



## Injury, hospitalization, and operation rates are low in aerial sports



Arif Alper Cevik<sup>a, b, \*</sup>, Filiz Baloglu Kaya<sup>b</sup>, Nurdan Acar<sup>b</sup>, Adnan Sahin<sup>b</sup>, Engin Ozakin<sup>b</sup>

<sup>a</sup> Internal Medicine, Emergency Medicine Clerkship, United Arab Emirates University, United Arab Emirates

<sup>b</sup> Department of Emergency Medicine, Eskisehir Osmangazi University, Turkey

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### ABSTRACT

**Objectives:** Aerial sports can cause serious injuries. The rate of injuries is nevertheless reasonably low, contrary to popular belief. This study aimed to evaluate the rate and severity of injuries to ASI patients presented to our Emergency Department (ED).

**Material and methods:** The study was held at a university medical center. The patients who were presented or transferred to the ED in a four year period were retrospectively reviewed.

**Results:** 73.2% of patients were male. The mean age of patients was 28.6. The distribution of injury rates by activity was as follows: 1.46% in parachuting, 0.35% in paragliding, and 0.04% in hang-gliding. 75.6% of patients were trainees. In 82.9% of patients, the injury occurred during the practical session of training. The most common injury is soft tissue and ligamentous (ST/L) injury (41.5%). 25 patients (61%) had isolated lower extremity injuries (13 of them had fractures). Other isolated injuries were head trauma in 2 (4.9%) and vertebral fractures in 3 (7.3%) patients. 4 (9.8%) patients were diagnosed with multiple injuries. The overall rate of hospitalization was 0.07% (0.16% in parachuting, 0.08% in paragliding, and 0.03% in hang-gliding). The need for operation in overall activities was 0.04% (0.08% in parachuting, 0.03% in paragliding, and 0.03% in hang-gliding). The mortality rate was found to be zero in the region.

**Conclusion:** Aerial sports are considered dangerous sports activities, but the injury, hospitalization, and operation rates are low.

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### 1. Introduction

Every day, more and more people are engaged in risky sports activities without paying attention to safety measures. Sports safety is influenced by many factors including age, type of sport, behavior of individuals, weather conditions or quality of sports gears. However, some sports activities are more prone to serious injuries than others, such as skiing, climbing, and aerial sports.

The World Aerial Sports Federation (FAI - Fédération Aéronautique Internationale) is the particular organization responsible for governing aerial sports since 1905. Today, the FAI lists thirteen different activities as air sports, including ballooning, hang gliding, paragliding, micro-lighting, and parachuting. The FAI has more than 100 member countries, and Turkey is one of the active members. Aerial sports centers in Turkey host many sportive activities for visitors from Turkey and other countries. One of the

major centers is located 20 km away from the city center. There are approximately 3400 flights in a regular season (5 months a year) in the area.

Human beings have been creating and popularizing new air sports activities since 1905, and there are some aerial sports in the world that are not included in the FAI official list yet, such as wingsuit flights. Increasing types of air sports activities is associated with increasing the number of people involved in these sports. With the increasing number of participants, the number of related injuries has also increased gradually.<sup>1</sup> Safety, as an aviation standard, is crucial for aerial sports. Special gear; well-designed, secure equipment; and high-quality flight training in those sports are critical to decreasing the number of serious injuries. Aerial sports can cause serious injuries. However, the rate of injuries is reasonably low contrary to popular belief. One of the most challenging aerial sports activities is skydiving. Barrows et al. reported that the

\* Corresponding author. United Arab Emirates, University College of Medicine, Emergency Medicine Clerkship, Internal Medicine, Al Ain 17666, United Arab Emirates.

E-mail address: [aacevik@uaeu.ac.ae](mailto:aacevik@uaeu.ac.ae) (A.A. Cevik).

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injury rate for skydiving is 0.17%, and two-thirds of the injuries were minor injuries that were managed with simple first aid.<sup>2</sup>

We are faced with air sports injuries (ASI) every summer in our region. There have so far been no studies on the rate and severity of these injuries in the region and country. Therefore, we aimed to evaluate the rate and severity of ASI patients presenting to our Emergency Department (ED).

## 2. Material and methods

### 2.1. The study design and setting

This is a retrospective study was held in the emergency department of the university hospital, which is a tertiary care center for trauma patients.

### 2.2. Patient selection

The patients who presented or were transferred to the ED for ASI for four consecutive years, were included in the study group. The patients having incomplete files (see data collection) or who were transferred to a different facility were excluded from the study.

