



## Consequences of the COVID-19 pandemic on fracture distribution: Epidemiological data from a tertiary trauma center in Turkey

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### Abstract

Redefinition of our social life for COVID-19, with social distance, prohibition of entering and exiting cities, closure of social areas and curfews effects every aspect of our lives, from psychological to physical. The aim of this study was to evaluate the injury mechanisms, fracture frequencies and priority treatment preferences in a tertiary trauma center from Turkey during the COVID-19 pandemic, both in adult and pediatric populations, and to compare them with pre-COVID-19 period. In this single-centered study, 960 patients (with 1039 fractures) who were admitted to a tertiary trauma center in Turkey, between April 2020 and December 2020 were examined. A control group of 964 patients (with 1070 fractures) who were admitted in the same date range of 2019 was formed. Patient demographics, injury mechanisms, fracture type and preferred treatment methods were recorded. There was a significant difference regarding injury mechanism between groups in both adult and pediatric populations ( $p=0.002$  and  $p<0.001$ , respectively). In adults, according to the residual values, there was significant difference between groups in terms of proximal humerus, elbow, forearm, hand, femoral shaft and knee fractures ( $p<0.001$ ). Among pediatric patients, a significant difference was found between groups in terms of proximal humerus, hand and knee fractures ( $p<0.001$ ). In the pediatric population, there has been a significant increase in the preference of conservative treatment in the pandemic group ( $p=0.002$ ). With increased indoors time, restriction of outdoors physical activities and lesser time in traffic, fracture distribution and priority treatment preferences have inevitably changed. In Turkey, the frequency of almost all upper extremity fractures except proximal humerus and humerus shaft fractures have increased significantly in the adult population, while the frequency of lower extremity fractures associated with high-energy injuries have decreased. In the pediatric population, treatment preferences are shifting towards conservative methods rather than surgery during the COVID-19 pandemic.

**Keywords:** pandemics, vehicle accidents, fracture epidemiology, trauma

### 1. Introduction

Although new vaccines developed nowadays are a ray of hope, the threat of COVID-19 is still as valid as on the first day, given the new mutations seen, lack of therapeutic drugs and doubts about the long-term efficacy of vaccines. As a result, public health measures are seen as the only way to prevent the progress of the pandemic since the early days (1, 2). A new concept of normal has been formed that redefines our social life with many features such as compulsory social distance, prohibition of entering and exiting cities, closure of cafes, restaurants, cinemas and other social areas, and curfews.

This “New Normal” has unavoidable effects on every aspect of our lives. While anxiety, increased stress and depression constitute the psychological aspect (3, 4), the changing injury mechanisms and fracture prevalence due to the decrease in the duration of outdoors physical activity and time in traffic and the increase in the time spent indoors constitute the physical aspect (5).

The aim of this study was to evaluate the injury mechanisms, fracture frequencies and priority treatment preferences in a tertiary trauma center from Turkey during the COVID-19 pandemic, both in adult and pediatric populations, and to compare them with pre-COVID-19 period.

### 2. Materials and Methods

This study was approved by the Ministry of Health and the local ethics committee. After ethical board approval, between April 2020 and December 2020, patients who were admitted to the emergency department of our hospital, which is one of the biggest tertiary trauma centers in Turkey, and consulted to the department of Orthopedics and Traumatology, were examined retrospectively. Inclusion criteria were determined as patients who admitted to the emergency department due to isolated orthopedic trauma, regardless of the injury mechanism and age, between the specified dates. In this context, patients with any internal organ injuries were not included in the study and a total of 1408 patients were examined. The exclusion criteria were determined as isolated soft tissue injuries without any fractures, fractures of axial skeleton (vertebra, scapula/clavicle, and ribs), pathological or old fractures, isolated joint dislocations without any fractures, ischemic wounds or diabetic feet, septic arthritis, abscess formations and prosthetic infections. A total of 448 patients were excluded from the study and 960 patients (with 1039 fractures) were evaluated.

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A control group was formed from the patients who were admitted to the emergency department for any reason and consulted to the department of Orthopedics and Traumatology in the same date range of the previous year (April - December 2019). Considering the same inclusion and exclusion criteria, 458 patients were excluded from the 1422 patients that were examined and a control group of 964 patients (with 1070 fractures) was formed.

