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Comparison of Injuries between U.S. Army Active Duty Paratroopers and Non-Paratrooper Soldiers, Calendar Years 2016 to 2018

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14. ABSTRACT BACKGROUND: A 2019 review of military paratrooper injury studies found a wide range of injury rates (3 to 55 acute injuries per 1,000 jumps) that reflected differences in populations, equipment, and environmental conditions. Though considered plausible that military paratroopers have higher injury risk than non-paratroopers, existing studies had reported paratrooper injury rates as injuries/1000 jumps so they could not be compared to injury rates of non-paratroopers. In addition, paratrooper studies had focused only on acute (ACT) injuries, and had not addressed risk of cumulative microtraumatic (CMT) overuse injuries.
OBJECTIVE: This investigation compared the types and direct medical costs of all injuries between a population of 31,621 Active Duty (AD) paratroopers and a group of 170,715 AD non-paratroopers over 3 years (CY2016--18).
RESULTS: Non-paratroopers had 2.93 injuries/Soldier while paratroopers had 3.05 injuries/Soldier during the 3-year study period (roughly 1 injury/ Soldier/year in both populations). Injury odds ratios were greater among paratroopers (e.g., ORs of 1.3 - 1.5), though being a woman, African American older age were also shown to be risk factors. Both groups experienced more CMT injuries, but paratroopers had a greater proportion of ACT injuries (25% vs 20%). Body sites most injured were also generally similar (leading sites being CMT injuries to the low back, knee, and shoulder). Though the study could not make direct causal associations, ACT head trauma and CMT shoulder injuries may be related to paratroopers' exposures. Average mechanical injury costs were $1,000/injury for non-paratroopers vs $837/injury for paratroopers. ACT injuries cost 2 to 3 times higher than CMT injuries. Per injured soldier, costs were $944/non-paratrooper and $822/paratrooper, per year.

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Comparison of Injuries between U.S. Army Active Duty Paratroopers and Non-Paratrooper Soldiers, Fiscal Years 2016 to 2018

PHIP No. 12-01-1219

1 REFERENCES

See Appendix A for a full list of references.

2 PURPOSE

This investigation compared the injuries and associated costs of Active Duty paratroopers (exposed cohort) to those of non-paratrooper Active Duty Soldiers (unexposed cohort) during a 3-year period from Calendar Years (CYs) 2016 through 2018. The analyses were conducted in accordance with the public health mission of the U.S. Army Public Health Center (APHC) to investigate and identify unique Army injuries, exposures, and risk factors in order to inform prevention strategies as described in Army Regulation 40-5.

3 BACKGROUND

3.1 Population of interest

To become a qualified U.S. military paratrooper, service members must successfully complete the 3-week Basic Airborne Course (BAC) at Fort Benning, Georgia. The BAC includes a rigorous physical conditioning program and high proficiency standards to ensure that all graduates have the ability to safely parachute as a means of combat deployment (HQDA 2018). Although qualified as paratroopers upon completion of BAC, not all graduates become operational paratroopers. As of 2012, the U.S. Department of Defense (DoD) capped its number of active, operational paratroopers at 49,000 positions (APHC 2019). The majority of these positions are assigned to the Army.

While the actual percentage of active paratroopers may vary each year as missions change, the U.S. Army paratrooper population consistently remains less than 10% of the overall Army Active Duty population of approximately 473,000 Soldiers, as noted in Defense Manpower Data Center (DMDC) reports from 2017 and 2018 (DMDC 2017; DMDC 2018).

The U.S. Army operational paratrooper population includes Soldiers with several occupational specialty codes who are assigned to a variety of units with diverse missions. Examples of specialties among paratroopers include infantry, Special Forces, rescue and firefighting, and aerial demonstration teams (e.g., U.S. Army Golden Knights). Most Army paratroopers are assigned to XVIll Airborne Corps, primarily to the 82nd Airborne Division (Fort Bragg, North Carolina). Other units support special operations and reconnaissance forces.

Depending on the type of unit and duties of an individual, additional paratrooper training programs may be required. For example, experienced jumpers may seek certification to become a Jumpmaster, or train to become certified in free-fall techniques referred to as High Altitude,

Low Opening (HALO). In addition to their regular salary, all active paratroopers receive a monthly hazard duty incentive pay (HDIP), often referred to as "Jump Pay" or "Parachute Duty Pay." As of 2017, Jump Pay was either $150 per month (regular) or $225 per month (HALO). Soldiers receiving Jump Pay must have parachute jumping as an essential part of their regular duties and conduct a minimum of four qualifying jumps per year (APHC 2019, U.S. DoD 2018, USC 2017, Powers 2019).

In epidemiological terms, differences in “exposure” among Army paratroopers refer to differences in the frequency of jumps, the types of equipment used (e.g., aircraft, parachutes, and type and weight of gear), the environmental conditions during jumps (e.g., lighting/time of day, landing area/terrain, and wind speed), as well as differences in operational procedures and training (APHC 2019). Despite these variations, the general duties of any U.S. Army paratrooper require each individual to maintain a high level of physical fitness and meet routine parachuting skills training requirements (HQDA 2018, USACRC 2015, DA 2009). These rigorous training requirements—meant to ensure safety—may provide an explanation for the apparently lower injury risk faced by U.S. paratroopers compared to the risks faced by paratroopers from other, international countries (APHC 2019).

3.2 Inconsistencies in the evidence

A 2019 APHC review of U.S. and international military parachuting-related injury studies synthesized recent evidence regarding paratrooper injuries and analyzed key similarities and inconsistences regarding injury rates, types of injuries, and injury risk factors (APHC 2019). Eighteen studies—each focused on a specific unit or units—and three reviews comprised the evidence for the meta-review.

Some prior research suggests that military paratroopers have a high risk of injury due to their “inherently dangerous” jump-related activities (Ekeland 1997, Bricknell 1997, Hay 2006). However, not all studies describe the risk this way. For example, Bar-Dayan et al. (2006) states that “parachuting is regarded as relatively safe,” and Knapik et al. (2003) elaborates, “[m]ilitary parachuting appears relatively safe if procedures that have been developed over long periods of time are followed.” These risk characterizations reflect the subjective nature of comparing risks between military activities.

Quantitative comparisons between the injury risks attributed to parachuting versus the injury risks attributed to other military activities have not been performed. One potential reason for this is that parachuting-related injury risk has historically been reported as the number of injuries per the number of jumps (most commonly the number of jumps is reported in terms of 1,000 jumps). While this metric standardizes risk in terms of jump-related exposure for comparisons between parachuting injury studies, it prevents the comparison of injury risks experienced by paratroopers with those of non-parachuting military service members (APHC 2019).

This APHC review identified studies reporting a wide range of paratrooper injury rates: from 3 to 55 injuries per 1,000 jumps. This large range likely reflects differences in injury definition, population, equipment, and environment (APHC 2019, Hughes 2008, Knapik 2003, Bricknell 1997, Farrow 1992). In addition to utilizing varying definitions of injury, past studies focused exclusively on acute traumatic (ACT) injuries. Often ACT injuries were directly attributed to an aircraft jump, and studies primarily included only those injuries observed immediately after paratroopers landed in the drop zone (DZ). The literature review’s findings suggest that the injury risk to U.S. military paratroopers is lower than the risk for other nationality military paratroopers. The review also notes the average injury rates among BAC trainees are more

than 50% lower than the rates among active, operational paratroopers (i.e., 6 ACT/1,000 jumps for BAC trainees versus 15 ACT/1,000 jumps for operational paratroopers). This is plausibly due to the strict oversight and safety controls over key risk factors (e.g., environmental factors such as wind speed, terrain, and landing technique) during the BAC (APHC 2019).

Additionally, this APHC review found that the types of injuries and body regions injured may differ between different populations. The lower extremities, especially ankles, were routinely identified in the reviewed literature as the body region most frequently injured during parachuting. However, the APHC review found that the most frequently injured body region(s) may differ between BAC trainees and operational paratroopers. Specifically, the review found that acute ankle fractures appeared to be most common among BAC trainees, while injuries to the back/spine, shoulder, head/neck, and soft tissue around the knees and ankles were more likely among operational paratroopers (APHC 2019).

3.3 Gaps

It is plausible that paratroopers have a higher rate of injury than military cohorts who do not have jump-related duties. However, no quantitative comparison of injury risk between these two populations was identified during the review. The use of different injury definitions, categories of injury types, and categories of body location by various researchers has contributed to inconsistent epidemiological findings.

