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Accidents and injuries related to paragliding on mount Babadağ, Turkey: A cross-sectional study

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Abstract:

OBJECTIVES: In light of the growing popularity of paragliding, this cross-sectional study aimed to investigate the epidemiology of paragliding accidents, providing insights into the types and severity of injuries sustained as well as the body regions most commonly affected.

METHODS: This cross-sectional retrospective study utilized data on adverse paragliding events on Mount Babadağ in Turkey, collected by the Muğla Sports Tourism Board (STB) between January 2020 and December 2021, with data sources including out-of-hospital STB forms and in-hospital electronic health records.

RESULTS: Out of 241,420 paragliding flights, a total of 44 accidents were identified, with only three resulting in fatalities. Most of the accidents occurred during take off and landing, but the deadliest phase was during flight. The majority of accidents were of low severity, with a median National Advisory Committee for Aeronautics score of 1 (interquartile range [IQR] 1–3) and a median injury severity score of 1 (IQR 1–7.75). The lower limb was the most commonly injured body part, accounting for 55.8% of injuries, followed by the upper limb at 30.8%.

CONCLUSIONS: Despite being considered an extreme sport, paragliding carries a relatively low risk of accidents and serious injuries, owing to advancements in training, equipment inspection, and protective gear.

Keywords:

Accident, adventure sports, injury, national advisory committee of aeronautics, paragliding

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Introduction

Paragliding, which originated in the 1940s and saw a surge in popularity during the 1980s, has become one of the most widespread extreme sports. Governed by aviation regulations, a paraglider is a lightweight aircraft that a pilot steers to descend from high to low altitudes using specialized parachute equipment. Paragliding can involve different types of flying, such as mountain, aerobatic, commercial tandem, or competitive flying.[1,2]

Paragliding has been a popular activity on Babadağ, a mountain located in the Fethiye region of Turkey, for over 30 years. The mountain's terrain is ideal for paragliding, with three take off points at an altitude of 1969 meters and a scenic 30-min flight over Ölüdeniz before landing. In recent years, the area has become a hub for aviation enthusiasts, with a growing number of commercial tandem flights catering to tourists and hosting air games. According to the Sports Tourism Board (STB) of Muğla,

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Box-ED Section

What is already known on the study topic?

- Despite the fact that Mount Babadağ in Turkey is a highly sought-after location for paragliding, with thousands of flights annually, there is very little available information regarding accidents, injuries, and safety of these flights in the area.

What is the conflict on the issue? Has it importance for readers?

- Although paragliding is widely regarded as a high-risk extreme sport, the lack of research on the subject limits the available evidence to support or refute this claim
- The findings of this study could be useful for individuals interested in paragliding, as well as for safety regulators and policymakers in the aviation industry.

How is this study structured?

- This cross-sectional and retrospective study includes both out-of-hospital and in-hospital data on adverse paragliding events on Mount Babadağ in Turkey, covering approximately 240,000 paragliding flights.

What does this study tell us?

- The risk of accidents and serious injuries associated with paragliding is relatively low despite it being considered an extreme sport, which can be attributed to advancements in training, equipment inspection, and protective gear.

there were a staggering 167,173 paragliding jumps made in 2021 alone, indicating a significant rise in the number of participants.[3]

Despite its reputation as a high-risk extreme sport, the evidence to support or refute this claim is limited due to a lack of research on the subject.[4] Understanding the epidemiology of injuries is crucial for creating appropriate treatment protocols for emergency responders and healthcare providers as well as developing safety guidelines and protective gear. Our study aimed to fill this gap by investigating the injury patterns and severity of paragliding accidents on Babadağ mountain.

Methods

Data on consecutive paragliding accidents between January 2020 and December 2021 were extracted from undesirable event forms collected by the STB at four hospitals in Muğla, Turkey, including Muğla Training and Research Hospital, Fethiye State Hospital, Letoon Hospital, and Lokman Hekim Esnaf Hospital. The study, approved by the ethical committee of Muğla University (reference number 210010-2, approval date November 22, 2021), was retrospective in nature and waived the need for informed written consent.