### 2.3. Data collection and measurements

A list of the patients was obtained from the hospital information system retrospectively. The detailed medical information of patients was found in electronic health records and archived patient files. Total number of flights was taken from the aerial sport center. Descriptive data of patients including age, gender, month of presentation, type of air sport, injured part of the body, need for hospitalization and operation, and mortality was recorded for the purpose of this study. Furthermore, we asked whether the injured patient was a trainee or an instructor, and also whether the accident happened during the practice session of training or in a competition.

### 2.4. Outcomes

Hospitalization, need for a surgical operation, morbidity, and mortality were defined as outcome measures of the study.

### 2.5. Analysis

Chi-Square and Fisher's exact tests were used for descriptive analyses. When the *p*-value is under 0.05, the results were considered statistically significant. Descriptive statistics were presented as mean and standard deviation (SD) for normally distributed variables. Statistical Package for the Social Sciences (SPSS, version 18) was used for statistical analyses.

### 2.6. Conflict of interest

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

## 3. Results

There were 44 patients in the hospital information system database in four consecutive years. 41 of those met the inclusion criteria. Table 1 presents descriptive information on the patients, injuries, and types of activity causing injury.

**Table 1**  
General distribution of patients.

	Parachuting	Paragliding	Hang-gliding
Total number of flight	1225	5660	6603
Male	12	15	3
Female	6	5	none
Mean age	24.9 [SD: 5.2]	31.4 [SD: 11.9]	32.0 [SD: 11.2]
Trainee	13	16	2
Instructor	5	4	1
Upper extremity ST/L injury	3	2	None
Upper extremity fracture	None	1	1
Lower extremity ST/L injury	8	3	1
Lower extremity fracture	9	3	1
Head injury	None	2	None
Vertebral injury	None	3	None
Multiple injury	1	3	None
Need for hospitalization	2	5	2
Need for operation	1	2	2
Mortality	None	None	None
Accident during launching	None	2	None
Accident during flight	None	None	None
Accident during landing	20	16	3

### 3.1. Age and gender

30 (73.2%) of patients were male. The mean age of patients was 28.6 (SD: 9.87, range 17–56). Male patients were older than female patients (30.9 [SD: 10.4] vs. 22.4 [SD: 4.25], *p* = 0.013). The patients injured during parachuting activities had a lower mean age than those injured during paragliding and hang-gliding (24.9 [SD: 5.2], *p* = NS). The mean age of patients with head trauma (39.0 [SD: 19.7]) was higher than that of patients with upper extremity fracture (36.0 [SD: 14.1]), multiple trauma (33.5 [SD: 9.8]), vertebral fracture (31.6 [SD: 14.3]), lower extremity trauma (27.4 [SD: 9.4]), and ST/L injury (25.7 [SD: 5.4]), *p* = NS.

### 3.2. Month of presentation

The distribution of patients according to the month they presented was as follows: 16 (39%) of patients in August, 11 patients (26.8%) in both June and July, two patients (4.9%) in September, and a patient (2.4%) in May.

### 3.3. Types of activity causing injury

Parachuting, paragliding, and hang-gliding were the three leading causes of ASI in the region. In the present study, 18 patients were injured in parachuting (43.9%), 20 patients in paragliding (48.8%) and three patients in hang-gliding (7.3%). During the period of the study, 1225 parachuting, 5660 paragliding, and 6603 hang-gliding flights were completed in the region. The injury rates by activity were 1.46% in parachuting, 0.35% in paragliding, and 0.04% in hang-gliding.

Level of experience (trainee or instructor), time of the incident (during training or competition), Safety Regulations.

Thirty-one (75.6%) patients were trainees. Of those, 23 (74.2%) were male. There were 10 injured instructors, and 7 (70%) of them were male. Thirty-four (82.9%) patients were injured during the practical session of training (PST). All seven patients (17.1%) who were injured in a competition accident were instructors. Trainee injuries were 72.2% in parachuting, 80.0% in paragliding, and 66.7% in hang-gliding. The majority of injuries occurred during practical sessions of training (83.3% in parachuting, 80.0% in paragliding, and 100% in hang-gliding).

Three of seven (42.9%) injuries that occurred in the competition were simple soft tissue injuries, while the remaining four patients

(57.1%) needed hospitalization. The rate of soft tissue injuries in competition is almost similar to the rate of injuries in the PST (41.2%). Three of four multiple injured patients were patients of PST.

As we collected the data retrospectively, we could not find the details of equipment and gear for patients in the hospital records. Following the data collection, we decided to visit the training and practice area of aviation activities in our region and found that strict rules for gear, equipment, and procedures have been applied as a standard in all activities.