Military parachuting injury rates described in the current literature do not estimate the risk of *all* injury types among paratrooper populations. Past parachuting injury studies have focused on ACT musculoskeletal (MSK) injuries. There does not appear to be any evaluation of the cumulative microtraumatic (CMT) injuries experienced by military paratroopers. The literature also fails to characterize any MSK injury-related long-term effects (LTE) that may be attributable to parachuting exposures. Potential LTE include post-traumatic osteoarthritis, spondylolysis, and spinal stenosis. The CMT injuries and injury-related MSK LTE experienced by paratroopers may result from repeated impacts from parachute jumps over time or the combination of repeated jumps and the repetitive stresses caused by other military activities (e.g., load carriage and foot marching). Since CMT injuries and LTE appear gradually, they cannot be attributed to a single jump like the injuries identified in previous studies (i.e., ACT injuries).

Ultimately, inconsistencies in the definitions of injury, risk, injury category, and injury location make it difficult to assess the overall consistency of evidence from intervention evaluations, such as the many studies on the parachute ankle brace (PAB) (APHC 2019, Luippold 2011, Knapik 2010). Despite evidence that the PAB was effective at reducing ankle injuries, the scientific findings were inadequate to change the unfavorable perceptions of the PAB (e.g. that it increased risk of injuries to other body regions) among the Airborne community. As a counter-example, the Army Airborne community itself designed a new parachute (T-11) which is larger and descends at a slower rate than the previous T-10 parachute, for both safety and tactical reasons (Knapik 2014a). Studies of the T11 used a consistent approach (such as when defining injury and body region categories) to demonstrate how injury reduction provided by the T-11, which supported the Airborne community's decision to implement the new design (Knapik 2014a).

3.4 Objectives

This investigation was conducted to address evidence gaps in accordance with recommendations from the prior APHC review (APHC 2019). Specific objectives included –

- Compare injuries between an Active Duty Army paratrooper population and those of a comparison cohort of Active Duty Army non-paratroopers. The following key public health questions were addressed –

  - *Is being an Army paratrooper a risk factor for injury or injury-related MSK LTE?*
  - *How does the distribution of injuries (types, body regions) among Army paratroopers compare to that of non-paratrooper Soldiers?*
  - *Do any intrinsic (demographic) risk factors influence injury risk among paratroopers?*
  - *How do the costs of injuries compare between paratroopers and non-paratroopers?*
  - *Do paratroopers and non-paratroopers require the same number of medical encounters for comparable injury types?*

- Standardize the injury definition and methods for categorizing injury types, body regions and sites, and demographic factors as a foundation for comparing future injury studies.

- Evaluate both ACT and CMT injuries, as well as injury-related MSK LTE.

4 METHODS

4.1 General

This investigation included a retrospective analysis of the injuries experienced by Active Duty Army paratroopers and a comparison cohort comprised of randomly selected Active Duty Soldiers with no paratrooper exposures. The study period extended from the start of CY 2016—coinciding with the Army-wide implementation of the new T-11 parachute design (Knapik 2014a)—and concluded at the end of CY 2018.

In the process of determining the paratrooper population, Soldiers with paratrooper duties were initially divided into “high exposure” and “low exposure” groups (defined in next section) to evaluate potential for a dose-response relationship between levels of exposure and injury risk. After the initial descriptive analyses, the low exposure group was removed from further evaluation due to their more limited exposure differences with the unexposed comparison cohort. After removal of the low exposure group, the high exposure group used as the study’s defined “paratrooper population.”

Each population included Soldiers on Active Duty during the entire study period from January 2016 to December 2018. All Reserve and National Guard personnel were excluded from both study populations. Injuries were determined using a comprehensive list of International Classification of Disease (ICD), Tenth Revision, Clinical Modification (ICD-10-CM) injury diagnosis codes in Soldiers’ electronic health records (EHR). This project was approved as a public health investigation by the Public Health Review Board of the U.S. Army Public Health Center (PHRB # 16-509).

4.2 Populations

4.2.1 Paratrooper population

The paratrooper population was determined by identifying Soldiers who had received HDIP (Jump/HALO) for the majority (19 or more) of the 36 pay periods for CY 2016 through CY 2018. To minimize dilution of the exposed population, Soldiers with the low exposures (18 or fewer months of HDIP) were excluded from both the paratrooper population and comparison group.

- Included Soldiers were considered to be “exposed” to the mechanical energy transfers to the body associated with parachute jumping in addition to those resulting from the other routine physical activities required of all Soldiers.

- The use of HDIP status was a surrogate for representing “exposure" since neither the number of jumps nor jump conditions that are known to be injury risk factors (e.g., equipment, time of day, weather, terrain, and type of plane) were accessible in a centralized data source. The number of months that each Soldier received HDIP was used as the exposure variable in the multiple logistic regression model, thus reflecting duration of individual exposure.

- The selected population included numerous paratrooper military occupational specialties (MOS). Though certain MOS (11X, B, C; 12B, C, K, N, R, T, W, Y; 13B, F, J, R; 14 G, P; 15B, D, E, F, G, H, N, P, Q, T, U, W, Y; 17 C, E; 19D; 25B, U; 35F; 42A; 68W; 88M; 91B; 92A, F, G, Y) had been initially identified for inclusion in the risk factor evaluation, MOS data were not available in the obtained dataset.

4.2.2 Comparison population (unexposed non-paratroopers)

An unexposed (non-paratrooper) population more than twice the size of the paratrooper population was used as a comparison group for this study. This comparison population was a random sample of Army Soldiers who were Active Duty from CY 2016 through CY 2018 who had not received any HDIP for jump duties during the study period. This was verified by excluding individuals in the exposed (paratrooper) population as well as the low exposure group from the comparison group. The comparison cohort was not matched to the demographics of the paratrooper population so that demographic characteristics could be evaluated in the regression analyses.

To determine how representative the comparison population was of the overall Army, data were evaluated against Army Active Duty DMDC gender and rank distributions for the study period using DMDC data (DMDC 2017, DMDC 2018). Since the DMDC data did not include race, this non-paratrooper population was compared to the Army-wide racial distribution data obtained from the Force Risk Reduction System (FR2), shown in Table 1.

Table 1. Distribution of Race, Active Duty Army Soldiers, December 2018

Racial demographic	Enlisted		Officer		TOTAL	
	#	%	#	%	#	%
White	252,006	67%	58,726	78%	310,732	69%
Black	90,316	24%	8,918	12%	99,234	22%
Asian/Pacific Isl.	30,051	8%	5,473	7%	35,524	8%
Other	3,133	<1%	2,558	3%	5,691	1%
TOTAL	375,506	100.0%	75,675	100.0%	451,181	100.0%

NOTES:
Source: Active Duty Strength statistics, Force Risk Reduction System (FR2), Population Dashboard: https://joint.safety.army.mil/Pages/home.html

4.3 Data sources

The DMDC provided the roster of exposed Soldiers, including their HDIP dates. The random sample comparison cohort was provided by the Defense Health Agency – Armed Forces Health Surveillance Branch (DHA-AFHSB). The DHA-AFHSB also provided the demographic and medical data from the Defense Medical Surveillance System (DMSS) for both cohorts. Using information provided by DHA-AFHSB for the two cohorts, cost data were extracted from healthcare encounter files located in the Military Health System Data Repository (MDR). Data were retrieved via the Military Health System Management Analysis and Reporting Tool (M2).

4.4 Injury Definition

This study used the Army's standardized epidemiological definition of injury: "Injury is the interruption of tissue function caused by either a single sudden or repeated external energy transfer, where energy can be mechanical, radiant, electrical, nuclear, or chemical in nature" (APHC 2017, Hauschild 2019). This comprehensive injury definition has previously been operationalized with specified ICD-10-CM diagnoses codes, so that the various types of injury diagnoses are categorized by causal energies based on a standardized taxonomy (APHC 2017, Hauschild 2019).

Analyses in this study focused primarily on the injuries attributed to the most common causal energy source: mechanical energy (APHC 2017, Hauschild 2018, Hauschild 2019). These mechanical injuries included those due to single high intensity forces (ACT injuries) as well as those due to lower energy repetitive forces (CMT injuries). Analyses also characterized whether the ACT and CMT injuries were MSK or non-MSK injuries. In addition, because evidence describes the MSK system as the system primarily injured by both general military activities as well as parachute jumping, this study compared the occurrence of injury-related MSK LTE in the populations (APHC 2019).

4.5 Incident Injuries and LTE

The previously established taxonomy-based list of ICD-10-CM injury diagnosis codes (APHC 2017, APHC 2019) was used to collect injury data encompassing CY 2016 to 2018 from the electronic health records of identified Soldiers. Injury incidence was defined as an initial medical encounter with any ICD-10-CM injury code as the primary diagnosis. To prevent double

counting, follow-up and sequelae visits associated with an incident injury were excluded. When codes did not specify initial encounters, a 60-day incident rule was applied (i.e., all encounter diagnoses for an injury of the same type and anatomical site within a 60-day period were considered to be a single injury incident).