To evaluate adult and pediatric patients separately, pandemic (2020 admissions) and control (2019 admissions) groups were divided into subgroups. 18 years of age was accepted as the border and patients aged 18 and over were considered adults, while patients under 18 years old were considered children. Patient demographics (age and gender), injury mechanisms, fracture type and preferred treatment methods (conservative or surgery) were recorded. Injury mechanisms were defined as low-energy falls, high-energy falls (such as falling off balcony, ladder or tree), direct blows (commonly seen as domestic injuries), high-energy direct traumas (usually associated with assaults or working place accidents such as concrete falling on workers), traffic accidents (as passengers, drivers or pedestrians), sports injuries and gunshot wounds.

Fracture types were examined under 13 main headings, consisted with anatomical locations: Proximal humerus fractures, humeral shaft fractures, fractures of the elbow area (distal humerus, proximal ulna or proximal radius), forearm fractures, wrist fractures (distal radius or ulna), hand fractures (carpal, metacarpal or phalangeal), pelvis/acetabulum fractures, hip fractures (femoral neck, pertrochanteric or subtrochanteric), femoral shaft fractures, fractures of the knee area (distal femur or proximal tibia), tibia/fibula shaft fractures, ankle fractures (distal tibia metaphyseal or malleolar) and foot fractures (tarsal, metatarsal or phalangeal).

Statistical analyzes were performed using SPSS 18 software. The compliance of the variables to normal distribution were examined by visual (histogram and probability graphs) and analytical (Kolmogorov-Smirnov/Shapiro-Wilk tests) methods. For variables that are not normally distributed, descriptive analyzes were defined using median and interquartile range whereas frequency tables were used for nominal variables. Whether there was a difference between the groups in terms of "Age" variable was compared using the Mann Whitney U Test. Comparison of categorical data, such as "Gender", "Injury mechanism" and "Fracture frequency", has been analyzed with the Chi-Square Test, and for data that does not meet the Chi-Square conditions, Monte Carlo was applied. Detailed comments were made using residual values. The situations where the P value was below 0.05 were considered statistically significant.

### 3. Results

The frequency of traffic accidents in the pandemic group for adult and pediatric populations were 11.7% (79 cases) and 4.2% (12 cases) respectively, with a significant difference between control group ( $p=0.002$  and  $p<0.001$ , respectively). Patient demographics of adult and pediatric populations can be seen in Tables 1 and 2.

**Table 1.** Demographic data of the adult population

Adult Population (N= 1418)		Pandemic Group (N= 674)	Control Group (N= 744)	P
Age		46.9 (Range: 18-99)	49 (Range: 18-95)	0.139
Gender	Male	348 (51.6%)	394 (53%)	0.321
	Female	326 (48.4%)	350 (47%)	
Injury Mechanism	Low-Energy Fall	355 (52.7%)	380 (51.1%)	0.002
	High-Energy Fall	61 (9.1%)	52 (7%)	
	Direct Blow	111 (16.5%)	107 (14.4%)	
	High-Energy Direct Trauma	55 (8.2%)	41 (5.5%)	
	Traffic Accident	79 (11.7%)	143 (19.2%)	
	Sports Injury	4 (0.6%)	8 (1.1%)	
	Gunshot Wound	9 (1.3%)	13 (1.7%)	

N: number of patients. P: statistical significance value.  $P<0.05$  was accepted as statistically significant

**Table 2.** Demographic data of the pediatric population

Pediatric Population (N= 506)		Pandemic Group (N= 286)	Control Group (N= 220)	P
Age		8 (Range: 0-17)	9.4 (Range: 0-17)	0.001
Gender	Male	200 (69.9%)	156 (70.9%)	0.811
	Female	86 (30.1%)	64 (29.1%)	
Injury Mechanism	Low-Energy Fall	220 (76.9%)	167 (75.9%)	<0.001
	High-Energy Fall	8 (2.8%)	13 (5.9%)	
	Direct Blow	40 (14%)	10 (4.6%)	
	High-Energy Direct Trauma	0	8 (3.6%)	
	Traffic Accident	12 (4.2%)	22 (10%)	
	Sports Injury	6 (2.1%)	0	

N: number of patients. P: statistical significance value.  $P<0.05$  was accepted as statistically significant

In adults, most common fractures seen in the pandemic group were hand (17.8%) and foot (15.8%) fractures. According to the residual values, there was significant difference between pandemic and control groups in terms of proximal humerus, elbow, forearm, hand, femoral shaft and knee fractures ( $p<0.001$ ) (Table 3).

