanisms of nasal fracture are traffic injuries, physical assault, falls, sports injuries and other causes. In this study, epidemiological data are discussed in relation to the location where the nasal fracture occurred. The aim of this study was to identify nasal fracture cases on the city map and to determine high-risk areas and the reasons, so that precautions can be taken. **Material and Methods:** The nasal fracture cases which were recorded in this city in the last 20 months were marked on the city map using the Geographic Information System (GIS) method. **Results:** According to the etiology, 33.66% of the cases were physical assault, 15.53% were falling, 27.19% were sport injuries, 10.75% were traffic injuries and 13.07% were other causes. When the etiological reasons were examined according to gender, in the male patients, physical assault was found to be 43%, traffic injuries 20%, sports injuries 20%, falling 11% and other causes 6%. In the female patients, falling was occured in 34%, physical assault in 27%, traffic injuries in 18%, sports injuries in 17% and other causes in 4%. **Conclusion:** The mapping of social health problems with GIS helps to provide information about the spatial distribution of diseases and to identify problematic points. To the best of our knowledge, this is the first study in literature to show the epidemiological and etiological data of nasal fractures on a map.

Keywords: Epidemiological monitoring; facial injuries; fractures; traumatology

ÖZET Amaç: Burun kırığı, maksillofasiyal travmaya bağlı en sık görülen kırık şeklidir. Burun kırığının en yaygın mekanizmaları; trafik yaralanmaları, fiziksel saldırı, düşmeler, spor yaralanmaları ve diğer nedenlerdir. Örnek toplama için il olarak Türkiye'nin güneydoğusunda yer alan 158.574 (2017) nüfuslu Siirt ili seçilmiştir. Bu çalışmada, burun kırığının meydana geldiği yer ile ilgili olarak epidemiyolojik veriler tartışılmıştır. Bu çalışmanın amacı, şehir haritası üzerinde burun kırığı vakalarını tespit etmek ve yüksek riskli bölgeleri ve nedenlerini belirleyerek önlem alınmasını sağlamaktır. **Gereç ve Yöntemler:** Bu şehirde son 20 ayda kaydedilen burun kırığı vakaları, Coğrafi Bilgi Sistemi (CBS) yöntemi kullanılarak şehir haritasına işaretlendi. **Bulgular:** Etiyolojiye göre olguların %33,66'sı fiziksel saldırı, %15,53'ü düşme, %27,19'u spor yaralanması, %10,75'i trafik yaralanması ve %13,07'si diğer nedenlerdi. Cinsiyete göre etiyolojik nedenler incelendiğinde, erkek hastalarda fiziksel saldırı %43, trafik yaralanması %20, spor yaralanması %20, düşme %11 ve diğer nedenler %6, kadın hastalarda ise %34'ünde düşme, %27'sinde fiziksel saldırı, %18'inde trafik yaralanması, %17'sinde spor yaralanması ve %4'ünde diğer nedenler olarak sonuçlandı. **Sonuç:** Sosyal sağlık sorunlarının CBS ile haritalanması, hastalıkların mekânsal dağılımı hakkında bilgi sağlanmasına ve sorunlu noktaların belirlenmesine yardımcı olmaktadır. Bildiğimiz kadarıyla bu çalışma, literatürde burun kırıklarının epidemiyolojik ve etiyolojik verilerini harita üzerinde gösteren ilk çalışmadır. Burun kırığı nedenlerinin ve coğrafi dağılımının belirlenmesi epidemiyolojinin daha iyi anlaşılmasını sağlar.

Anahtar Kelimeler: Epidemiyolojik izlem; fasiyal yaralanmalar; kırıklar; travmatoloji

Nasal fracture is the most common form of fracture due to maxillofacial trauma.[1-3] The nose is located in the middle of the face and is a protruding structure, thereby increasing the risk of fracture. Functions such as breathing, smell and speech resonance, and cosmetic reasons such as beauty and facial expression increase the importance of nasal fracture. The most common mechanisms of nasal fracture are

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traffic injuries, physical assault, falls, sports injuries and other causes (collisions, work injuries, etc.) and these injuries are more common in males and young adults.[4,5]

Geographic Information System (GIS) is an information system that integrates the functions of collecting, storing, analyzing and using the data obtained in location-based operations. It is widely used to identify the current situation of a disease or for case mapping and to identify high-risk regions.