### 3.4. Injuries by body part

The most common injury is soft tissue and ligamentous (ST/L) injury (17 patients, 41.5%). 12 of the ST/L injuries were in lower extremity, and five of them were in the upper extremity. 94.1% of ST/L injury patients had parachuting and paragliding injuries. 25 patients (61%) had isolated lower extremity injury (13 of them had fractures). There were seven upper extremity injuries, and two of them were fractures.

Other isolated injuries were head trauma in two (4.9%) and vertebral fracture in three (7.3%) patients. Four (9.8%) patients were diagnosed with multiple injuries. Patients with head trauma presented due to paragliding injury. The paragliding injury was also the cause of all three vertebral fractures. Nine of 13 patients (69.2%) with lower extremity fracture presented due to parachuting injury. Three of four multiple injured patients presented due to paragliding injury and the last one with multiple injuries due to parachuting injury.

ST/L injuries and extremity fractures were more common in male patients. 70.6% of the patients with ST/L injury, 100% of the patients with upper extremity fractures and 76.9% of patients with lower extremity fractures were male. Vertebral injuries were more common in female patients (66.7%). Head trauma was equally encountered in both genders. We did not find any neck, thoracic and abdominal injuries in our study. There was no death recorded at the time of presentation and in the clinical follow-up.

### 3.5. Outcome measures

Nine patients (22.0%) were admitted, and 32 patients (78.0%) were discharged from the ED. The majority of patients injured in parachuting and paragliding were discharged from the ED (16 patients, 88.9%, and 15 patients, 75.0%, respectively) while two out of three (66.7%) patients with hang-gliding injuries were admitted. 2 patients with hang-gliding injuries were operated. 55.6% of patients hospitalized had a paragliding injury (see Table 2).

30% of injured instructors and 19.4% of injured trainees were admitted for operation and further observation. 2 of 9 hospitalizations (22.2%) were due to injuries during competition; the other 7 hospitalizations were due to injuries during practical sessions of training.

All soft tissue injuries (17 patients) were discharged from the

ED. 50% of patients with head trauma, 66.7% of patients with vertebral fractures, all patients with upper extremity fractures, 15.4% of patients with lower extremity fractures, and 50% of patients with multiple injuries were hospitalized.

36.4% of female patients and 16.7% of male patients were hospitalized ( $p = 0.176$ ). The hospitalization rates of injured patients by aerial sports were as follows: 11.1% in parachuting, 25.0% in paragliding, and 66.7% in hang-gliding. The details related to the patients are presented in Table 2.

In total number of flights, we found that the overall rate of hospitalization was 0.07% (0.16% in parachuting, 0.08% in paragliding, and 0.03% in hang-gliding). The need for operation in overall activities was 0.04% (0.08% in parachuting, 0.03% in paragliding, and 0.03% in hang-gliding). The mortality rate was found to be zero in the region.

There was no significant difference between activity groups in the need for hospitalization and operation.

## 4. Discussion

Air sports activities are growing all around the world, and related injuries are increasing. Literature reveals a variety of injury rates. The mortality rate (0.005%) and injury rate (0.14%) were reported in a study evaluating 110,000 parachuting jumps.<sup>3</sup> Injuries described as significant in this study were soft tissue injuries (36.9%) and fractures (63.1%). A report assessing aviation-related injuries showed that parachuting is the most common air sports activity that causes injury.<sup>4</sup> The majority of parachuting injuries were in lower extremities. Although these results were quite similar to our findings (see Table 1), the injury rate related to parachuting activities in our study was 1.46%. Parachuting injuries were responsible for 69.2% of the lower extremity fractures in our study.

Landing is the most dangerous part of parachuting, and it is responsible for the majority of injuries.<sup>3</sup> Ignorance or noncompliance with regulations, inexperience, and carelessness are the factors that potentially affect the injury rate. However, appropriate equipment may be necessary to reduce the injury rates.<sup>5,6</sup> As we collected the data retrospectively, we could not find the details of equipment and gear of patients. To determine how effective the safety regulation for aviation sports is in our region, we decided to visit the training area and found that there are strict rules for gear and equipment, and procedures are applied as a standard. As the injuries reported in this study were mostly in trainees, the reason of the injuries might be the inexperience of pilots.

Para and hang-gliding are new aerial sports growing in the 20th century. The mortality rate was found 0.7% in Schulze et al.'s report,<sup>7</sup> and major injuries are common in these sports. In our study, three of the major injuries were vertebral fractures, and all occurred in paragliding flights. Four out of five operations were performed on patients who presented due to para- and hang-gliding injuries.

