U.S. Army Parachute Mishap Fatalities: 2010–2015

Erik S. Johnson; Steven J. Gaydos; Joseph J. Pavelites; Russ S. Kotwal; John E. Houk

INTRODUCTION: Despite the large number of U.S. military members who conduct parachuting operations, its inherent safety risks, and the introduction of a new military parachute in 2010, little has been published in the last decade on U.S. military parachute fatalities.

METHODS: Parachute fatality investigative records maintained by the U.S. Army Combat Readiness Center were reviewed for U.S. Army fatalities resulting from military parachuting operations from January 1, 2010, through December 31, 2015. De-identified data on cases were collected, including causes, lethal injuries, and demographic, environmental, and missional factors. A descriptive analysis was performed.

RESULTS: There were 13 cases which met study inclusion criteria. Most occurred during static-line operations and were jumps from a C-17 aircraft using a T-11 parachute. The two most common assigned accident codes were "improper or abnormal exit" and "unstable or improper body position," which combined accounted for 33% of cases. Also noteworthy at 11% each were "entanglement," "parachute malfunction," and "dragged on the drop zone," and at 6% each were "static line injury," "lost or stolen air," and "drop zone hazard." In 69% of cases blunt force trauma was the cause of death.

DISCUSSION: Incident factors included human actions, equipment failure, and the environment. Death from blunt force trauma upon impact with the ground as the most frequent lethal injury was expected for parachute operations. This descriptive study provides awareness to military leaders of circumstances in which fatalities occur. Future investigations should include data on the total number of jumps to provide a more comprehensive analysis of risk.

KEYWORDS: parachute mishap, fatalities, T10, T11, parachute accident, paratroopers, airborne operations.

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The U.S. Army has trained soldiers to conduct military parachuting (airborne) operations for over 80 yr.[4] The concept of parachute insertion of infantry soldiers (paratroopers) was first considered about 100 yr ago at the close of World War I.[4] However, it was not until World War II that the potential of airborne operations was fully realized, with numerous successful deployments by both Axis and Allied forces.[4] Airborne operations remain a regularly trained capability today among both regular airborne and special operations units and are considered a significant asset in the projection of military force.

In 1965 it was reported that civilian sport skydiving had resulted in about 1 fatality per 17,000 jumps.[5] It is estimated that approximately 3.2 million civilian skydiving jumps occurred annually in the U.S. during the mid-1990s, and this activity resulted in about 40 fatalities per year (about 1/80,000 jumps).[3] The U.S. Army performs an estimated 200,000 military parachute training jumps per year; however, this number varies based on operational demands.[7] This amount is about twice the number of jumps conducted by the military in the 1960s.[4] A study in 2004 estimated that U.S. military combat (nontraining) jumps totaled over 70,000 from the beginning of World War II in 1941 through the wars in Iraq and Afghanistan up through 2004.[12] In 1965, Kiel described 20 military training parachute fatalities from 1946 through 1963 (approximately 1.2 fatalities per year) during over 1 million training jumps (nearly 2 fatalities per 100,000 jumps, at four major Army training sites).[4] As a point of clarification, Kiel also described 77 fatalities from 1950–1963 (5.5 per year), but further detail on service connection, mission, or total number of jumps for these cases was not

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available in the study. In 1990, Mellen and Sohn studied the autopsy reports of 49 military parachute fatalities that occurred from 1964 through 1989, yielding roughly two fatalities per year.[14] However, they included high altitude jumps and sport jumps as well as static-line, and these may have included fatalities from other branches of military service. More recent U.S. Army parachute fatality numbers have not been published in the open literature.

Hundreds of thousands of soldiers take part in airborne training operations every year. Injuries occur regularly and fatalities only rarely. A review of U.S. Army parachute fatalities has not been published since 1990[14] and a new parachute (the T-11) was introduced in 2010. It is prudent to regularly assess parachute mishap fatalities for safety factors, accident prevention, and health promotion. The purpose of this study is to provide a descriptive observational analysis of U.S. Army airborne fatalities that have occurred since the T-11 was introduced.

METHODS

Subjects

De-identified data on parachute mishap fatalities from accident investigation reports were collected. Cases were defined as a U.S. Army parachute mishap fatality that occurred during a military parachute operation (training or otherwise) from January 1, 2010, through December 31, 2015.