In this study the spatial distribution of nasal fracture cases occurring in the central districts of Siirt province, which was selected as the pilot city for sample collection, is analyzed and the epidemiological data are discussed in relation to the location where the nasal fracture occurred. The aim of the study was to identify nasal fracture cases on the city map and to determine high-risk areas and the reasons in order to take precautions.

MATERIAL AND METHODS

This retrospective study included 433 patients who admitted to Siirt State Hospital otolaryngology outpatient clinic with nasal trauma and who were diagnosed with a nasal fracture between 01.03.2017 and 01.11.2018.

Siirt, in the south-east of Turkey, with a population of 158,574 (2017) was selected as the city for sample collection. The nasal fracture cases which were recorded in this city in the last 20 months were marked on the city map using the GIS method. In this study, the spatial distribution of nasal fracture cases occurring in the central districts of Siirt province was mapped using Esri ArcGIS®10.3 software (United States) with the Kernel density method.[6]

The location of the nasal fracture cases was obtained and recorded from the hospital database. Age, gender, mechanism of injury (assault, sports injury, fall, traffic injuries, etc.), and the location where the fracture occurred in the city were recorded. A total of 29 patients who did not show the location on the map were excluded from the study.

Ethical Statement: The study protocol was approved by Manisa Celal Bayar University Medical Faculty Clinical Researches Ethics Committee (protocol number: 2021/209, date: 11 November 2021) and all participants provided written informed consent. The study was conducted in accordance with the principles of the Declaration of Helsinki.

STUDY AREA

Located in the south-east Anatolia region of Turkey where there are high plateaux and mountains, Siirt Province is surrounded by Batman, Bitlis, Van and Şirnak provinces. Approximately 70% of the total population of this geographical area, where a continental climate prevails, live in the city centre. Therefore, this study was carried out in the city centre of Siirt due to the frequent occurrence of nasal fracture cases in the city centre. The working area shown in Figure 1 is approximately 1,700 ha. and has 18 central neighborhoods in total.

SPATIAL ANALYSIS METHOD

The distribution of point data with location information features has three basic patterns: (i) clustered, (ii) random, and (iii) homogeneous. In this study, which characteristic pattern features has the point distributions was first determined by The Nearest Neighbour Distance Analysis. The Average Nearest Neighbour (ANN) measures the distance between each feature centroid and the nearest neighbour centroid location, and all these nearest neighbour distances are then averaged. The ANN ratio is calculated as the observed average distance divided by the expected average distance. ANN helps to determine the point data distribution feature. The ANN ratio is calculated using the following equation:[7,8]

In the equation, the upper calculation is the mean distance of the nearest neighbour based on a euclidian distance algorithm and the lower calculation is the expected mean distance given in a random pattern, where di is the distance between i and its nearest neighbouring feature, n is the case number, and a is the area. If ANN is <1, the pattern exhibits clustering or if ANN is >1, the pattern exhibits dispersion.[6] In this study, the nasal fracture case distribution showed a clustered pattern feature since the ANN index resulted in 0.65 (Figure 2).

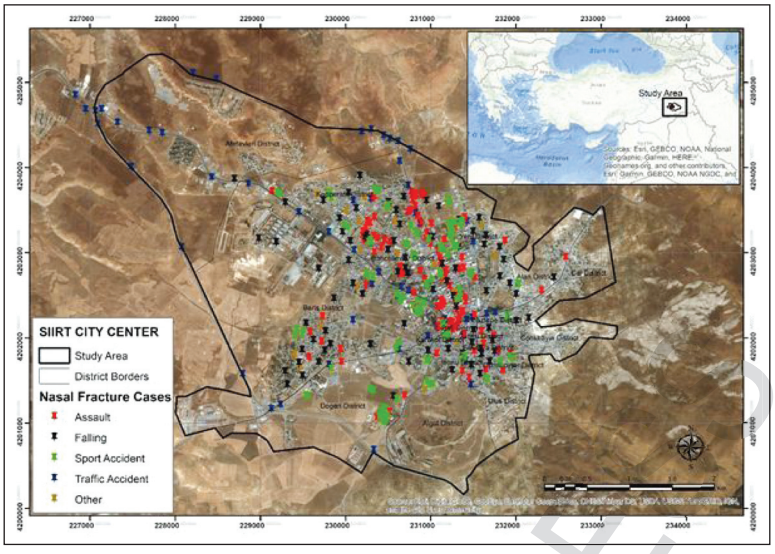

FIGURE 1: Study area and distribution of nasal fracture cases.

