

Hot-Air Balloon Tour Accidents in the Cappadocia Region

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- BACKGROUND:** The incidence of hot-air balloon tour accidents in Turkey is not clear, as published data are scarce. This study aimed to determine the rate of such accidents, including passenger fatalities and injuries, across all flight hours and to also compare these types of accidents to those of other commercial air tour crashes.
- METHODS:** Hot-air balloon tour accident reports in the Cappadocia region were analyzed for 1,415,943 passengers during 81,112 flight hours undertaken between August 2013 and July 2017. The flight and accident data were obtained from the Accident Investigation Board and the Directorate General of Civil Aviation.
- RESULTS:** There were 12 accidents which occurred during the flight hours examined (a rate of 14.8 accidents per 100,000 h). There were 33 individuals seriously injured, 3 fatally in all passengers (3.7 fatalities per 100,000 h in these flights). The majority of accidents that produced serious and fatal injuries occurred during the last year of the study. The most common cause of accidents was a hard landing (58.3%). All accidents occurred during the landing phase of the flight. Seven patients experienced multiple traumas and lower extremity injuries constituted the majority of cases ($N = 21$).
- DISCUSSION:** The fatality rate of commercial balloon rides was lower than that for lighter-than-air craft, which include balloons and blimps (sports aviation flights), and the crash rate of hot-air balloons was higher than those of aircraft (airplanes and helicopters) tour flights. However, there is still insufficient information in the literature to properly compare this activity with commercial motorized aircraft tours and other hot-air balloon flights.
- KEYWORDS:** aviation, aircraft, accidents.

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Hot-air balloon tour flights are very popular activities throughout the world and are performed in many countries.¹ Turkey is one such destination and there are five Turkish cities where these flights are carried out: Nevşehir and Denizli (year-round flights), Ankara and Eskişehir (seasonal flights), and Bitlis (regional flights). Nevşehir, located in the Cappadocia region, conducts 99% of all the hot-air balloon tour flights in Turkey, according to the Directorate General of Civil Aviation (DGCA).¹³

Although there is no certain date for the first flight in this region, some studies reported that the first tourist flights were carried out in the 1990s.^{1,8} The Turkish Aeronautical Association (TAA) stated that in Turkey, the first balloon flight was in Cappadocia in 1983 by TAA Gökçen Aviation.²¹ According to the DGCA annual report, there were 6 hot-air balloon companies and 31 balloons in 2002, and these numbers rapidly increased to 17 companies and 187 balloons in 2012.⁴ As a result of the increase in commercial aviation activities, various regulations were implemented by the DGCA in order to provide

flight and ground safety in 2013. The Slot Service Center was established in order to evaluate takeoff permit requests and the number of flights was limited to two periods per day, whereas there had been no limitations before this regulation was put into place. Also, the global positioning system (GPS) data for the actual flights are now stored daily at the end of the morning and afternoon periods.⁷

A large number of tourists visit this region annually to experience balloon rides. In 2017, 2.2 million domestic and foreign tourists visited Nevşehir.¹⁸ The commercial balloon flights are aimed at sightseeing and observing the valleys, cave churches, and fairy chimneys, which are unique geological formations.

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These flights are operated by 25 licensed companies with 239 balloons in the city and are performed year-round depending on weather conditions. Despite strict precautions, accidents related to flights sometimes occur in Turkey and have drawn the attention of the national and international press. This situation has caused concern about the safety of hot-air balloon tours conducted in this region.

Hot-air balloon flights are an important sector of aviation, but their safety does not get the attention it deserves. Furthermore, there are no published epidemiological data on hot-air balloon tour accidents in Turkey and the incidence of commercial hot-air balloon tour accidents is not clear, as most published reports in the literature address only morbidity and mortality. The aim of this study was to determine the incidence of hot-air balloon tour accidents and their outcomes, and to compare these accidents with those of other commercial air tour crashes.