Descriptive analyses for injury incidents (CY 2016 to 2018) were aggregated and presented for -

- Demographics
- Injury risk as a percentage (%) of the incident injuries/number of Soldiers in cohort
- Injury risk as a % of the Soldiers in a cohort with one or more injuries/total number of Soldiers in cohort
- Taxonomic injury distributions consistent with APHC methodology [APHC 2018] for aggregate (CY 2016 to 2018) injuries, including the percentages of different categories and subcategories of injuries, ranked percentages of mechanical injuries by body region, and injury types—including a chi-squared goodness-of-fit analysis.

Logistic regression analyses (univariate and multivariate) were conducted to evaluate the association of exposures (i.e., paratrooper status) and demographic risk factors (e.g., gender, race, age, and rank) to injury incidence. The logistic regression analyses were performed to determine to the odds of Soldiers having one or more injuries. Four outcomes of interest were investigated: mechanical injury (yes/no), ACT injury (yes/no), CMT injury (yes/no), and the injury-related MSK LTE (yes/no). Interaction models were used to evaluate potential additive or synergistic influence of demographic risk factors. The magnitude of the crude odds ratios (OR) was compared with the magnitudes of strata-specific ORs from multivariate models between key risk factors to determine if effect measure modification and/or confounding was present.

4.6 Direct Medical Injury Costs

As previously described, this study applied an "incident rule" to the specified ICD-10-CM injury codes to estimate the number of unique injuries that each population experienced during the study period January 2016 to December 2018. While this approach has been routinely used in Army injury studies (APHC 2017), it does not reflect the total number of *encounters* (i.e., visits to a healthcare provider) that Soldiers sought for each unique injury. For example, a sprained ankle is a single injury – but there may be many follow-up and sequelae encounters required to treat that injury.

An additional approach was used for this study's cost analyses. Since the Army paid direct medical costs (e.g., providers, diagnostics, medications, etc.) for each *encounter*, this study's cost analyses captured cost data for *all encounters* associated with each of the ICD-10-CM injury codes in the DX1 position. This approach more comprehensively reflects the medical cost burden of each population's injuries. While some injuries may require just a single encounter, more severe injuries frequently require numerous encounters, including both hospitalizations and outpatient follow-ups. Therefore, direct cost may be used as a possible surrogate for measuring injury severity.

Specifically, cost data for the taxonomy-based list of ICD-10-CM mechanical injury diagnosis codes were retrieved from healthcare encounter files for the paratroopers (exposed) and comparison group (unexposed) Soldiers from MDR.[1] Data sets included the Army-paid costs for

[1] Data were obtained from the MDR because of the size of the data capture effort.

all inpatient hospitalizations and outpatient visits to military treatment facilities (MTFs) and the costs of the purchased care (TRICARE)[2] at non-MTFs.

Inpatient hospitalization data files from MDR included—
- Standard Inpatient Data Record (SIDR), for MTFs
- TRICARE Encounter Data Institutional (TED-I), purchased from network facilities

Outpatient data files from MDR included—
- Comprehensive Ambulatory/Professional Encounter Record (CAPER), for MTFs
- TRICARE Encounter Data Non-Institutional (TED-NI), purchased from network facilities

Data retrieved from each MDR file (SIDR, TED-I, CAPER, and TEDNI) were prepared for analysis separately. Each file was evaluated to ensure completeness and accuracy of data (i.e., all months and including only Active Duty Soldiers from either the comparison or paratrooper population). The MDR files were each merged with the APHC taxonomy ICD codes for mechanical injuries based on the primary diagnosis code (DX1), and categorized by injury group (e.g., ACT/CMT/MSK/non-MSK), body region (e.g., head & neck, spine & back, etc.), and injury type (e.g., fracture, dislocation, etc.). Once the MDR files were aligned with the injury taxonomy variables, the cost datasets were merged with incident injury dataset by associated social security number (SSN).

For each of the resulting datasets, there was one line of information for each encounter, including demographic information (i.e., sex, beneficiary category, date of birth) and encounter information (i.e., the primary ICD code, the full cost associated with that encounter, the body region associated with the mechanical injury ICD code as an ACT, CMT, MSK and/or non-MSK injury, and the designation by injury type (e.g., fracture, dislocation, amputation, etc.)).

The combined files were de-identified (SSNs removed) so that only months of HDIP was used to categorize the encounter as belonging to either the paratrooper or unexposed comparison population. The final direct costs for mechanical injuries were determined by summing the cost of each encounter by ICD-10-CM injury diagnosis code and were reported by body region and type of injury. Total costs between the two populations could not be directly compared due to the substantial difference in population sizes. To allow comparisons between the two populations, the following averages were calculated and reported, using total cost as the numerator -

- *Average direct medical cost for all mechanical injuries/Soldier* (January 2016 to December 2018) was calculated for each population as the total cost divided by the total number of personnel in the respective population.

- *Average direct medical cost of mechanical injury encounters by subcategories* was calculated for each population using the total cost divided by the number of encounters, reported by injury categories, types, and body regions. Calculations were also performed for men and women separately.

2 TRICARE is a healthcare program of the U.S. Department of Defense Military Health System, that pays for care delivered by civilian providers

- *Average cost of incident mechanical injuries by subcategories* was calculated for each population using the sum of the cost divided by the number of incident injuries previously calculated in the study (Section 4.5). Average costs were reported by injury categories, types and body regions. Calculations were also performed for men and women separately.

4.7 Number of encounters per mechanical incident injury

To determine the average number of encounters for injuries (all mechanical, ACT, and CMT injury categories), the total number of identified encounters (per Section 4.6) was divided by the associated number of incident injuries (per Section 4.5).

5 FINDINGS

5.1 Demographics

Table 2 depicts the resulting demographic characteristics of the selected (unexposed) comparison cohort of non-paratroopers (N=170,715) compared to that of the selected (exposed) group of paratroopers (N=31,621). Data show some notable demographic differences. For example, women comprised just 5.2% of the paratrooper population versus 16% of the non-paratrooper comparison cohort. Among rank groupings, there was a substantially higher proportion of senior enlisted Soldiers in the paratrooper population (60.3%) versus in the non-paratrooper comparison cohort (33.4%).

The representativeness of the unexposed randomly selected comparison group was supported by a comparison of gender and rank distributions to Army Active Duty DMDC data (DMDC 2017, DMDC 2018). For example, DMDC data indicate between 15 and 16% of Soldiers were women between CY 2016 - 2018 compared to the 16.6% of this study's comparison group. The distribution of Black Soldiers (22%) is also comparable to the 24%. Army distribution (Table 1).

Table 2. Demographics of Unexposed and Exposed Paratrooper Populations

Active Duty Army Soldiers January 2016 to December 2018		UNEXPOSED **Non-Paratroopers** Comparison Cohort		EXPOSED **Paratroopers** >18 months jump pay	
Demographic		Total		Total	
		N	%	N	%
TOTAL		170,715	**100**	31,621	**100**
Sex	Men	142,326	**83.4**	29,982	**94.8**
	Women	28,389	**16.6**	1,639	**5.2**
Age	<25	60,278	**35.3**	6,609	**20.9**
	25-34	66,352	**38.9**	16,849	**53.3**
	35-44	32,183	**18.9**	6,898	**21.8**
	45+	11,881	**7.0**	1,265	**4.0**
Rank	Junior Enlisted (E1-E4)	84,887	**49.7**	8,798	**27.8**
	Junior Officer (O1-O3)	14,578	**8.5**	2,354	**7.4**
	Senior Enlisted (E5-E9)	57,083	**33.4**	19,076	**60.3**
	Senior Officer (O4-O10)	9,345	**5.5**	982	**3.1**
	Warrant Officer (W1-W5)	4,822	**2.8**	411	**1.3**
Race	White	113,331	**66.4**	23,408	**74.0**
	Black	39,089	**22.9**	4,852	**15.3**
	Other	11,571	**6.8**	1,721	**5.4**
	Unknown	6,724	**3.9**	1,640	**5.2**

NOTES:
- Paratroopers were defined as having an exposure period represented by 19 or more months of jump pay out of the total 36 months' pay during study timeframe; Appendix B contains additional details of the "low exposure" cohort of Soldiers who received ≤18 months jump pay
- Age data was missing in records of 21 non-paratroopers
- All comparison chi-square tests are significant ($p<0.01$)