Most common fractures seen in the pandemic group in pediatric population were elbow (25.1%) and wrist (19.1%) fractures. According to the residual values, there was significant difference between pandemic and control groups in terms of proximal humerus, hand and knee fractures ( $p<0.001$ ) (Table 4).

**Table 3.** Fracture frequency of adult fractures in pandemic and control groups

Fracture (N= 1571)	Pandemic Group (N= 736)	Control Group (N= 835)	P
Proximal Humerus	34 (4.6%)	66 (7.9%)	< 0.001*
Humerus Shaft	13 (1.8%)	22 (2.6%)	
Elbow	43 (5.8%)	20 (2.4%)	
Forearm	26 (3.5%)	8 (1%)	
Wrist	94 (12.8%)	90 (10.8%)	
Hand	131 (17.8%)	114 (13.7%)	
Pelvis/ Acetabulum	71 (9.6%)	82 (9.8%)	
Hip	93 (12.6%)	99 (11.9%)	
Femur Shaft	13 (1.8%)	34 (4.1%)	
Knee	32 (4.3%)	70 (8.4%)	
Tibia/Fibula	16 (2.1%)	15 (1.8%)	
Ankle	54 (7.3%)	73 (8.7%)	
Foot	116 (15.8%)	142 (17%)	

N: number of fractures.

In adults, surgical treatment was preferred in 316 fractures (42.9%) in the pandemic group and 325 fractures (38.9%) in the control group, with no significant difference between groups ( $p= 0.186$ ). On the other hand, in pediatric population, there was a significant difference between groups regarding preferred treatment methods ( $p= 0.002$ ) (Table 5).

**Table 4.** Fracture frequency of pediatric fractures in pandemic and control groups

Fracture (N= 538)	Pandemic Group (N= 303)	Control Group (N= 235)	P
Proximal Humerus	2 (0.7%)	8 (3.4%)	< 0.001*
Humerus Shaft	7 (2.3%)	4 (1.7%)	
Elbow	76 (25.1%)	62 (26.4%)	
Forearm	31 (10.2%)	18 (7.7%)	
Wrist	58 (19.1%)	33 (14%)	
Hand	44 (14.5%)	13 (5.5%)	
Pelvis/ Acetabulum	12 (4%)	10 (4.3%)	
Hip	0	1 (0.4%)	
Femur Shaft	11 (3.6%)	17 (7.2%)	
Knee	5 (1.7%)	18 (7.7%)	
Tibia/Fibula	16 (5.3%)	10 (4.3%)	
Ankle	11 (3.6%)	12 (5.1%)	
Foot	30 (9.9%)	29 (12.3%)	

**Table 5.** Preferred treatment methods of adult and pediatric populations

Preferred Treatment Method	Adult Fractures (N= 1571)		Pediatric Fractures (N= 538)	
	Pandemic Group (N= 736)	Control Group (N= 835)	Pandemic Group (N= 303)	Control Group (N= 235)
Conservative Treatment	420 (57.1%)	510 (61.1%)	234 (77.2%)	153 (65.1%)
Surgical Treatment	316 (42.9%)	325 (38.9%)	69 (22.8%)	82 (34.9%)
P	0.186		0.002	

#### 4. Discussion

Although there are many studies in the literature analyzing the effects of the COVID-19 pandemic on social life, studies focusing the effect of changes in our social habits on fracture frequency and priority treatment preferences are usually limited to the countries in which they have been conducted (5-11). To our knowledge, this is the first study in the literature that examines this subject to such a wide extent in Turkey. This is the main strength of our study. One of the most important findings in our study was that there was a significant difference between pandemic and control groups in terms of proximal humerus, elbow, forearm, hand, femoral shaft and knee fracture frequencies in adult population. Additionally, in the pediatric population, there was significant difference between pandemic and control groups in terms of proximal humerus, hand and knee fracture frequencies. Furthermore, there was a significant difference between groups regarding treatment methods in the pediatric population.