METHODS

Data Collection

Commercial hot-air balloon tour flights that occurred in Nevşehir and accident reports of these flights between August 2013 and July 2017 were reviewed retrospectively; no flight records before 2013 were available. Hot-air balloon accident data were obtained from the Accident Investigation Board² and included the number of accidents, deaths, and serious injuries. Moreover, the causes and flight phases of the accidents as well as the brands of the balloons were noted. Data on all the flights (81,112) and passengers (1,415,943) were obtained from the DGCA¹³ during this period. The number of companies involved and flight rates by region were also noted. As a single flight lasts for an average of 1 h (range: 45–90 min), each flight is considered to have a 1-h duration by the DGCA. Therefore, we used the same approximation in our study, with one flight equal to 1 h (81,112 h in total).

Procedure

Commercial flight tours are conducted in the specific and allowed areas of Nevşehir. These areas are located at a certain distance from the city center and flights take place in areas where there are valleys, fairy chimneys, and cave churches. Up to 150 commercial balloon flights are conducted in two periods on a daily basis, with a maximum of 100 flights in the morning and 50 in the afternoon. The time intervals are between 30 min before sunrise and 11:00 local time and from 14:00 local time until 30 min after sunset.²⁰ The Cappadocia University Slot Service Center regulates hot-air balloon flights depending on daily weather conditions and indicates flight suitability to the balloon companies and pilots in three ways. A red flag indicates that the meteorological conditions are not suitable for flight within the determined sector and time interval and that the flight operation cannot be performed. A yellow flag indicates that meteorological conditions are not suitable for flight within the determined sector and time interval, but that the conditions are likely to change at the end of the specified time interval, so one

may stay on standby until the flag is updated to green or red. A green flag indicates that flight operations can be carried out based on the decision of the company and the balloon pilot within the determined sector and time interval.⁹ Therefore, daily flight numbers can be quite variable due to weather conditions. Furthermore, according to data taken from the DGCA, on some days there were no flights, while on other days, flights occurred in the morning, afternoon, or both. However, the number of such days was uncertain in the data taken from the DGCA.

The DGCA is a member of the International Civil Aviation Organization.³ So international aviation terms are used in our country as shown below.

“Accident” is defined as one of the following:

- A) A person is fatally or seriously injured as a result of being in the aircraft, having direct contact with any part of the aircraft, or experiencing direct exposure to a jet blast.
- B) The aircraft sustains damage or structural failure.
- C) The aircraft is missing or is completely inaccessible.

“Fatal injury” is defined as an injury resulting in death within 30 d of the accident.

“Serious injury” is defined as one of the following:

- A) Requires hospitalization for more than 48 h.
- B) Results in a fracture of any bone (except simple fractures of fingers, toes, or nose).
- C) Involves lacerations that cause severe hemorrhage or nerve, muscle, or tendon damage.
- D) Involves injury to any internal organ.
- E) Involves second- or third-degree burns, or any burns affecting more than 5% of the body surface.

A “serious incident” is defined as an incident (occurrence) involving circumstances in which an accident nearly occurred but did not happen; it is associated only with the safety of the operation and its results are different from those of an accident. Therefore, serious incidents were excluded from the study. Training flights and their accidents were also excluded because there were very few to evaluate in the study, and these flights included only a pilot instructor and a student.

The types of injury were obtained from hospital records. The Ahi Evran University Faculty of Medicine Clinical Research Ethics Committee approved the study (2017-18/215).

Statistical Analysis

Statistical analyses were performed using IBM SPSS statistical package for Windows, version 21.0 (Chicago, IL). Variables were expressed as the mean \pm SD. Categorical variables were expressed as frequencies and percentages. Fisher’s exact test was used to compare categorical variables. A critical α value of 0.05 was accepted as statistically significant.

RESULTS

Between August 2013 and July 2017, 12 accidents occurred, resulting in an accident rate of 14.8 per 100,000 h. From among

Table I. Frequencies of Hot-Air Balloon Tour Flights and Accidents.

CATEGORY*	2013	2014	2015	2016	2017	TOTAL
Companies	22	25	25	25	25	n/a
Flight hours [†]	2778	26,590	27,778	14,773	9193	81,112
Passengers	47,397	482,586	498,812	232,764	154,384	1,415,943
Accidents	--	2	3	1	6	12
Serious injuries	--	5	5	1	22	33
Fatal injuries	--	1	--	--	2	3

* From August 2013 until July 2017.