5.2 Incident injuries and injury–related long-term effects

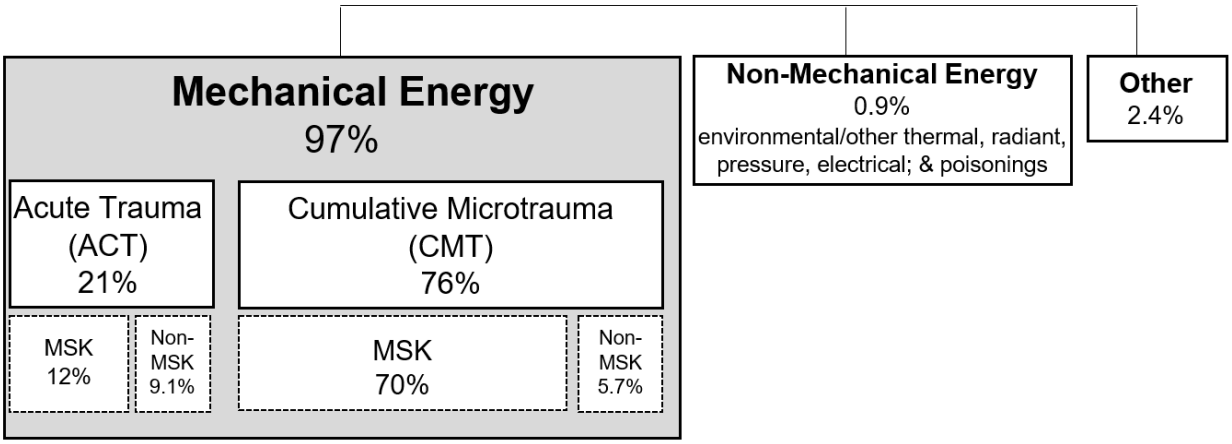
5.2.1 Incident injuries and injured Soldiers

On average, non-paratroopers experienced 2.93 injuries/Soldier (500,093 injuries/170,715 Soldiers) while paratroopers experienced 3.05 injuries/Soldier (96,338 injuries/31,621 Soldiers) during the 3-year study period. This equates to roughly one injury per Soldier per year in both populations.

The distributions of injuries by causal energy categories are shown in Figures 1 and 2. Mechanical energy transfers caused over 97% of all incident injuries experienced by Active Duty Soldiers, regardless of assigned paratrooper exposure status. In addition, most injuries experienced by both groups (81% non-paratroopers and 80% paratroopers) were MSK injuries. However, paratroopers experienced a greater proportion of ACT injuries (26%) compared to non-paratroopers (21%).

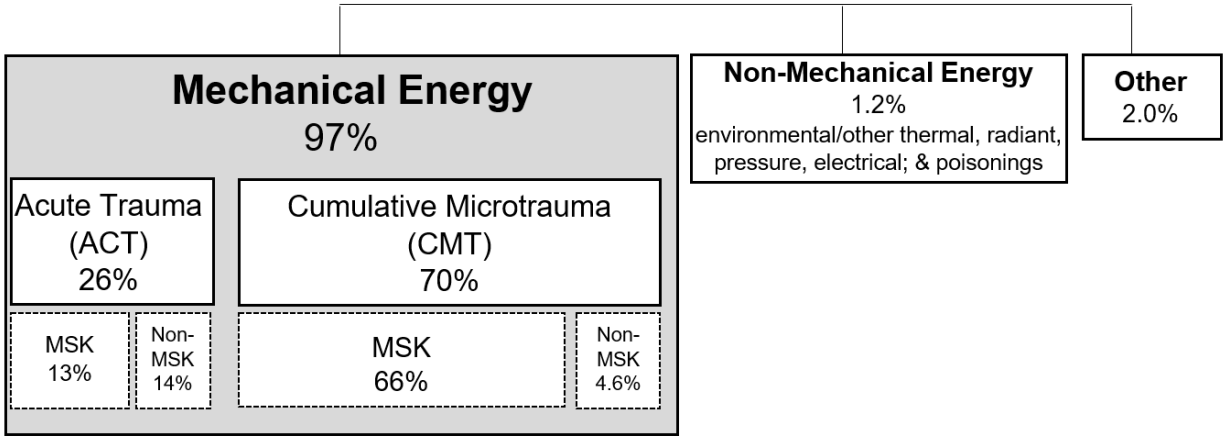
Though exposures were not considered adequately robust to be included as part of the paratrooper population, the “low exposure” cohort of Soldiers who had received $\leq$18 months Jump Pay experienced a proportion of ACT injuries (24%) between the aforementioned percentages, suggesting a dose-response relationship. Injury category proportions for the different demographic groups are provided in Appendix B.

Figure 1. Percentage distribution of non-paratrooper injuries by causal energy



NOTES
- Non-Paratrooper Soldiers N=170,715, incident injuries n=500,093, CY 2016 through CY 2018
- Percentages rounded to 2-significant digits; subcategory totals may be affected by rounding

Figure 2. Percentage distribution of paratrooper injuries by causal energy



NOTES
- Paratroopers N=31,621, incident injuries n=96,338, CY 2016 through CY 2018
- Percentages rounded to 2-significant digits; subcategory totals may be affected by rounding

Tables 3 and 4 (below) compare percentages of injured Soldiers by different injury categories. The percentage of Soldiers injured in the paratrooper population was higher than that of the unexposed population for all subcategories except for CMT injuries (Table 4). The CMT injury rates for both populations were substantially higher for MSK injuries compared to non-MSK injuries. Compared to the proportion of injured Soldiers in the comparison population, a slightly smaller proportion of paratroopers experienced CMT injuries.

Tables 3 and 4, in conjunction with the demographics from Table 2, also provide the basis for calculations of relative risk (RR) and odds ratios (OR) between genders. For example, the RR of injuries (Table 3) among female paratroopers compared to male paratroopers is 1.13, with a Confidence Interval (CI) of 1.1 to 1.15, p<.001. The OR is 1.8 (CI 1.6 to 2.1), p<.000001.

Table 3. Percentages of non-paratrooper and paratrooper Soldiers with any injury, any mechanical injury, and any MSK injury

Exposure Cohort	Sex	% of Injured Soldiers in Population		
		Any injury*	Mechanical injuries	Mechanical MSK (ACT +CMT)
Non-Paratroopers	All	73.1	70.6	59.8
	Men	71.5	69.2	58.3
	Women	81.1	77.4	67.6
Paratroopers	All	79.7	76.8	61.9
	Men	79.4	76.6	61.6
	Women	84.6	81.0	66.4

NOTES:
- * Any injury refers to all of the various taxonomic categories of injuries (see Appendix B)
- MSK (musculoskeletal), ACT (acute traumatic), and CMT (cumulative microtraumatic)
- Number of Soldiers: Unexposed Cohort = 170,715; Paratroopers = 31,621
- Soldiers (in both cohorts) who experienced at least once injury CY 2016 through 2018: All injuries N=150,046; Mechanical injuries N=144,764; Musculoskeletal injuries N=121,714

Table 4. Percentages of injured non-paratrooper and paratrooper Soldiers with ACT and CMT injuries

Exposure Cohort	Sex	% of Injured Soldiers in Population			
		ACT		CMT	
		MSK	Non-MSK	MSK	Non-MSK
Non-Paratroopers	All	9.6	7.1	50.3	3.6
	Men	9.7	7.3	48.6	3.6
	Women	9.0	6.2	58.6	3.6
Paratroopers	All	12.9	11.5	49.0	3.4
	Men	12.8	11.5	48.8	3.4
	Women	13.8	11.5	52.7	3.1

NOTES:
- MSK (musculoskeletal), ACT (acute traumatic), and CMT (cumulative microtraumatic)
- Number of Soldiers: Unexposed Cohort = 170,715; Paratroopers = 31,621Soldiers(in both cohorts) who experienced at least one injury CY 2016 through 2018: Mechanical injured N=144,764; Musculoskeletal injured N=121,714

5.2.2 Body regions and anatomical sites injured

Tables 5a and 5b portray the distribution of mechanical injuries by region and anatomical site for the top five injured anatomical sites for ACT, CMT, and All mechanical injuries. Additional details, including distributions by gender, are provided in Appendix C.