Materials

Accident investigation reports were completed by the U.S. Army Combat Readiness Center (USACRC) and stored digitally in the Risk Management Information System (RMIS). The USACRC serves as a central organization that investigates all Army "Class A" mishaps, which are those that involve a fatality, a permanent disability, or exceed $2 million in property damages. RMIS is a secure, searchable, digital database of accident investigation reports generated by investigative teams from the USACRC. Access to the system is granted by request through the USACRC.

Procedure

Cases were identified using a search tool within RMIS. The category of "ground" accidents was selected, the accident classification of "Class A" was selected, the date range of January 1, 2010, through December 31, 2015, was set, and the search term of "parachute" was entered. The brief case description provided in the search results was used to further determine if the case met the inclusion criteria of a U.S. Army soldier who died while performing a parachute jump, on a military operation, while on duty. Cases of off-duty sport skydiving were excluded. Data on numerous factors were collected in a de-identified table. Factors included age, rank, gender, height, weight, parachute type used, lethal injuries sustained, aircraft used, exit door used, jump altitude, temperature, humidity, wind speed, and time of day (day vs. night). The reports do not indicate a source or time for data on height and weight. Date of the incident was not included to protect the identity of the deceased. Factors such as weight of carried load and landing zone description were not consistently described in the reports and were not included in this analysis. An Institutional Review Board exemption was granted by the Army Medical Department Center and School, Joint Base San Antonio, TX.

Analysis

A retrospective study was conducted of U.S. Army fatalities that occurred in the performance of parachute operations from 2010 through 2015. Described were factors, incident causes, and lethal injuries associated with U.S. Army parachuting activities obtained from accident investigation reports, using person, place, and time variables as described above. Data were collected, de-identified, and descriptively analyzed.

RESULTS

A total of 13 fatalities met inclusion criteria for the 6-yr period (2.2 per year). Three other fatalities were excluded as two resulted from sport skydiving (off duty) and one was a case that contained the word "parachute" but did not involve parachuting activities.

Of the 13 fatalities, 12 (92%) were men and 10 (77%) were enlisted personnel. Rank ranged from E2 (Private PV2) through O6 (Colonel), with the ranks of E2 and E5 (Sergeant) sharing the mode at three fatalities each. Ages ranged from 19 to 59 yr. Of the 13 jumps that incurred a fatality, 9 (69%) were during daylight hours and 10 (77%) were from altitudes between 1000 and 1250 ft above ground level (305 and 381 m). For the 10 that were static-line jumps, the mean altitude was 1125 ft (SD 107) (343 m, SD 33) and for the 3 freefall high altitude jumps the mean was 14,300 ft (SD 2451) (4359 m, SD 747). Temperature (at ground) data was available for nine of the cases, ranging from 42.8 to 89.6°F. Wind speeds were not clearly listed for every case but ranged from 2 knots to gusts up to 23 knots at ground level and from 2 knots to 18 knots at jump altitude. Wind speeds were reported inconsistently as ranges, single values, and single values with gusts. Using the midpoint of a range as the wind speed and excluding the gusts, wind speed data are listed in **Table I**. Seven (54%) involved jumps out of the left aft door, five (38%) out the right aft door, and one (8%) out a central rear door or "ramp." Of the 13 fatalities, 12 occurred on jumps from fixed-wing aircraft. Of the jumps, 10 (77%) were on static-line training missions, 6 of which were tactical (simulated combat scenario, carriage of full combat-load based on a specified mission) and 4 nontactical. The total carried load for each paratrooper was not consistently available in the reports. Additional demographic, environmental, and equipment factors are summarized in Table I.

The causes of the incidents and the lethal injuries (listed cause of death) are summarized in **Table II**. Accident investigators assigned 11 different causal codes across the 13 cases, with up to 2 codes used per case, totaling 18 codes.

Table I. Summary of Demographic and Environmental Factors of U.S. Army Parachute Fatalities ($N = 13$), Static Line (SL) and Military Freefall (MFF), 2010 to 2015.