The National Advisory Committee of Aeronautics (NACA) score [Table 1] was used to assess the severity of injuries, and accidents resulting in injury were categorized into four classes based on their severity level.[5] These classes include: no injury (NACA 0); minor injury (NACA I, II), which typically do not require emergency medical treatment; major injury (NACA III, IV, V, VI), which almost always require emergency medical measures; and fatal injury (NACA VII).

To classify the severity of injuries, the Advanced Trauma Life Support guidelines were consulted and both the injury severity score (ISS) and revised trauma score (RTS) were utilized.[6] The ISS system was used to sort injuries by site, including the upper or lower extremities, chest, abdomen, spine, pelvis, and head/face.

Only patients who were 18 years or older, had completed the STB form, and were evaluated either in-hospital or out-of-hospital following a paragliding accident were included. Patients who were under 18 years of age, were involved in accidents that nonparagliding sports flights, or paraglided outside of Babadağ were excluded. Additionally, patients who were lost to follow-up or whose STB forms were not available were also excluded.

Information pertaining to victim nationality, flying type (single or tandem), flight phase (takeoff, flying, or landing), and injury location were collected from the STB forms. In addition, electronic hospital records were utilized to determine the victim's age, gender,

Table 1: National Advisory Committee of Aeronautics score and patient distribution

NACA score	Description	*n* (%)	NACA groups, *n* (%)
0	No injury or disease	4 (7.7)	None, 4 (7.7)
1	Simple injuries that do not require medical attention	24 (46.2)	Minor, 31 (59.6)
2	Simple injuries but can be fixed with simple medical intervention	7 (13.5)	
3	Moderate injuries, may require hospitalization	9 (17.3)	Major, 14 (26.9)
4	Moderate to severe but not life-threatening disorder. Emergency medical measures	4 (7.7)	
5	Severe injuries, situations that may require urgent medical resuscitation	1 (1.9)	
6	Patients undergoing cardiopulmonary resuscitation due to respiratory or cardiac arrest	-	
7	Fatal injury	3 (5.8)	Mortal, 3 (5.8)

NACA: National Advisory Committee of Aeronautics

nationality, flying type, injured body part, and certain outcome variables such as need for hospitalization, need for intensive care unit (ICU) admission, length of hospital stay, and all-cause mortality. Injury severity was assessed using the NACA score, ISS, and RTS at the time of admission.

The distribution of data was assessed for normality using the Kolmogorov–Smirnov test. Continuous variables were reported as either mean ± standard deviation or median (interquartile range [IQR]), depending on whether they followed a normal or nonnormal distribution. Categorical variables were presented as absolute values and percentages. Spearman's rank correlation was used to examine the associations between the NACA score and ISS and RTS. Statistical significance was set at $P < 0.05$ for all tests. All analyses were carried out using SPSS for Windows, release 23.0 (SPSS Inc, Chicago, IL, USA).

Results

Over the study period, 44 out of 241,420 paragliding flights (187,639 tandem and 53,781 single) originating from Babadağ resulted in accidents, representing a rate of 0.0182%. A total of 62 victims were involved in the 44 accidents; however, only 52 victims with both out-of-hospital and in-hospital data were included in the study. The patient flow diagram and types of flights are shown in Figure 1. The mean age of the included subjects was 37.9 ± 10.6 years, with a range of 22–64 years. The study population was primarily male, with 44 participants (84.6%). The majority of victims were from Turkey (n = 29, 55.8%), followed by Germany (n = 7, 13.5%), Russia (n = 6, 11.5%), and 10 other countries (n = 10, 19.2%).

Three single-flight victims died (two at takeoff and one at landing), with the causes of death being traumatic brain injury and high-energy multitrauma. Of the 49 surviving victims, 14 (29.2% of all cases) were treated at Babadağ's own trauma center by an emergency physician and did not require further hospitalization, while 35 were admitted to an emergency department. Among these, 12 were hospitalized (10 in a regular ward and two in the ICU), and the remaining 23 were discharged and followed as outpatients. The median length of hospitalization was 1 day (IQR 1–4 days).