Table 5a. Non-Paratroopers' top five mechanical injuries by body region and site

Body Region	% mechanical injuries			Anatomical Site	% of mechanical injuries			Ranking of Top 5		
	ACT	CMT	ALL		ACT	CMT	ALL	ACT	CMT	ALL
HEAD & NECK	3.6	2.4	6.0	TBI	0.7	0.0	0.7			
				Other head	1.1	0.0	1.1			
				Face	0.4	0.0	0.4			
				Eye	0.8	0.0	0.8			
				Ear	0.1	2.4	2.4			
				Neck	0.6	0.0	0.6			
				Head/Neck, Other	0.0	0.0	0.0			
SPINE & BACK	1.2	24.0	26.0	Back, Upper	0.2	4.4	4.5			
				Back, Middle	0.1	1.4	1.5			
				Back, Lower	1.0	16.0	17.0		1	1
				Back, Other	0.0	2.6	2.6			
TORSO	1.3	0.1	1.4	Chest	0.7	0.1	0.8			
				Abdomen	0.2	0.0	0.2			
				Pelvis	0.3	0.1	0.4			
				Trunk, Other	0.0	0.0	0.0			
UPPER EXTREMITY	6.7	14.0	21.0	Shoulder	1.8	7.1	8.9	4	3	3
				Arm, Upper	0.4	0.1	0.5			
				Elbow	0.7	1.3	2.1			
				Arm, Lower	0.7	0.2	0.9			
				Wrist	0.5	2.8	3.3			
				Hand, Finger	2.5	1.9	4.3	1		
				Arm, Other	0.0	0.6	0.6			
LOWER EXTREMITY	8.7	36.0	45.0	Hip	0.8	4.8	5.6			5
				Leg, Upper	0.7	1.4	2.2			
				Knee	1.7	12.4	14.1	4	2	2
				Leg, Lower	1.9	2.8	4.6	3		
				Ankle	2.1	5.8	8.0	2	5	4
				Foot, Toe	1.4	6.5	8.0	5	4	4
				Leg, Other	0.0	2.2	2.2			
OTHER	0.1	1.7	1.8	System-wide	0.0	0.0	0.0			
				Multiple	0.0	0.0	0.0			
				Unspecified	0.1	1.7	1.8			
TOTALS	**22.0**	**78.0**	**100**	**TOTALS**	**22.0**	**78.0**	**100**			

NOTES:
- Non-paratroopers Soldiers N = 170,715; mechanical incident injuries n = 483,250; CY 2016 through 2018
- Percentages are rounded to two significant digits
- Colors denote: orange= leading regions and top 5 locations; pink= leading ACT, purple= leading CMT

Table 5b. Paratroopers' top five mechanical injuries by body region and site

Body Region	% of mechanical injuries			Anatomical Site	% of mechanical injuries			Ranking of Top 5		
	ACT	CMT	ALL		ACT	CMT	ALL	ACT	CMT	ALL
HEAD & NECK	6.0	2.5	8.5	TBI	1.6	0.0	1.6			
				Other head	2.0	0.0	2.0	5		
				Face	0.6	0.0	0.6			
				Eye	1.0	0.0	1.0			
				Ear	0.2	2.5	2.7			
				Neck	0.7	0.0	0.7			
				Head/Neck, Other	0.0	0.0	0.0			
SPINE & BACK	1.8	24.0	26.0	Back, Upper	0.2	4.4	4.6			
				Back, Middle	0.1	1.7	1.8			
				Back, Lower	1.5	16.0	17.0		1	1
				Back, Other	0.0	2.2	2.2			
TORSO	1.7	0.1	1.8	Chest	0.9	0.1	1.0			
				Abdomen	0.3	0.0	0.3			
				Pelvis	0.5	0.0	0.5			
				Trunk, Other	0.0	0.0	0.0			
UPPER EXTREMITY	7.5	14.0	22.0	Shoulder	2.1	7.7	9.8	4	3	3
				Arm, Upper	0.5	0.1	0.6			
				Elbow	0.6	1.5	2.1			
				Arm, Lower	0.9	0.2	1.1			
				Wrist	0.6	2.3	2.8			
				Hand, Finger	2.9	1.9	4.7	1		
				Arm, Other	0.0	0.6	0.6			
LOWER EXTREMITY	10.0	31.0	41.0	Hip	0.8	3.3	4.1			
				Leg, Upper	0.9	1.2	2.1			
				Knee	1.8	11.0	13.0		2	2
				Leg, Lower	2.2	1.9	4.2	3		
				Ankle	2.7	6.3	9.0	2	4	4
				Foot, Toe	1.7	5.2	7.0		5	5
				Leg, Other	0.0	2.0	2.1			
OTHER	0.1	1.1	1.2	System-wide	0.0	0.0	0.0			
				Multiple	0.0	0.0	0.0			
				Unspecified	0.1	1.1	1.2			
TOTALS	**27.0**	**73.0**	**100**	**TOTALS**	**27.0**	**73.0**	**100**			

NOTES:

- Paratroopers N = 31,621; mechanical incident juries n = 93,176; CY 2016 through 2018
- Percentages are rounded to two significant digits
- Colors denote: orange= leading regions and top 5 locations; pink= leading ACT, purple= leading CMT

5.2.3 Injury types

A comparison of the distributions of the different types of mechanical injuries was conducted using a chi-squared goodness-of-fit test (Table 6). Though differences were statistically significant due to the large population sizes, results show relatively similar injury distribution patterns between paratrooper and non-paratrooper populations. The most predominant type of MSK injury was “MSK tissue damage, other” (over two-thirds of the mechanical injuries in both populations). Although internal organ injuries make up only a small percentage of total injuries in both populations, paratroopers experience these injuries at a higher rate—primarily in the form of traumatic brain injuries (TBI) and concussions.

The 12 most commonly diagnosed injuries (based on ICD code) are experienced in similar proportions in both populations (Table 7; additional data in Appendix D). Over 50% of the injuries in both cohorts are CMT MSK tissue damage diagnoses for location-specific related pain syndromes. Diagnosis for sprained ligament of the ankle was the only ACT injury among the leading diagnoses.

Table 6. Chi-squared goodness-of-fit: paratroopers vs. non-paratroopers mechanical injuries

Injury type	Test Percent [a]	Paratroopers Percent [b]
MSK tissue damage, other	73.3	69.0
Tissue damage, other [c]	5.0	6.8
Sprain/joint damage	5.2	5.8
Contusion/superficial	3.8	3.9
Strain/tear	3.7	4.0
Fracture	2.1	2.9
Nerve	3.8	2.5
Open wound	2.0	2.9
Internal organ & blood vessel [d]	0.7	1.7
Dislocation	0.4	0.5
Crush	0.1	0.1
Amputation	<0.1	<0.1

NOTES:
[a] Test percent based on distribution of unexposed non-paratroopers’ mechanical injuries (n=483,250)
[b] Paratroopers mechanical injuries (n=93,176) distributions significantly different than test percent ($p < 0.01$)
[c] Primary injury types include noise-induced hearing loss; radiculopathies in spine/back
[d] Primary injuries are concussions or other traumatic brain injury

Table 7. Leading diagnoses: non-paratroopers and paratroopers

ICD code	ICD description	Body Region	Anatomical site	Injury Type		% of mechanical injuries	
						Non-Paratrooper	Paratrooper
M545	Low back pain	Spine & Back	Back, Lower	MSK Tissue Damage, Other	CMT-MSK	13.4	13.9
M2556	Pain in knee	Lower Extremity	Knee	MSK Tissue Damage, Other	CMT-MSK	9.7	8.8
M2551	Pain in shoulder	Upper Extremity	Shoulder	MSK Tissue Damage, Other	CMT-MSK	6.1	6.8
M2557	Pain in ankle and joints of foot	Lower Extremity	Ankle	MSK Tissue Damage, Other	CMT-MSK	5.3	5.8
M2555	Pain in hip	Lower Extremity	Hip	MSK Tissue Damage, Other	CMT-MSK	4.2	2.9
M542	Cervicalgia	Spine & Back	Back, Upper	MSK Tissue Damage, Other	CMT-MSK	3.6	3.8
S9340	Sprain of ligament of ankle, initial encounter	Lower Extremity	Ankle	Sprain/Joint Damage	ACT-MSK	1.1	1.4
M7967	Pain in foot	Lower Extremity	Foot, Toe	MSK Tissue Damage, Other	CMT-MSK	2.7	2.6
M549	Dorsalgia, unspecified	Spine & Back	Back, Other	MSK Tissue Damage, Other	CMT-MSK	2.3	1.9
M2553	Pain in wrist	Upper Extremity	Wrist	MSK Tissue Damage, Other	CMT-MSK	2.0	1.8
M722	Plantar fascial fibromatosis	Lower Extremity	Foot, Toe	MSK Tissue Damage, Other	CMT-MSK	2.1	1.4
M7960	Pain in leg	Lower Extremity	Leg, other	MSK Tissue Damage, Other	CMT-MSK	1.6	1.4

NOTES:

- Unexposed Soldiers N = 170,715, mechanical incident injuries n = 483,250, January 2016 to December 2018
- Paratroopers N = 31,621, mechanical incident injuries n = 93,176, January 2016 to December 2018
- Details in Appendix D

Combining the distribution of injuries by both body regions and injury types for non-paratroopers and paratroopers yields the matrices in Tables 8a and 8b. These tables illustrate the proportion of injuries that are classified as “MSK Tissue damage, Other,” most of which are CMT injuries. These tables demonstrate that the primary body sites injured in both populations are knee, lower back, and shoulder. Though fractures represent only a small proportion (<3%) of injuries experienced by both populations, paratroopers have a greater proportion of ACT fractures (96% of fractures versus 85% of fractures among non-paratroopers; the remaining 15% are CMT stress fractures). Appendix C provides additional details including separate analyses for men and women.