[†] Each flight was considered to have lasted for 1 h.

the 1,415,943 passengers who rode the balloons during this time, 33 individuals experienced serious injuries (a rate of 0.002%), with 3 of those injuries (0.0002%) being fatal. The fatality rate was 3.7 per 100,000 h in these flights. The majority of accidents that produced serious and fatal injuries occurred in the last year of the study (Table I).

Of all accidents, 25% resulted in fatal injuries and an average of one person died per fatal accident. The fatal injuries occurred in various situations, including hard landing, falling from the basket, and collision, and there was no statistical difference between the cause of injury and number of fatal accidents ($P > 0.05$). Furthermore, 91.7% of all accidents resulted in serious injury, with a mean of three serious injuries (SD: 2.49, range 1–7) per accident. Among all accidents, 58.3% were caused by hard landings (the most common cause of injury), whereas 25% were caused by collisions and 8.3% each were caused by fire and falling. All accidents occurred during the landing phase of the flight (Table II).

Including the three who died, seven patients experienced multiple traumas. Two patients died at the scene after landing, while the third fell from the basket during landing while trying to take photographs and failing to follow the rules in the process. He was transported to the hospital but died on the same day. Of the remaining seven patients with multiple traumas, four were admitted to the hospital and survived. Lower extremity injuries constituted the majority of cases (21), while 4 patients experienced upper extremity injuries. Three patients experienced head trauma and one suffered burns (Table III).

Table II. Occurrences and Details of Hot-Air Balloon Tour Accidents.

DATE	MANUFACTURER	FATAL INJURY (N)	SERIOUS INJURY (N)	CAUSE OF INJURY	PHASE OF FLIGHT
Dec. 2014	Ultramagic	1	2	Hard landing	Landing
Dec. 2014	Ultramagic	-	3	Hard landing	Landing
June 2015	Ultramagic	-	1	Fire	Landing
Aug. 2015	Cameron	-	3	Collision with base station	Landing
Aug. 2015	Cameron	-	1	Collision with power lines	Landing
May 2016	Cameron	-	1	Hard landing	Landing
Feb. 2017	Ultramagic	1	-	A tourist fell from the basket after failing to comply with the rules	Landing
Mar. 2017	Lindstrand	-	1	Hard landing	Landing
Mar. 2017	Lindstrand	-	6	Hard landing	Landing
Mar. 2017	Ultramagic	-	1	Hard landing	Landing
Mar. 2017	Lindstrand	-	7	Hard landing	Landing
Apr. 2017	Kubicek	1	7	Collision with power lines	Landing

DISCUSSION

The Cappadocia region has reached its limit of the number of flights and, due to requests for new flight areas, the DGCA has begun to investigate flight suitability in other regions as well.⁴ Even so, one of the issues that most affects the requests for

flights is the safety issue among passengers, regardless of the location. This is because aircraft accidents usually have specific characteristics that distinguish them from other accidents in terms of exposure, risk, frequency, and implications.¹⁷

In this study, it was found that 12 accidents occurred during a total of 81,112 flight hours; there were only 3 fatalities during that time. The accident rate was 14.8 accidents per 100,000 h and the fatality rate was 3.7 per 100,000 h. In comparison, De Voogt et al. reported an average of 26 fatalities per 100,000 flight hours for lighter-than-air craft, which include balloons and blimps.¹² This difference may be related to the fact that the study by De Voogt et al. included fatalities in blimp accidents. It is not clear how that inclusion contributed to the fatality rate. Also, serious incidents were excluded from the present study, but it was not stated whether they were excluded from De Voogt et al.'s study, although the term "accident" was used throughout their article. Furthermore, De Voogt et al. investigated sports aviation accidents. Cowl et al. showed that the rate of crashes with fatalities or serious injuries could differ among different types of balloon flights.¹⁰ To the best of the author's knowledge, no other study has compared accident and fatality rates for hot-air balloon flights.