The "pandemic of our age", which deeply affects the whole world, changes, and shapes everything from our work patterns to our kinship relationships, from our social habits to our health routines. For this reason, it is inevitable that the injury mechanisms will change during this period. It is essential to master this change and to be shaped accordingly, in order to provide maximum benefit to our patients. One of the most important lifestyle-changes we encountered in this period was the increased indoors time. It is a logical assumption that, with increased indoors time, common reasons for fractures such as traffic accidents will decline while minor fractures due to domestic accidents will increase. Our study supports this hypothesis. Even though the frequency of low-energy falls is similar in both groups, the frequency of traffic accidents declined while the frequency of direct blows has increased in the pandemic group, both in adult and pediatric populations ( $p= 0.002$  and  $p< 0.001$ , respectively). Another notable increase was observed in the frequencies of high-energy direct trauma and high-energy falls in adult population. Curfews, prohibitions on city entrance and exits, flexible working patterns, increased indoors time and increased stress are the main reasons for the change in injury mechanisms. In particular, with the curfews and the prohibitions of city entrance and exits, traffic rates decrease significantly, which reduces the frequency of traffic accidents. With flexible working patterns and lesser workforce engaging in manual labor, it is inevitable to have an increase in occupational accidents, despite all workplace safety measures taken. The decrease in children's playing time in parks and playgrounds and a considerable increase in indoors activity time results in a decrease in high-energy injury mechanisms seen in the pediatric population and an increase in household accidents (12). Finally, increased stress and anxiety during the COVID-19 pandemic, with combination of fear of infection,

can damage the mechanisms of people to cope with stress, resulting in an increase in boxer's fracture cases, especially in adolescents (13).

In the pandemic group, average age of patients in pediatric population was 8 years (Range: 0-17 years) whereas in the control group average age was 9.4 years (Range: 0-17 years) ( $p=0.001$ ). Our findings are consistent with the literature. Turgut et al., in their study of 670 fractures, has stated that pediatric patients with a fracture was younger, compared to pre-pandemic period (5). The reason for this may be the restriction of the time spent outside and the decrease in sports activities, which are one of the main causes of adolescent fractures (5, 12).

Considering that phalanx fractures of hand and foot are among the most common fractures (14, 15), it was an expected result that the most common fractures of adults in our study were hand (17.8% vs. 13.7%) and foot (15.8% vs. 17%) fractures both in pandemic and control groups. According to the residual values, there was a significant increase in the frequency of hand fractures (carpal, metacarpal and phalangeal fractures) in both adult and pediatric patients ( $p<0.001$  and  $p<0.001$ , respectively). Furthermore, a significant increase in elbow and forearm fractures were observed in adults during the COVID-19 pandemic. However, proximal humerus fracture frequency was decreased significantly, both in adult and pediatric populations. There are reports with similar results in the literature (5,9,16,17). As mentioned before, with increased stress during the COVID-19 pandemic, an increase of boxer's fracture cases, especially in adolescents, is expected (13). In addition, the increased indoors time leads to an increase in domestic accidents, which explains the increased frequency of phalanx fractures. The increase of elbow and forearm fractures of adults can be explained with the increase of occupational accidents, especially in heavy-duty workers and manual laborers, which is an inevitable result of flexible work-pattern. Absence of sports and school injuries of pediatric population may explain the decrease of proximal humerus fracture frequency (16). On the other hand, it is an unexpected result that proximal humerus fractures in adult population decreases, considering the increase in other upper extremity fractures and the fact that proximal humerus fractures of elderly usually occurs with domestic injuries, independently from the pandemic (17).