Lower extremity was the most commonly injured body part (55.8% of all cases, n = 29), followed

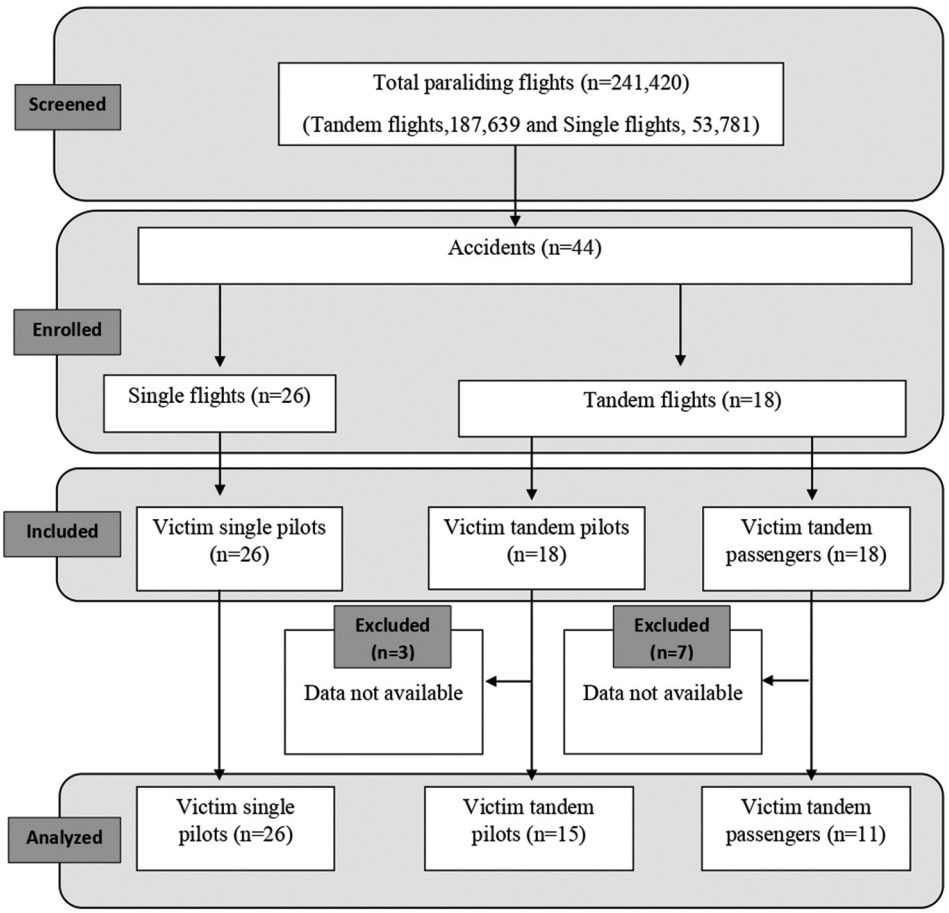

Figure 1: Flow diagram of the study design. This figure displays the initial study population, through exclusions, to the final study population

by upper extremity (30.8%, n = 16), back (19.2%, n = 10), head (13.5%, n = 7), chest (13.5%, n = 7), and abdomen (5.8%, n = 3) [Figure 2]. Two or more body part injuries were seen in 17.3% (n = 9) of victims, while the median NACA score and ISS were 1 (1–3) and 1 (1–7.75), respectively. The majority of injuries were minor (NACA I, II), followed by major (NACA III, VI) and fatal (NACA VII) [Table 1]. There was a significant positive correlation between NACA score and ISS (r = 0.979, P < 0.001) and an inverse correlation between NACA score and RTS (r = −0.427, P < 0.001). The majority of injuries occurred at takeoff (46.1%, n = 24), followed by landing (44.2%, n = 23) and flight (9.6%, n = 5). The association between flight phase and number of victims to NACA groups is presented in Table 2, while the number of injuries by body part is summarized in Table 3.

Discussion

Our study provides novel insights into the injury patterns and demographics of paragliding accidents in the Fethiye region by analyzing both out-of-hospital and in-hospital victims. To our knowledge, this is the first study to provide such a comprehensive analysis. Our findings are consistent with previous reports indicating that paragliding is predominantly a male sport with a mean age of late 30s.[1,3,4,7] Additionally, the participation of paragliders from 12 different countries outside of Turkey and the high number of tandem flights suggest the commercial significance of Babadağ for paragliding.