FACTOR (UNITS)	*N*	MEAN	STANDARD DEVIATION	MEDIAN	INTERQUARTILE RANGE
Age (yr)	13	29.6	10.9	27.0	11.5
Height (inches)	13	69.8	3.39	70.0	6.50
Weight (lb)	13	186	39.2	186	58.5
Body Mass Index	13	26.5	3.75	26.4	5.23
Jump Altitude (ft above ground level)	13	4150	5650	1250	5840
Temperature (°F)	9	71.1	13.5	75.0	21.5
Dew Point (°F)	5	41.9	17.6	36.0	37.2
Ground Wind Speed (knots)	11	6.95	3.78	7.00	7.00
Jump Altitude Wind Speed (knots)	7	11.6	5.87	14.0	14.0

EQUIPMENT USED

AIRCRAFT TYPE	FREQUENCY	PARACHUTE USED	FREQUENCY
C-17 Airplane	6	T-11 (SL)	7
C-130 Airplane	3	Ram Air/MC-4 (MFF)	3
C-31 Airplane	1	SF-10/MC-6 (SL)	2
Skyvan Airplane	1	T-10 (SL)	1
DHC-6-100 Airplane	1		
UH-60 Helicopter	1		

DISCUSSION

This descriptive analysis represents a collective series of fatality cases from U.S. Army airborne operations from 2010 through 2015. Provided are critical data for military commanders and leaders concerning the circumstances surrounding airborne fatalities. The crude rate of 2 fatalities per year (13 in 6 yr) is comparable to that reported by Mellen and Sohn in 1990.[14] It may be roughly estimated for static line missions ($N = 10$) that the fatality rate was less than 1 per 100,000 jumps (1/120,000), based on the approximation of 200,000 static-line jumps per year.[7] This is less than half the rate that was described by Kiel in 1965, at approximately 2 per 100,000 jumps.[4] This suggests, based on the measure of fatalities, that airborne static-line training operations may be safer now than in the 1950s and 1960s.

The main purpose of static-line military parachuting operations is to quickly position a large number of combat-ready soldiers at strategic locations on the battlefield.[6] Often, this is carried out at relatively low altitudes to avoid radar-detection and to reduce the amount of time soldiers spend in the air where they are vulnerable to enemy fire.[1] There are several different classifications of military parachuting, including high-altitude low-opening (HALO), high-altitude high-opening, and static-line. By far the most common type of military parachuting is the static-line method. Static-line parachuting refers to operations whereby the soldier's parachute is immediately deployed as he exits the aircraft, by means of the parachute's ripcord line connected to an anchored, or "static," line in the aircraft (see **Fig. 1**). This operation may deliver hundreds of personnel from altitudes as low as 500 ft (152 m) and offers the soldier, who is often encumbered by bulky equipment, a hands-free, decision-free method of releasing the parachute. This form of parachuting has no deliberate freefall component and the paratrooper is equipped with a back-up or "reserve" parachute that is actuated by the jumper if the main parachute fails to adequately slow descent. It is noteworthy that paratroopers are trained to initiate a parachute landing fall upon contact with the ground. This maneuver is intended to distribute ground impact forces over the body surface, ostensibly reducing the risk of serious injury. Here, the soldier lands with feet and knees together, striking the ground with the balls of the feet first, and then rolling on to the side of the body with the calf, the thigh, the buttocks and the flank making contact with the ground in succession. The jumper then rolls onto his or her back and then onto the opposite side, swinging the legs over to complete the maneuver (see Fig. 1).

Military parachuting by HALO and high-altitude high-opening methods, as their names suggest, involve exiting the aircraft at much higher altitudes, often to avoid enemy warning systems and to retain the element of surprise in order to conduct more clandestine operations. These higher jumps, categorized as military freefall operations, are generally used for much smaller groups of soldiers. It is

Table II. Incident Code (Incident Type) and Cause of Death (Cited Lethal Injury) for U.S. Army Parachute Fatalities ($N = 13$), 2010 to 2015.

CAUSAL CODES		LETHAL INJURIES	
CODE	FREQUENCY	INJURY	FREQUENCYs
Abnormal exit	3	Blunt force trauma	9
Unstable or improper body position	3	Neck injury	2
Entanglement	2	Asphyxiation	1
Parachute malfunction	2	Electrocution	1
Dragged on the drop zone	2		
Static line injury	1		
Lost or stolen air	1		
Drop zone hazard	1		
Other	3		

More than one causal code can be assigned to a single incident.