Commercial sightseeing air flights are also performed by other aircraft such as airplanes and helicopters. A separate study revealed that the air tour helicopter crash rate was 1.8 per 100,000 flight hours between 1995 and 2008 in Hawaii; 36% of all crashes involved fatalities, with an average death rate of 4.4 individuals per fatal crash.¹⁵ In a study by Ballard et al., the crash rate of both airplanes and helicopters in the United States was found to average 2.7 per 100,000 flight hours between 2000 and 2011. Of these crashes, 20% involved at least one fatality, averaging 3.5 deaths per fatal crash.⁶ Our study found that the crash rate of hot-air balloons was 14.8 per 100,000 flight hours and the fatality rate was 3.7 per 100,000 flight hours between 2013 and 2017. The crash rate of hot-air balloons seems to be higher than those of aircraft (airplanes and helicopters) tour flights; however, other data (fatality rates) of motorized aircraft tour crashes are still insufficient and there are no other

Table III. Injury Types of Hot-Air Balloon Tour Accidents.

TYPES OF INJURY	FATAL (N)	SERIOUS (N)	TOTAL (N)
Multiple trauma	3	4	7
Lower extremity trauma	--	21	21
Upper extremity trauma	--	4	4
Head trauma	--	3	3
Burn	--	1	1
Total	3	33	36

denominator values such as the number of passengers to compare these flights.

In our study, all accidents resulted in a fatal or serious injury (25% fatal and 91.7% serious injury). A study in the United States found that fatalities or serious injuries occurred in 79.2% of all paid passenger flight crashes, in 60.3% of recreation flight crashes, and in 58.6% of balloon race crashes from 1964 to 1995.¹⁰ Another study, also in the United States, found that 83% of commercial hot-air balloon tour crashes resulted in at least one serious or fatal injury between 2000 and 2011.⁵ This proportion was 76.9% in hot-air balloon incidents (type not specified) in Switzerland from 1980 to 2014.¹⁹ These proportional differences show that the rate of serious or fatal accidents may be different according to the regions, the types of balloon flight, and different crash definitions (accident or incident).

Several studies reported that the majority of accidents occur during the landing phase. Persoz et al. found that in 39 balloon crashes, 66.7% occurred during the landing phase in Switzerland.¹⁹ The rate was 81% of 78 hot-air balloon crashes in a study by Ballard et al. in the United States.⁵ Hasham et al. reported that 83% of hot-air balloon accidents happened during the approach and landing phases of flight in the United Kingdom from 1976 to 2004.¹⁶ In our study, all accidents occurred during the landing phase of a flight.

The causes of balloon flight crashes vary and include everything from collision with a fixed object to fire. De Voogt and van Doorn found that hard landings contributed to 35% of the 530 balloon crashes counted in sport aviation accidents.¹² Another study reported that 65% of commercial balloon tour crashes occurred as a result of hard landings and collision with fixed objects contributed to half the serious injuries, the majority (85%) of the minor injuries, and all the fatalities.⁵ Collisions with power lines or the ground and hard landings were the causes of 77.5% of balloon flight crashes in another study.¹⁶ The most common cause of accidents in our study was a hard landing. Collision, particularly with power lines, was the second common cause of an accident. As such, the local government is endeavoring to bury power lines underground on the flight routes of balloons in this region.

Most studies on balloon accidents have found that lower extremity injuries are the most common, since all the kinetic energy is directed to the legs after a collision with a fixed object or the ground. Deaths are usually related to multiple traumas after falling from the basket, colliding with objects, or being electrocuted.^{11,16} The most commonly identified causative factors are wind and weather changes, pilot error, power lines, and equipment failure.^{10,14} Lower extremity injuries were common

in our study; moreover, deaths occurred after a hard landing, falling from the basket, and collision. However, causative factors could not be obtained from the Accident Investigation Board's data.

In conclusion, the fatality rate of commercial hot-air balloon flights was lower than that for lighter-than-air craft, which include balloons and blimps (sports aviation flights) and the crash rate of hot-air balloons was higher than those of aircraft (airplanes and helicopters) tour flights. However, there is still a need for more data to compare commercial balloon rides to other commercial motorized aviation flights as well as other types of hot-air balloon flights. It was observed that half of the accidents in our region during the study period were experienced within the last year. This situation suggests that hot-air balloon flights need to be revisited in terms of flight safety, regulations, and precautions. Otherwise, the accidents will cause a bad reputation for our region and create problems in new areas where flights will be planned and carried out.

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