The mortality rates associated with paragliding have varied widely, with reported rates ranging from 0.75 to 47 deaths/100,000 flights, possibly due to a lack of early recorded data in the sport and the gradual professionalization of the activity.[4,8-11] As noted by Canbek *et al*., who documented paragliding in the Fethiye region from 2004 to 2011, 18 deaths occurred in 242,354 flights, with inadequate training and inspection cited as contributing factors to the direct correlation between the number of flights and accidents.[3] In our study, covering the period of January 2020 to December 2021 and comprising 241,420 flights, we observed fewer accidents and deaths, indicating that commercialization has led to intensified training and oversight resulting in improved safety. Nonetheless, one of the three fatalities we recorded involved an unsupervised paraglider.

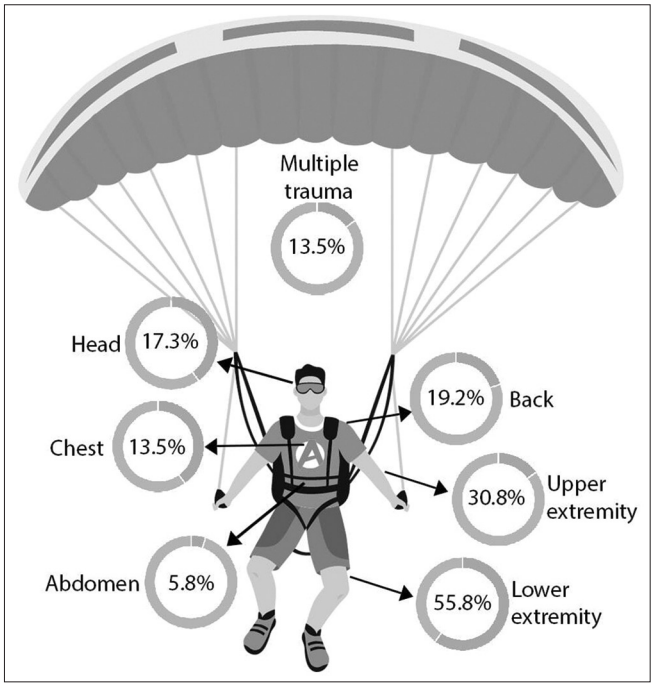

Figure 2: Percentage of injuries occurring to different body parts

Accidents in paragliding are often related to environmental conditions, competitive flying, aerobatics, and mountain launches. Unfortunately, our study did not have information on the weather conditions or the experience level of the pilots involved in the accidents. It is possible that the three fatalities we observed in single-flight accidents were due to opposing wind or aerobatic maneuvers. Additionally, like other studies, we found that there were more accidents during single flights compared to tandem flights.[7] This may be because hired pilots on commercial tandem flights prioritize safety and fly more cautiously.

Our findings suggest that the landing phase may pose the greatest risk for accidents in paragliding. While previous research on paragliding has typically highlighted takeoff as the most dangerous phase, our study found that injuries were distributed evenly between takeoff (46.1%) and landing (44.2%). This pattern is consistent with

Table 2: Distribution between flight phase and number of victims to National Advisory Committee of Aeronautics groups

	Take-off, *n* (%)	Flight, *n* (%)	Landing, *n* (%)
None	-	3 (6.1)	1 (2.0)
Minor	16 (32.6)	-	15 (30.6)
Major	8 (16.3)	-	6 (12.2)
Mortal	-	2 (4.0)	1 (2.0)
Total	24 (48.9)	5 (10.2)	23 (46.9)

Table 3: Distribution of injuries sustained in different body regions in paragliding