5.2.4 Injury-related MSK LTE

Though not technically considered “injuries” themselves, the identified injury-related MSK LTE diagnoses were considered to be the result of prior injury (either ACT or CMT). Results of the LTE diagnoses are presented in Appendix D. Non-paratroopers experienced 0.43 injury-related LTE/Soldier (73,601 MSK LTE/170,715 Soldiers) while the paratroopers experienced 0.37 LTE/Soldier (11,667 MSK LTE/31,621 Soldiers) during the study period. The leading MSK LTE category in both populations was the subsequent and sequelae encounters resulting from initial ACT injuries (38% of all non-paratroopers; 45% of all paratroopers). The next most frequent diagnosis category in both populations was spinal stenosis (25% of all non-paratroopers, 21% of all paratroopers). Both men and women had similar primary injury-related MSK LTE diagnoses.

5.2.5 Regression analyses for risk factors

Results of univariate and multivariate logistic regression analyses for all mechanical injuries, ACT MSK injuries, CMT MSK, and injury-related MSK LTE are presented in Appendix E. Paratrooper status (exposure) was consistently shown to be a risk factor for all mechanical injuries, ACT MSK injuries, and CMT MSK injuries in all unadjusted and adjusted ORs (e.g., univariate OR of 1.43, and a multivariate OR of 1.52 for all mechanical injury). The OR was less than 1.0, however, for injury-related MSK LTE. Female gender (e.g., univariate OR of 1.57, and a multivariate OR of 1.43 for all mechanical injury) and Black race (e.g., univariate OR of 1.62, and a multivariate OR of 1.33 for all mechanical injury) demographic groups also exhibited higher injury and injury-related MSK LTE risk in regression analyses. Though less substantial for ACT MSK, data also showed a pattern of higher injury and MSK LTE risks among the older age groups (35 to 44, 45+ years) and advanced rank groups (enlisted E5 to E9 and officers 04 to 010, including W1 to W5).

5.2.6 Interactions, effect measures, and confounding

Appendix F describes the additional analyses regarding the relationship between sex and paratrooper exposure as well as race and paratrooper exposure on mechanical injury risk. Results suggest there was not a significant interaction between sex and paratrooper exposure or between race and paratrooper exposure in regard to risk for mechanical injury. Strata-specific ORs were different but within 10% of the crude ORs suggesting greater association with paratrooper status (exposure) than with injury risk.

Table 8a. Non-paratroopers' mechanical injury incidence: percentages by body site and injury type

Body Region	SITE	Fracture		Dis-location	Sprain/Joint Damage		Strain/ Tear		MSK Tissue Damage, Other		Internal organ	Open wound	Nerve		Contusions/ Superficial		Tissue damage, other		% total injuries
		ACT	CMT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	
HEAD & NECK	TBI	--	--	--	--	--	--	--	--	--		--	--	--	--	--	--	--	--
	Other head	--	--	--	--	--	--	--	--	--		--	--	--	--	--	--	--	1.1
	Ear	--	--	--	--	--	--	--	--	--		--	--	--	--	--	--	2.4	2.4
SPINE & BACK	Back, Upper	--	--	--	--	--	--	--	--	3.8		--	--	--	--	--	--	--	4.5
	Back, Middle	--	--	--	--	--	--	--	--	1.4		--	--	--	--	--	--	--	1.5
	Back, Lower	--	--	--	--	--	--	--	--	14.0		--	--	1.6	--	--	--	--	17.0
	Back, Other	--	--	--	--	--	--	--	--	2.6		--	--	--	--	--	--	--	2.6
TORSO	Chest	--	--	--	--	--	--	--	--	--		--	--	--	--	--	--	--	--
UPPER EXTREMITY	Shoulder	--	--	--	--	--	--	--	--	6.9		--	--	--	--	--	--	--	8.9
	Elbow	--	--	--	--	--	--	--	--	1.3		--	--	--	--	--	--	--	2.1
	Wrist	--	--	--	--	--	--	--	--	2.2		--	--	--	--	--	--	--	3.3
	Hand, Finger	--	--	--	--	--	--	--	--	1.8		--	--	--	--	--	--	--	4.3
LOWER EXTREMITY	Hip	--	--	--	--	--	--	--	--	4.7		--	--	--	--	--	--	--	5.6
	Leg, Upper	--	--	--	--	--	--	--	--	1.4		--	--	--	--	--	--	--	2.2
	Knee	--	--	--	1.2	--	--	--	--	12.0		--	--	--	--	--	--	--	14.0
	Leg, Lower	--	--	--	--	--	--	--	--	2.6		--	--	--	--	--	--	--	4.6
	Ankle	--	--	--	1.7	--	--	--	--	5.8		--	--	--	--	--	--	--	8.0
	Foot, Toe	--	--	--	--	--	--	--	--	6.0		--	--	--	--	--	--	--	8.0
	Leg, Other	--	--	--	--	--	--	--	--	2.0		--	--	--	--	--	--	--	2.2
% ACT vs CMT		85%	15%	100%	97%	2.8%	93%	7.4%	2.0%	98%		100%	19%	81%	86%	14%	53%	47%	
% of mechanical injuries		2.1%		0.3%	5.2%		3.7%		73%		0.7%	2%	3.7%		3.7%		5.0%		

NOTES:

- Non-paratrooper Soldiers N = 170,715; Incident mechanical injuries n = 483,250, January 2016 through December 2018
- Numbers shown have been rounded to two-significant digits; most % are shown as "--" which means <1% of all mechanical injuries (injury types not shown are Amputations, and Crush – each of these is <1% of mechanical injuries)
- As shown in bottom row - 73% injuries are MSK Tissue Damage, Other; as shown in far right column leading injured body sites are knee, low back, shoulder
- Red text and pink highlighted boxes emphasize injury types discussed in text
- Complete data is presented in Appendix C
-

Table 8b. Paratroopers' mechanical injury incidence: percentages by body site and injury type; Jan 2016 to Dec 2018

Body Region	SITE	Fracture		Dis-location	Sprain/Joint Damage		Strain/ Tear		MSK Tissue Damage, Other		Internal organ	Open wound	Nerve		Contusions/ Superficial		Tissue damage, other		% total injuries
		ACT	CMT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	
HEAD & NECK	TBI	--	--	--	--	--	--	--	--	--	1.6	--	--	--	--	--	--	--	1.6
	Other head	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.2	--	2.0
	Ear	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.5	2.7
SPINE & BACK	Back, Upper	--	--	--	--	--	--	--	--	4.0	--	--	--	--	--	--	--	--	4.6
	Back, Middle	--	--	--	--	--	--	--	--	1.7	--	--	--	--	--	--	--	--	1.8
	Back, Lower	--	--	--	--	--	--	--	--	15.0	--	--	--	1.1	--	--	--	--	17.0
	Back, Other	--	--	--	--	--	--	--	--	2.2	--	--	--	--	--	--	--	--	2.2
TORSO	Chest	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0
UPPER EXTREMITY	Shoulder	--	--	--	--	--	--	--	--	7.6	--	--	--	--	--	--	--	--	9.8
	Elbow	--	--	--	--	--	--	--	--	1.5	--	--	--	--	--	--	--	--	2.1
	Wrist	--	--	--	--	--	--	--	--	2.0	--	--	--	--	--	--	--	--	2.8
	Hand, Finger	--	--	--	--	--	--	--	--	1.8	--	1.2	--	--	--	--	--	--	4.7
LOWER EXTREMITY	Hip	--	--	--	--	--	--	--	--	3.3	--	--	--	--	--	--	--	--	4.1
	Leg, Upper	--	--	--	--	--	--	--	--	1.2	--	--	--	--	--	--	--	--	2.1
	Knee	--	--	--	1.3	--	--	--	--	11.0	--	--	--	--	--	--	--	--	13.0
	Leg, Lower	--	--	--	--	--	--	--	--	1.9	--	--	--	--	--	--	--	--	4.2
	Ankle	--	--	--	2.0	--	--	--	--	6.3	--	--	--	--	--	--	--	--	9.0
	Foot, Toe	--	--	--	--	--	--	--	--	5.0	--	--	--	--	--	--	--	--	7.0
	Leg, Other	--	--	--	--	--	--	--	--	2.0	--	--	--	--	--	--	--	--	2.1
% ACT vs CMT		96%	4%	100%	98%	2%	95%	5%	2.0%	98%	100%	100%	19%	81%	94%	6.1%	63%	37%	
% of mechanical injuries		**2.9%**		**0.5%**	**5.8%**		**4.0%**		**69%**		**1.7%**	**2.9%**	**2.4%**		**3.8%**		**6.8%**		