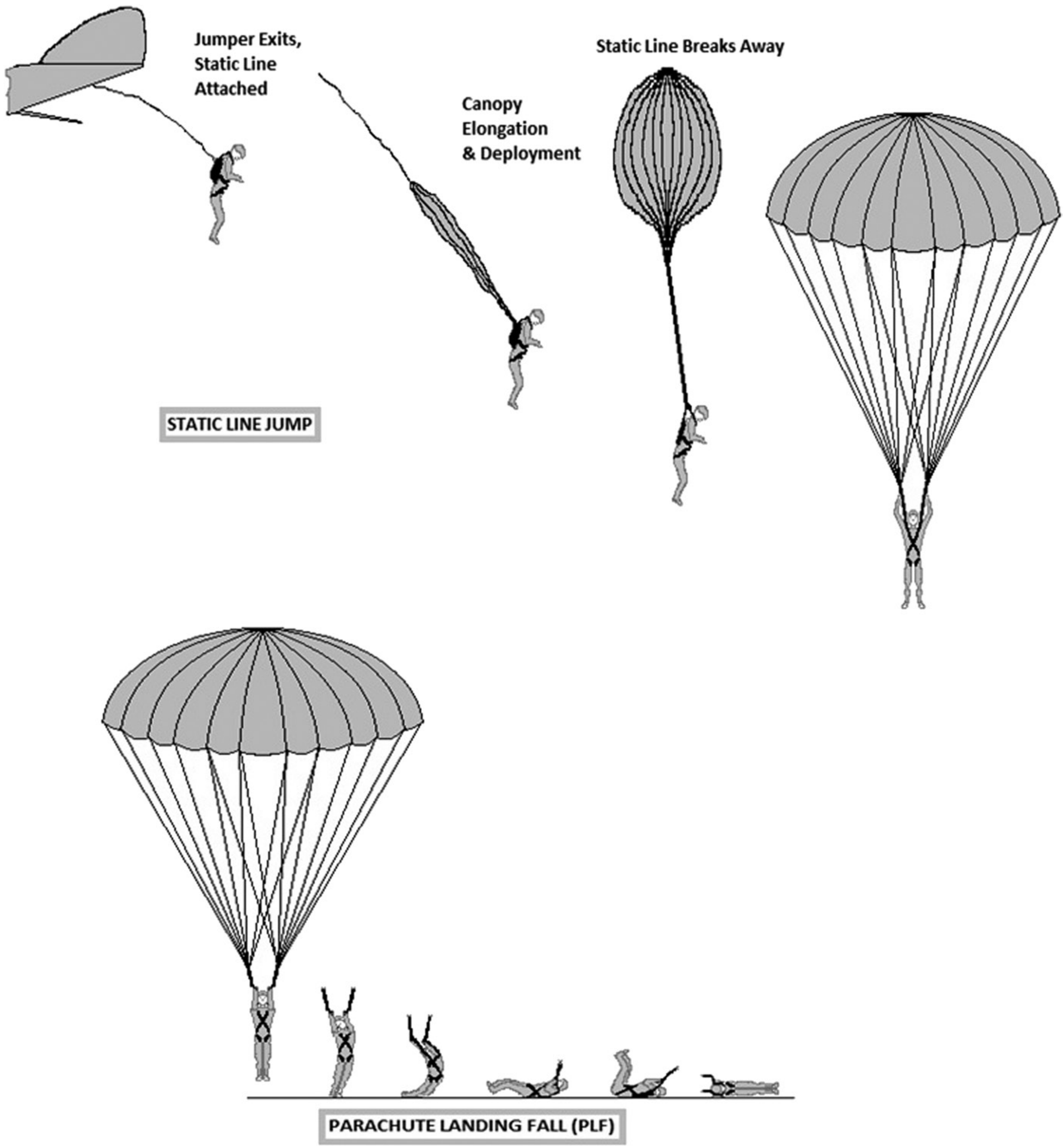

Fig. 1. Static line jump and parachute landing fall. Image credit: John Houk, U. S. Army.

worth noting that soldiers conducting HALO operations can have a considerable amount of time in free-fall before the parachute is deployed manually by the parachutist.

As a generalization from this study, fatalities are largely enlisted soldiers approximately 30 yr of age with a BMI of 26.5. Fatalities occur most frequently on static-line jump operations with a T-11 parachute from standard jump altitudes (1250 ft/381 m) from a C-17 airplane out a side door. A suboptimal exit from the aircraft or event in the air may lead to a failure of the parachute to properly slow the decent of the soldier, resulting in substantial impact with the ground and death from severe blunt force trauma. However, these demographics likely describe the typical airborne trainee rather than a subgroup of trainees at increased risk during parachute operations. Only a single fatality occurred exiting out a rear door and only one fatality involved a helicopter. However, if the C-17 and the T-11 are the aircraft and chute used most frequently, then these observations should not lead one to presume there is an association with the magnitude of the findings.