	Distribution of injuries			
	Minor, *n* (%)	Modarete, *n* (%)	Serious, *n* (%)	Unsurvivable, *n* (%)
Lower extremity	14 (26.9)	6 (11.5)	6 (11.5)	3 (5.8)
Upper extremity	10 (19.2)	2 (3.8)	1 (1.9)	3 (5.8)
Back	4 (7.7)	-	3 (5.8)	3 (5.8)
Head	3 (5.8)	1 (1.9)	-	3 (5.8)
Chest	3 (5.8)	1 (1.9)	-	3 (5.8)
Abdomen	-	-	-	3 (5.8)

studies of other air sports.[12-14] Earlier research by Zeller *et al*. who conducted one of the earliest studies of paragliding accidents, suggested that the lower-energy injuries occurring during takeoff and landing were typically less severe, while more serious and fatal injuries tended to occur during the flight phase.[12] Our data support this explanation, as shown in Table 2. However, we did not collect data on weather conditions or pilot experience, which may have also contributed to the incidence and severity of accidents.

Over time, there have been changes in the location and severity of injuries sustained during paragliding. In a study conducted in 2003, Exadaktylos *et al*. observed that spinal injuries accounted for a high proportion, 83.3%, of all injuries.[2] However, in 2015, Canbek *et al*. reported higher rates of extremity injuries, with 47.2% of accidents involving the lower extremities, including the pelvis, and 27.7% affecting the upper extremities.[3] In a study performed by Bäcker *et al*. in 2019, it was found that lower extremity and upper extremity injuries occurred in 27.7% and 24.3% of cases, respectively, and that thoracic and abdominal injuries were uncommon but potentially fatal.[15] Our study similarly found that extremity injuries were common, with 55.8% occurring in the lower extremities and 30.8% in the upper extremities, while thoracic and abdominal injuries were associated with high trauma scores and mortality rates [Figure 2 and Table 3]. Improvements in protective equipment have resulted in a reduction in spinal injuries and a shift towards more minor extremity injuries.

Our study found a low incidence of severe trauma in paragliding accidents. On the other hand, previous studies may have been skewed towards severe cases by including only hospitalized victims.[15,16] Our low median ISS and NACA scores indicate that injuries tended to be less severe in our dataset, and we were able to include significant data on nonhospitalized victims through STB forms. Previous studies have suggested that prehospital emergency physicians may underestimate the severity of injuries, which could also contribute to the discrepancy in reported ISS and NACA scores.[7] A similar study in the United States based on accident form data from the Powered Paragliding Association found that the majority of cases had either no NACA score or a minor one.[14]

Limitations

There are a number of limitations to this study. Firstly, the findings may not be generalizable to other locations outside of Babadağ. Secondly, retrospective analysis of well-defined criteria for out-of-hospital and in-hospital evaluation was challenging due to incomplete accident reporting by out-of-hospital organizations. The lack of specific International Classification of Diseases (ICD) codes related to paragliding accidents also hindered data access. Additionally, confounding variables such as weather conditions, pilot experience, passenger weight, and comorbidity were not taken into account. To fully understand the incidence and prevalence of paragliding accidents in Turkey, further large-scale, prospective research is necessary.

The limitations of our study highlight the need for prospective, large-population research to determine the incidence and prevalence of paragliding accidents in Turkey. Overall, our findings suggest that while paragliding does carry risks, it can be a safe sport with proper training, equipment, and oversight.

Conclusions

In conclusion, our study provides valuable insights into the incidence and characteristics of paragliding accidents in the Babadağ region of Turkey. We found that minor trauma to the extremities is the most common injury, and most accidents do not require hospitalization. We also observed a low median ISS and NACA scores, indicating that paragliding accidents in our study population were generally not life-threatening. However, we did identify thoracic and abdominal injuries as having a high mortality rate. Our study did not find a direct relationship between the number of accidents and the number of flights, which may be attributed to the improved safety measures, training, and equipment that have been developed in recent years.

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Author contributions statement
OFK: Conceptualization – Ideas, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Visualization – Preparation, Writing – original draft – Preparation, Writing – review and editing – Preparation.

YG: Conceptualization – Ideas, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Visualization – Preparation, Writing – original draft – Preparation, Writing – review and editing – Preparation.

Conflicts of interest
None declared.

Ethical approval
Approved by the ethical committee of Muğla Sıtkı Koçman University (reference number 210010-2, approval date November 22, 2021).

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