NOTES:

- Paratroopers N = 31,621; Total incident mechanical injuries n = 93,176, January 2016 through December 2018
- Numbers shown have been rounded to two-significant digits; most % are shown as "--" which means <1% of all mechanical injuries (injury types not shown are Amputations, and Crush – each of these is <1% of mechanical injuries)
- As shown in bottom row - 69% injuries are MSK Tissue Damage, Other; as shown in far right column leading injured body sites are knee, low back, shoulder
- Most other injury types and % shown as "--" are <1% of all mechanical injuries
- Red text and pink highlighted boxes emphasize injury types discussed in text
- Percent of fractures higher for paratrooper than comparison (table 8a) and greater portion are ACT
- Complete data are presented in Appendix C

5.3 Cost of Injuries

The combined hospitalized and outpatient direct medical costs of all mechanical injuries are shown in Appendix G. The total direct cost for all mechanical injury encounters during the 3-year study period was $483,352,672 for the unexposed Soldiers (N=170,715) and $78,018,272 for paratroopers (N= 31,621).

5.3.1 Average cost of injury per Soldier

The average direct medical cost for mechanical injuries per Soldier was $2,831/non-paratrooper and $2,467/paratrooper for the 3-year study period. Annually, these estimates equate to a cost of $944/non-paratrooper and $822/paratrooper, per year.

5.3.2 Average cost of mechanical injury encounters

The average costs by *encounter* and percentages of encounter costs are shown in Tables 9a and 9b. The average mechanical injury encounter cost was similar in both paratrooper and non-paratrooper populations. ACT injury encounters were the highest costs in both populations, on average three to four times higher than the costs for CMT injury encounters.

More than two-thirds (68%) of the non-paratroopers' direct costs and over half (54%) of the paratroopers' direct costs were for CMT injuries. Average costs per encounter for ACT injuries were about the same for paratroopers and non-paratroopers, but paratroopers had slightly lower costs for CMT injuries compared to those of non-paratroopers. Average costs per encounter for all mechanical and CMT injuries were similar between men and women. However, the average ACT injury encounter cost was lower among female non-paratroopers compared to their male counterparts while the average ACT injury encounter cost for female paratroopers was higher compared to their male counterparts.

Table 9a. Non-paratroopers' mechanical injury encounters: % and average medical costs

Injury/Energy Sub-Category	Body System	Total cost	% Cost of all MECH	AVG Cost per Injury Encounter	AVG Cost per Female Injury Encounter	AVG Cost per Male Injury Encounter
All Mechanical		$483,352,672	100%	**$279**	**$234**	**$291**
All ACT		$154,890,529	32%	**$741**	**$566**	**$773**
	MSK	$109,528,886		$866	$662	$903
	NON-MSK	$45,361,642		$549	$428	$572
All CMT		$328,462,143	68%	**$216**	**$201**	**$220**
	MSK	$306,651,907		$211	$197	$215
	NON-MSK	$21,810,236		$309	$289	$313

NOTES:
- Costs for all encounters including follow-ups/sequelae for incident injuries defined by ICD-10 injury codes
- 82% of total cost of mechanical injuries are for male injury encounters

Table 9b. Paratroopers' mechanical injury encounters: % and average medical costs

Injury/Energy Sub-Category	Body System	Total cost	% Cost of all MECH	AVG Cost per Injury Encounter	AVG Cost per Female Injury Encounter	AVG Cost per Male Injury Encounter
All Mechanical		$78,018,273	100%	**$276**	**$275**	**$276**
All ACT		$36,073,478	46%	**$742**	**$854**	**$735**
	MSK	$22,623,983		$837	$892	$833
	NON-MSK	$13,449,495		$624	$810	$611
All CMT		$41,944,794	54%	**$179**	**$166**	**$180**
	MSK	$39,743,712		$176	$163	$177
	NON-MSK	$2,201,082		$253	$265	$253

NOTES:
- Costs for all encounters including follow-ups/sequelae for incident injuries defined by ICD-10 injury codes
- 93% of total cost of mechanical injuries are for male injury encounters

Average direct medical costs for mechanical injury *encounters* by specific body region and type of injury are shown in Appendix G. Based on average encounter costs, the most costly types of injury encounters were amputations and acute internal organ injuries. Acute internal organ head injuries (e.g., concussions, TBI) averaged $1,126 per encounter among paratroopers. This cost was less than the average cost of encounters for similar injury diagnoses among non-paratroopers ($1,497). These costs were more than the average cost of fracture encounters ($1,174 for paratroopers vs $1,087 for non-paratroopers). Other ACT MSK injuries had even lower average encounter costs.

Some CMT injury encounters had relatively high average costs – for example, CMT joint injuries had an average cost of $1,560/encounter for paratroopers and $1,835/encounter for non-paratroopers. The average encounter cost for *upper extremity CMT joint injuries* was higher for paratroopers than non-paratroopers ($1,876 versus $857). Among CMT upper extremity injuries, the highest costs – and most notable difference between populations - were for *shoulder injuries* ($3,004 for paratroopers versus $729 for non-paratroopers).

5.3.3 Average cost of mechanical injuries

The average direct medical costs of mechanical *injury incidents* (also referred to as *injuries*) are shown in Tables 10a and 10b by injury subcategory and gender. The average cost of a mechanical injury was almost 20% higher for non-paratroopers ($1,000/injury for non-paratroopers versus $837/injury for paratroopers). Highest costs in both populations were for ACT MSK incident injuries, which were two to three times higher than for CMT injuries.

Though among non-paratroopers the average cost per injury was lower for women compared to men (Table 10a), the cost was higher for female paratroopers compared to male paratroopers (Table 10b). Paratrooper women had higher average ACT incident injury costs, but lower average CMT injury costs than non-paratrooper women. Paratrooper men had lower average ACT and CMT incident injury costs than non-paratrooper men.

Table 10a. Non-paratroopers' average direct medical costs per mechanical injury

Injury/Energy Sub-Category	Body System	Total cost	Incident injuries	AVG Cost per Injury	AVG Cost per Female Injury	AVG Cost per Male Injury
All Mechanical		$483,352,672	483,250	$1,000	$845	$1,041
All ACT		$154,890,529	104,297	$1,485	$1,001	$1,590
	MSK	$109,528,886	58,961	$1,858	$1,235	$1,991
	NON-MSK	$45,361,642	45,336	$1,001	$703	$1,066
All CMT		$328,462,143	378,953	$867	$810	$882
	MSK	$306,651,907	350,364	$875	$815	$892
	NON-MSK	$21,810,236	28,589	$763	$729	$770

NOTES:

- Cost data shown in Appendix G

Table 10b. Paratroopers' average direct medical costs per mechanical injury

Injury/Energy Sub-Category	Body System	Total cost	Incident injuries	AVG Cost per Injury	AVG Cost per Female Injury	AVG Cost per Male Injury
All Mechanical		$78,018,273	93,176	$837	$904	$833
All ACT		$36,073,478	25,364	$1,422	$1,674	$1,406
	MSK	$22,623,983	13,255	$1,707	$1,868	$1,697
	NON-MSK	$13,449,495	12,109	$1,111	$1,476	$1,086
All CMT		$41,944,794	67,812	$619	$626	$618
	MSK	$39,743,712	63,407	$627	$627	$624
	NON-MSK	$2,201,082	4405	$500	$603	$495

NOTES:

- Cost data shown in Appendix G

Additional details showing average direct medical costs for mechanical injury *incidents* by specific body region and type of injury are shown in Appendix G. As with encounters, amputations were the most costly (on average $28,000/injury among non-paratroopers as compared to $20,000 among paratroopers). The average costs of CMT sprain/joint damage injuries among paratroopers were half that of non-paratroopers ($8,000/injury for paratroopers vs $16,000/injury unexposed).

5.4 Number of encounters per injury

Table 11 presents the average number of medical encounters per incident injury for all mechanical injuries, and by subcategories (ACT and CMT, by MSK and Non-MSK systems). Overall injuries required an average of two to four encounters, with CMT injuries requiring more encounters, on average, for both populations. Overall, paratroopers required fewer encounters (approximately 10% or less) than the non-paratroopers.