It is important to clarify what constitutes an exposure to parachute operations in order to understand the nature of fatalities that occur while performing them. Most of the literature reviewed addressed parachuting mishaps as events that occurred once the parachutist had left the aircraft and continued through time in the air and during the landing sequence, such as improper opening of the parachute or landing in water. However, defining and counting cases in other forms of accidents may be more challenging, as in the cases where the parachute opens and fills within the aircraft, the parachutist is struck by an aircraft after jumping, or the jumper is ensnared on the exterior of the aircraft and is dragged through the air. Another challenge to understanding fatalities during airborne operations comes with a large number and interplay of a variety of factors. This is related to the complex environment in which these operations occur.

As might be expected, nonfatal injuries from parachuting are also variable, with a few notable patterns.[1,2] The current estimate for injury rates in Army parachuting is about 6 per 1000 jumps, compared to estimates for World War II that were on the order of 21 to 27 injuries per 1000 jumps.[9,14] Concussions appear to be the most frequently encountered parachute injury in studies with the largest populations.[9,10] Other injuries, in descending order of frequency, are sprains and fractures to the ankle, lower back, and knee.

Several factors are associated with an increased risk of parachuting injuries. Greater wind speed, increased temperature, increased humidity, use of fixed-wing aircraft (i.e., airplanes) vs. rotary-wing aircraft (i.e., helicopters), side exit doors, night jumps, heavier carried load, greater body weight, enlisted rank, female gender, jumper inexperience, and a hard, uneven landing surface have all been associated with an increased risk of injury.[1,9,11]

Newer parachute designs are inclined to reduce the risk of injury.[1] From the 1950s into the early 2000s the U.S. Army had been using the T-10 parachute (with multiple successive variants), fully integrating it by 1954. However, in 2010 the Army phased in a new parachute, the T-11.[8] Much of the published literature regarding injuries and fatalities in military parachuting has referred to soldiers using the T-10 chute. To date, only two studies addressed the use of the T-11 injury rates and patterns.[8,10] Some of the key differences highlighted in these studies include the rate of descent [T-10 at 22 $\text{ft} \cdot \text{s}^{-1}$ (7 $\text{m} \cdot \text{s}^{-1}$) and T-11 at 19 $\text{ft} \cdot \text{s}^{-1}$ (6 $\text{m} \cdot \text{s}^{-1}$)] and canopy size and shape (the T-11 has corner vents to reduce oscillation and a larger canopy that is more square than the rounded, center-vented T-10)[9] (see **Fig. 2** for comparison images of these two static-line parachutes). In a large prospective observational study,[10] the overall injury rate for the T-11 was less than that with the T-10, and head injury in particular was significantly reduced with the T-11. However, the T-11 did demonstrate an elevated rate of entanglement. To date, no literature had been published addressing T-11 parachute fatalities.

Fig. 2. T-10 parachute (left) and T-11 parachute (right). Photo Credit: Ryan Steelman, U.S. Army Public Health Command.

In previous studies of military parachute mishap fatalities,[4,13,14] blunt force trauma (often associated with abrupt deceleration on impact with the ground) had been found to be the most prevalent cause of death in association with a mechanism of death from hemorrhage (from rupture, laceration, and fracture of vital organs, vessels, and structures). These injuries were most likely to occur in instances where the parachute failed to open or malfunctioned. As demonstrated in Table II, blunt force trauma was also the most prevalent cause of death in this study. Of the 18 incident codes used, 6 (33%) related to position and technique of the jumper. The process of properly jumping from the aircraft is carefully described and trained. However, if not closely adhered to within the jump sequence, deviations from procedure can be fatal. While not every instance of deviation results in a mishap, fatalities are a likely consequence of this high-risk event given the sheer number of jump iterations per year. Continued efforts to emphasize the importance of following procedure are encouraged.

This study has some particular and important limitations. The data necessary to support causal inference were not available in this analysis. As a strictly descriptive study of fatality cases, the lack of a comparison population or denominator data precludes a more substantial analysis.

It would be prudent for the safety of soldiers undergoing training in airborne operations, in which fatalities and injuries occur with some regularity, to periodically review both injury and fatality data, including summary information on jump total statistics. Future investigations into parachute fatalities including data on the total number of jumps for each investigated factor would provide a more comprehensive and informative analysis. Such study should also include autopsy data to better demonstrate injury patterns and it is recommended that autopsy reports be included in the formal records of all Class A fatality mishap investigations so that these data are available to researchers interested in improving the safety of future paratroopers.

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