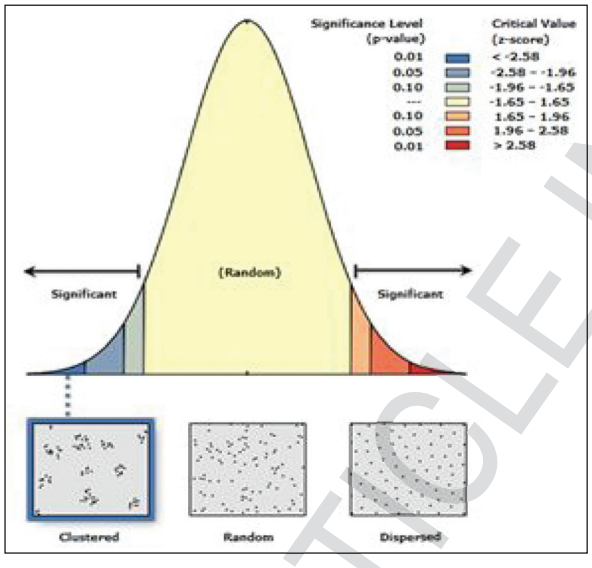

FIGURE 2: Graphic of nasal fracture cases with average nearest neighbour.

The Kernel Density Analysis method was used to determine where the nasal fracture cases with clustered point pattern feature were concentrated in Siirt city centre. Kernel density is a non-parametric approach to determine the probability density function of the random variable. It determines a magnitude per unit area from point features using a kernel function to fit a smoothly tapered surface to each point.[9] The surface value is highest at the location of the point, and diminishes away from the point, reaching zero at the end of the radius (Figure 3).[10]

The kernel density method imposes a regular grid onto the study area and uses a three dimensional kernel function to visit each grid cell (Figure 3) and to calculate a density value assigned to each grid cell.[11] The final kernel density estimate for one cell is then calculated by totalling all the values obtained from all the kernel density functions for that particular cell.[12]

The location information of patients who were diagnosed with nasal fracture between 01.03.2017 and 01.11.2018 were first added to the Google Earth program in kml format. After converting the obtained data to shapefile format in the ArcGIS software, the properties of point patterns were first presented with ANN. Kernel Density Analysis was then applied to the nasal fracture cases, which were found to show clustered point pattern characteristics.

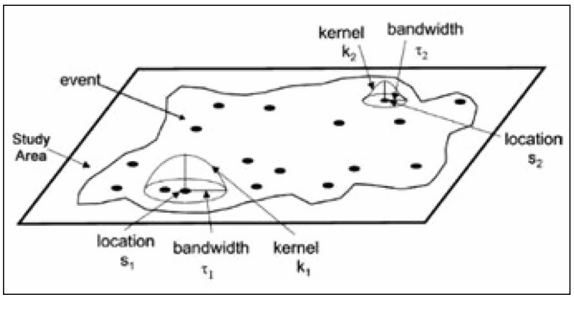

FIGURE 3: The principle of kernel function.

RESULTS

The study included a total of 404 patients with nasal fracture recorded between 01.03.2017 and 01.11.2018. The patients comprised 294 males (72.77%) and 110 females (27.22%) with a mean age of 22.30 years (range: 2-91 years). According to gender, the average age was 21.90 years in males and 23.38 in females. Of the female patients, 57 were younger than 18 years old and 53 were older. Of the male patients, 146 were under 18 years old and 148 were older. Of the male patients, 146 were under 18 years old and 148 were older (Table 1).

When patients were classified according to gender and age groups, in the male group, 57 were aged 0-10 years, 111 were 11-20 years, 70 were 21-30 years, 21 were 31-40 years, 19 were 41-50 years, 12 were 51-60 years, and 4 were older than 60 years. In the female group, 31 were aged 0-10 years, 33 were 11-20 years, 15 were 21-30-years, 12 were 31-40 years, 9 were 41-50 years, 5 were 51-60 years, and 5 were older than 60 years (Figure 4).

According to the etiology, 33.66% of the cases were physical assault, 15.53% were falling, 27.19% were sport injuries, 10.75% were traffic injuries and 13.07% were other causes. When the etiological reasons were examined according to gender, in the male patients, physical assault was found to be 43%, traffic injuries 20%, sports injuries 20%, falling 11% and other causes 6%. In the female patients, falling was occured in 34%, physical assault in 27%, traffic injuries in 18%, sports injuries in 17% and other causes in 4%. In patients aged younger than 18 years, sports injuries occured in 49%, falling in 23%, physical assaults in 19%, traffic injuries in 8% and other causes in 1% (Figure 5).