According to the residual values, knee fractures (distal femur and tibial plateau fractures) were significantly lower in both adult and pediatric populations in the pandemic group ( $p<0.001$  and  $p<0.001$ , respectively). Additionally, a significant decrease was found in femoral shaft fractures in the adult population. Femoral shaft, distal femur and tibial plateau fractures are often associated with high-energy injuries in younger adults, such as traffic accidents. The reduced time spent in traffic during the COVID-19

pandemic may be the main reason for the decrease in the frequency of these fractures. On the other hand, in the pediatric population, femoral shaft fractures can be seen with domestic injuries, like falling from bunk beds. Therefore, it was not surprising that although femoral shaft fracture frequency was decreased in pediatric population, there was no significant difference, according to the residual values.

In adults, 316 fractures (42.9%) in the pandemic group and 325 fractures (38.9%) in the control group were treated surgically ( $p=0.186$ ). Most operated fractures were hip fractures in both groups (88 fractures, 12% and 76 fractures, 9.1% respectively), similarly with the literature (6,7), followed by ankle fractures (41 fractures, 5.6% and 66 fractures, 7.9%, respectively). Because hip fractures usually occur in the elderly population with osteoporotic background and with low-energy injuries such as domestic accidents, it was an inevitable fact that the frequency of hip fractures remained stable during the COVID-19 pandemic, as stated in the literature (5, 8, 18). Ankle fractures usually occur because of low-energy injuries such as basic falls or ankle sprains, and surgery is necessary if the fracture is instable (19). Therefore, it was an expected result that the frequency and necessity of surgery of ankle fractures did not change during the COVID-19 pandemic, just like hip fractures. Among pediatric patients, while 234 patients (77.2%) were treated conservatively and 69 patients (22.8%) surgically in the pandemic group, 153 patients (65.1%) were treated conservatively, and 82 patients (34.9%) were treated surgically in the control group ( $p=0.002$ ). Most operated fractures were elbow fractures in both groups (41 fractures, 13.5% and 31 fractures, 13.2%, respectively), with majority of cases being supracondylar fractures of humerus. Turgut et al. has stated that the rate of surgically treated fractures has increased during the early times of the COVID-19 pandemic (5). On the other hand, Iyengar et al. has suggested that conservative methods provide an alternative in non-obligatory fractures during the pandemic (20). Our study has shown that, while no significant difference was found among adults, treatment priority has shifted to conservative methods in children. Bram et al. have found a similar adaptation in their study of 1745 pediatric fractures (12). Parents' fear of increased virus exposure with hospitalization may be the main reason for this adaptation. Furthermore, the assignment of all available medical personnel to COVID-19-related wards and intensive care units, the conversion of most operating rooms into intensive care units, the provision of all available patient beds to COVID-19 patients and the reluctance of the surgeon to operate in an atmosphere of increased risk of viral exposure, in order to protect himself and his surgical team, also play an important role in this adaptation. Although all these factors are valid for adult fractures, the conservative treatment indications for adult fractures are

much more limited and the pediatric population responds much better to conservative treatment, which explains the limitation of this adaptation only to the pediatric population. Therefore, conservative methods have been the primary choice for all possible fractures in pediatric population during the COVID-19 pandemic.

There are some limitations in our study. First of all, there are many probable confound factors associated with fracture frequencies and injury mechanisms, such as weather conditions, which we were not able to take into account. Secondly, open phalanx fractures such as subtotal amputations were not included in the study. The reason for this is, in accordance with the internal regulations of our hospital, such fractures are consulted to the plastic surgery department and the treatment is planned by them. Thirdly, our fracture frequency analyses are based on anatomical classifications. However, more accurate results can be obtained with advanced statistics that evaluate specialized or common fractures such as pediatric supracondylar humerus fractures or physeal fractures as separate groups. Finally, although our findings as a single-centered study suggest a country-wide fracture epidemiology, the fact that our study was based on a single hospital is an important limitation.

The distribution and frequencies of fractures have inevitably changed during the COVID-19 pandemic, with increased indoors time, restriction of outdoors physical activities such as contact sports, lesser time in traffic and increased stress. In Turkey, the frequency of almost all upper extremity fractures except proximal humerus and humerus shaft fractures have increased significantly in the adult population, while the frequency of lower extremity fractures associated with high-energy injuries have decreased. In the pediatric population, treatment preferences are shifting towards conservative methods rather than surgery during the pandemic of our age.

### Conflict of interest

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

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