Injuries may occur during the takeoff, flight, and landing.

**Table 2**  
Details of admitted patients.

Patients	Age	Gender	Type of sport	Specifics of injury	Result
1	21	Female	Paragliding	Lumbar 3rd fracture	Operated and recovered
2	26	Male	Hang-gliding	Colles fracture of radius	Operated and recovered
3	32	Male	Paragliding	Minor head Trauma and Tibial fracture	No operation, recovered
4	25	Male	Parachuting	Lumbar 2nd, left transvers process fracture and Fibula fracture	No operation, recovered
5	26	Female	Paragliding	Lumbar 2nd fracture	No operation
6	20	Female	Parachuting	Tibia and Fibula fracture	Operated and recovered
7	25	Female	Paragliding	Minor head Trauma	No operation, recovered
8	46	Male	Paragliding	Colles fracture of radius	Operated and recovered
9	45	Male	Hang-gliding	Tibial fracture	Operated and recovered

Lautenschlager et al. reported that 60% of all accidents occurred during the landing phase, 26% at launching, and 14% during the flight in paragliding.<sup>8</sup> The injuries reported in this study happened during landing with a rate of 95.1%. Lautenschlager et al. also reported that the major injuries are spine (36%) and lower extremity (35%) injuries. The rates of spine injury and lower extremity injury were respectively 7.3% and 61% in our study. Spinal and lower extremity injuries were also reported as the most common injuries (34.9% and 13.4%) by Krüger-Franke et al.<sup>9</sup>

Injuries can be minimized by using appropriate footwear, padded back protection, the right size of parachutes or gliders, and improving piloting skills and safety training in courses.<sup>5,7,8</sup> In our study, the majority of the patients were trainees (inexperienced pilots). This also shows the importance of experience and training in preventing accidents. Although no death due to an accident was found in our study, hang-gliding injuries were found to be fatal in some reports, and the majority of fatal injuries were due to pilot errors, takeoff with inappropriate equipment, and unsafe weather conditions.<sup>10</sup>

The distribution of injury rates by activity was as follows in our study: 1.63% in parachuting, 0.31% in paragliding, and 0.04% in hang-gliding. Barrows et al. reported that the injury rate in skydiving is 0.17%, and two-thirds of the injuries were minor and could be managed with simple first aid.<sup>2</sup> Westman et al. reported that the rate of non-fatal injury incidents was 48 per 100,000 jumps.<sup>11</sup> Supporting our findings in this study, they found that the lower extremities, spine, and shoulders were the most frequently injured body parts. They also stated that licensed skydivers experienced the most serious injuries, although trainees had a greater injury rate. We could not find a significant difference in injury severity between trainees and instructors probably because of the small number of injured patients in our study.

Although the distribution of hospitalization rates of injured patients by the aerial sports was 11.1% in parachuting, 25.0% in paragliding, and 66.7% in hang-gliding, the total number of injured patients was low in our study. The overall hospitalization rate in total number of flights was 0.07%, and the need for an operation was 0.04% in the present study. The mortality rate was found zero. Although aerial sports are considered dangerous sportive activities, our findings may suggest that the air sports activities mentioned in our study have the low injury, morbidity, and no mortality rates.

However, aerial sports may cause severe injuries and mortality. In 2015, Canbek et al. reported that 64 accidents happened during 242355 paragliding flights. 82 athletes were traumatized in those accidents. 18 out of 82 lost their lives (21.9%). Overall death rate in paragliding flights was 0.000074 in their study.<sup>12</sup>

#### 4.1. Limitations

This is a retrospective analysis of patients although organized

prospective data were compiled for the purpose of the study. Because there is no particular information on the description of gears, education level of pilots, equipment details, and weather conditions, the data compiled is not fully complete. Furthermore, we have no access to all patients injured in aerial sports since some patients might have had simple first aid and were not transferred or referred to our hospital. Therefore, the overall injury rate can be estimated to be higher than our results. However, it would not be wrong to say that overall hospitalization and operation rates will remain the same because, as a regional trauma center, we receive all serious injuries.

#### 5. Conclusion

ST/L injuries are the most common types of injuries in aerial sports activities and mostly do not require hospitalization. Hang gliding and paragliding injuries are more severe than parachute injuries. Although all patients should be evaluated using a multiple-trauma approach because of the possibility of high-energy trauma, the majority of injuries can be managed by basic medical care in the end. Aerial sports are considered dangerous sportive activities, but injury, hospitalization, and operation rates are low.

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