The map produced by 404 cases in the central neighborhoods of Siirt province is shown in Figure 6.

According to the results of the density map, it was found that the nasal fracture cases were concentrated on Gures Avenue in the city centre and Bahçelievler, Batı, Karakol and Yeni Mahalle neighbourhoods around this street.

TABLE 1: The number of patients, average age and under 18 years old distribution.

	Male	Female	Total
Number of patients	294 (72.77%)	110 (27.22%)	404 (100%)
Average age (years)	21.90	23.38	22.30
Under 18 years old	146/294 (49.65%)	57/110 (51.81%)	203/404 (50.24%)

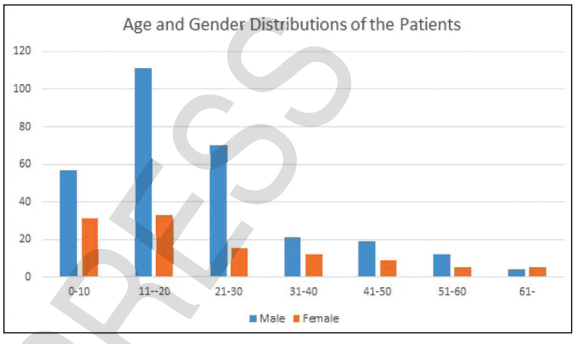

FIGURE 4: Age and gender distributions of the patients.

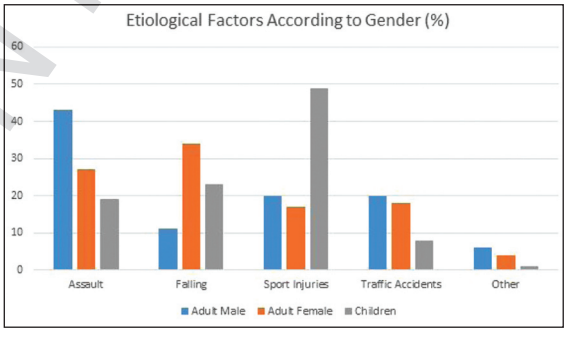

FIGURE 5: Etiological factors according to gender.

DISCUSSION

The mapping of social health problems with GIS helps to provide information about the spatial distribution of diseases and to identify problematic points. GIS support was first used in mapping the spatial distribution of infectious diseases, such as cholera epidemics in the 1800s.[13] At the present time, these methods are frequently preferred in epidemiological studies. In this study, with the use of the kernel density method, nasal fracture distribution and high-risk areas were determined. According to the results, cases of nasal fractures are more frequently seen in the city centre and newly developing neighborhoods of Siirt city. This is because these areas are the cen-

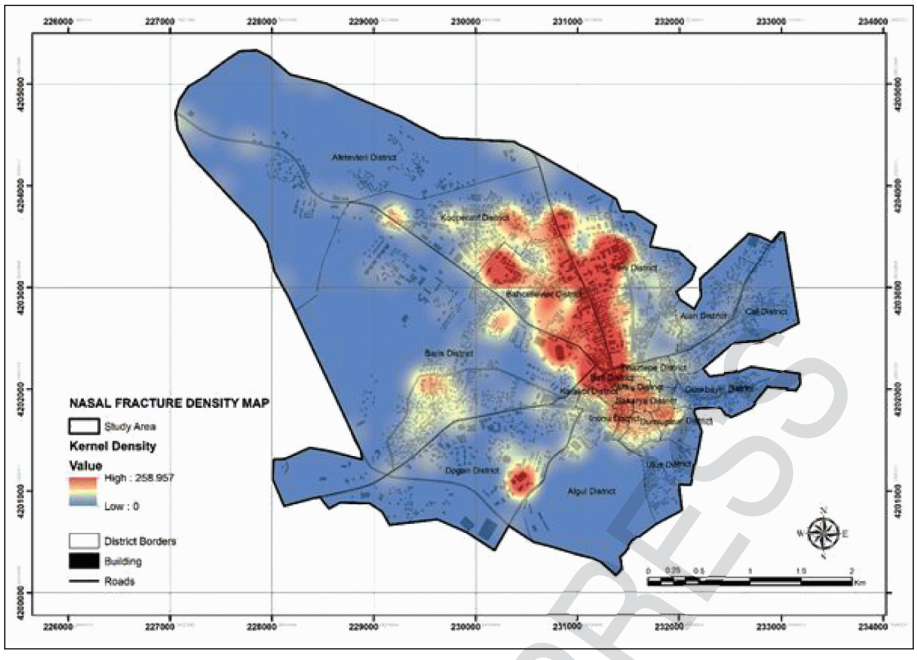

FIGURE 6: Nasal fracture density map.

tre of city life and residential areas. Thus, in these neighbourhoods, housing and population are more crowded and dense than in the outlying areas of the city. It has been observed that especially in newly developing neighborhoods, the cases of assault have become widespread. This can be attributed to arguments becoming physical among young people due to the sociocultural decline often seen in these neighbourhoods. Increasing the sociocultural level and security measures in these neighbourhoods could decrease street arguments, and lead to a reduction of cases of assault.

Nasal fracture is a common condition caused by maxillo-facial trauma, which has cosmetic and functional results due to the location in the middle of the face. Etiological causes, age and gender differences have been evaluated in many epidemiological studies. In this study, etiological data were marked on the city map using the ArcGIS method and evaluated with a density map. To the best of our knowledge, this is the first study in literature to show the epidemiological and etiological data of nasal fractures on a map.

Nasal fracture cases are more common in underdeveloped societies with low sociocultural levels.[14] Higher population densities, unemployment, and low education levels in these areas, may increase interpersonal violence. Fracture cases have been reported to be intensified in areas where there is a higher density of population and personal communication. Especially in males, the rate of physical assault is high. The reason for more higher incidence in males has been evaluated as more frequent exposure to physical contact and arguments.[15] Nasal fractures as a result of physical assault are more common in high risk areas such as schools, busy streets and shopping areas. In underdeveloped societies, although violence against women is common, it is often not reported because of male dominance in the social structure. Therefore, due to the concealment of domestic violence in particular, the etiology in female patients has been recorded predominantly as falls and other reasons rather than physical assault. Increasing the sociocultural level to enable women to express themselves more easily, providing easier contact with security forces and increasing street camera systems could provide real data. Despite frequent trauma in the paediatric population, the lower rate of physical assault in the etiology may be related to the elasticity of the nasal bones and lower energy of trauma, causing nasal soft tissue damage rather than nasal fractures.[16]

Most of the fall cases occurred in the home and no particular intensity was observed on the map.

The rate of these cases was higher in women, children and the elderly. The map density of falls was not concentrated in any specific area especially because of falls on icy streets in the winter, children in the school playground, and dizziness, chronic diseases, unsupported mobilization and on domestic slippery floors such as in the bathroom for the elderly population.

When the nasal fractures due to traffic injuries were marked on the map, an increase was observed in the intersection areas and on ring roads where vehicle speed increased. Nasal fractures and multiple trauma can be seen together as a result of in-vehicle and out-of-vehicle traffic injuries in the city. However, in underdeveloped countries, traffic injuries are more frequent due to the use of alcohol, not using seatbelts and driving without a license.[17] Important precautions that can be taken include increasing the number of pedestrian underpasses and overpasses, educating pedestrians about safe road crossing, increasing both pedestrian and motorist awareness and reducing drink-driving habits.

School sports halls, football fields, basketball fields and other sports areas are marked on the map and nasal fractures are concentrated in these regions. Nasal fractures are more common in children due to sports injuries than physical assault and falling, and sports injuries may be caused by higher energy trauma.[18,19] As males and children do sports more often than females, this is reflected in the increase in fracture frequency.

CONCLUSION

In conclusion, the determination of nasal fracture etiologies and geographic distribution provides a better understanding of epidemiology. The same GIS can be used to understand the epidemiology of diseases in many different disciplines such as oncology, infectious diseases, orthopaedics, dermatology or endocrinology. This will help to map the diseases, determine high-risk areas and prepare precautionary action plans.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Mert Cemal Gökgöz, Merve Ersoy Mirici;* ***Design:*** *Merve Ersoy Mirici;* ***Control/Supervision:*** *Mert Cemal Gökgöz;* ***Data Collection and/or Processing:*** *Mert Cemal Gökgöz, Merve Ersoy Mirici;* ***Analysis and/or Interpretation:*** *Merve Ersoy Mirici;* ***Literature Review:*** *Mert Cemal Gökgöz, Merve Ersoy Mirici;* ***Writing the Article:*** *Mert Cemal Gökgöz;* ***Critical Review:*** *Mert Cemal Gökgöz, Merve Ersoy Mirici;* ***References and Fundings:*** *Merve Ersoy Mirici.*

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