Table 11. Average number of medical encounters per incident injury, by category

Injury Type	Unexposed			Paratroopers		
	Encounters	Incident injuries	Encounters /Injury	Encounters	Incident injuries	Encounters /Injury
ALL MECH	1,730,717	483,250	3.58	282,534	93,176	3.03
ACT	209,134	104,297	2.01	48,593	25,364	1.92
MSK	126,474	58,961	2.15	27,032	13,255	2.04
NON-MSK	82,659	45,336	1.82	21,561	12,109	1.78
CMT	1,521,583	378,953	4.02	233,941	67,812	3.45
MSK	1,450,966	350,364	4.14	225,250	63,407	3.55
NON-MSK	70,617	28,589	2.47	8,691	4,405	1.97

6 DISCUSSION

This study evaluated whether Soldiers who were “exposed” to the activity of parachute jumping during a 3-year study period had a greater risk of injury than a comparison cohort of Soldiers who had no parachute jump exposures and whether their medical costs were higher. This investigation assessed the potential influence of intrinsic demographic characteristics on injury risk and whether there were differences in the types of injuries or chronic injury-related MSK conditions and associated direct medical costs. The study also compared the number of medical encounters required for each type of injury.

6.1 Populations

Demographic differences identified in this study indicate that in comparison to the unexposed Active Duty Army sample, paratroopers are less likely to be women (5.2% versus 17%), less likely to be black (15% versus 23%), and much more likely to be a senior enlisted Soldier. For example, paratroopers were comprised of 60% senior enlisted (E5-E9) compared to 33% of Soldiers at this rank among non-paratroopers. This finding may be explained by the time required to develop and maintain the specialized skills sets required for paratroopers. The monetary incentives to maintain HDIP duties may be especially attractive to this non-commissioned officer (NCO) population. The smaller proportion of women was expected, given that there tend to be substantial physical requirements needed to carry the paratrooper gear. Especially given the substantially higher proportion of enlisted Soldiers in the paratrooper population and larger proportion of Blacks among enlisted shown in Table 1, it is unclear why the proportion of Blacks among paratroopers was notably smaller than among the non-paratroopers. This finding may reflect career and skill set preferences.

The paratroopers (N = 31,321) were all Active Duty Soldiers who received Jump/HALO hazard pay for at least 19 of the 36 months between CY 2016 and CY 2018. As previously described, the nature of specific parachuting “exposures” within this population are expected to have varied by individual MOS, assigned unit, as well as the nature of individuals’ jump experiences (i.e., the number and frequency of jumps, environmental factors such as wind speed, lighting, terrain, type of aircraft, type of parachute, and weight of gear). However, all paratroopers included in this study had successfully graduated from BAC and then maintained a high level of physical and jump-related skill training for a minimum of a year and a half in order to retain their operational paratrooper status.

Though the exposed paratroopers were excluded from the unexposed comparison group, the unexposed non-paratrooper population (N= 170,715) is a reasonable representation of the overall Active Duty Army population for the study period. The representativeness of this random sample was supported by a comparison of gender and rank distributions to Army Active Duty DMDC data (DMDC 2017, DMDC 2018) and to racial distribution data obtained from the FR2 (Table1).

6.2. Comparison of incident injuries and injury-related LTE risk

6.2.1 Incident injuries

The findings of this study indicate that paratrooper exposure increases a Soldier's risk of injury. This finding supports the assumption that, in general, paratroopers' duties are inherently more hazardous.

Being a woman, being African American (Black race), being of greater years in age (>25 years), and possessing a more advanced rank are demographic factors that appear to also independently increase risk of injury, as has been suggested by previous studies. For example, military women have been reported to have injury rates 1.1 to 10 times higher than their male counterparts (1.5 to 2.5 times higher being most common) (Borden Institute 2011, Hauschild 2018; APHC 2017 HOF, Jones 2015). This higher injury risk, however, has been found to be less substantial or even negligible when studies have adjusted for physical fitness (Jones 2015, APHC 2019 FS 12-021-0319; Anderson 2017). Though this study did not have access to fitness measures, it is plausible that female paratroopers represent a particularly fit group of Active Duty women.

By the same logic, this may also be true for risk attributed to older age groups, since prior studies have suggested that risk of injury may increase with age (Jones 2015). The reason for this study's identification of a higher risk of injury in the Black race group is not clear. Current data on race as a risk factor for mechanical injury is limited with inconsistent findings. Though Jones et al. (Jones 1993) found black Soldiers to have a lower injury risk than white counterparts, Grier et al. (2010) found a higher injury risk among blacks. In an evaluation of specific MSK tendon and ligament injuries among U.S. Soldiers, White et al. (2007) hypothesized that a higher risk of tendon and ligament injuries among blacks may be attributed to a genetic component of the soft tissues but concluded that current evidence is inadequate to support this theory.

Though paratroopers had lower risk of injury-related MSK LTE, this finding should not be misconstrued to mean that paratrooper exposure is protective of these persistent or permanent conditions. It is more plausible is that that those who develop MSK LTE would not be able to maintain active paratrooper status, and thus were less likely to have been captured in the paratrooper population via the methods used in this study.

6.2.2 Injury types and body locations

Overall, there were more similarities than differences in the types of incident injuries between non-paratroopers and paratroopers. Though military parachuting injury literature has focused exclusively on a limited set of ACTs, this study systematically identified all medically evaluated injuries in both populations from CYs 2016 through 2018. Consistent with previous evaluations of Army injuries (Hauschild 2019, Hauschild 2018, Jones 2015), both populations primarily experienced injuries caused by the transfer of mechanical energy, and both populations experienced many more CMT (overuse) injuries than ACT injuries. The finding that

paratroopers—in comparison to non-paratroopers—have a higher proportion of ACT than CMT injuries is not entirely surprising (since paratroopers by nature of their duties are assumed to be more likely to suffer ACT injuries), but this had not been previously demonstrated. Paratroopers may also be more resilient to CMT "overuse" injuries or may less likely to report CMT injuries as these could prevent their continued status as a paratrooper (it is possible that Soldiers with low paratrooper exposures who were excluded from the paratrooper population were diagnosed with CMT injuries and thus lost paratrooper status).

The distribution of injuries by body region groups also showed similarities between study populations. Both populations experienced most injuries to the lower extremity body region, followed by the back and spine, and then upper extremity region (shown in first column in Tables 8a and 8b). These same *body regions* have been found to be the most frequently injured regions among other Soldier population studies (Hauschild 2019, Hauschild 2018, Jones 2015). More specifically, *anatomical sites* (shown in second column in Tables 8a and 8b) that were most frequently injured in both groups were (1) the lower back, (2) the knee, and (3) the shoulder. When looking at the unique anatomical sites, the ankle ranked 4th in both study groups (tied with the foot/toe in the non-paratrooper population). This may appear to contradict the prevailing parachute injury literature, which identifies the ankle as the most frequently injured anatomical site (APHC 2019, Knapik 2003, Bricknell 1997). However, this contradiction can be explained by the inclusion of CMT injuries, which have not been addressed in prior paratrooper injury studies (APHC 2019). The leading injured body regions and anatomical sites highlighted by this study are primarily reflecting CMT injuries.

When assessing only ACT injuries, the most frequent ACT injured site among both populations is the hand/finger (paratroopers 2.9% vs non-paratroopers 2.5%). This is inconsistent with the prevailing paratrooper literature which indicates that the ankle is the most injured site. However, because the non-paratrooper population also experiences most ACT injuries to the hand/finger, not all hand/finger injuries may be attributed to parachuting. The second most frequent ACT injury location among paratroopers is the ankle, while among non-paratroopers it is the knee. Ankle injuries are the third most common ACT injured site among non-paratroopers. The proportion of ACT ankle injuries in the two populations (paratroopers 2.7% vs non-paratroopers 2.1%) is not substantially different. As with ACT hand/finger injuries, not all paratroopers' ankle injuries are likely to be attributed to parachuting. Although ACT injuries to the head-and-neck body region are only a small portion of all injuries, the anatomical grouping "Other head" injuries ranked in the top five of the ACT injuries among paratroopers. This finding supports information in prevailing literature, which states that head-and-neck injuries are common among paratroopers, including concussions, traumatic brain injuries (TBI), and lacerations (APHC 2019, Knapik 2014b, Knapik 2011, USARC 2015, Hay 2006, Craig 1999).

The majority of injuries (>80%) in both populations were to the MSK system and the most prominent types of injuries were grouped as "MSK tissue damage, other." The diagnoses that were most frequent in this category were non-specific pain syndromes to certain body locations, such as pain in the lower back, knee, or shoulder. These same CMT diagnoses have previously been identified as the most frequent injury diagnoses among trainees (Hauschild 2018) as well as Soldiers (Hauschild 2019).

The next most common injury type was tissue damage to non-MSK systems. The most frequent types of diagnoses included noise-induced hearing loss and radiculopathies (nerve damage). It is not clear why paratroopers appear to have a slightly higher proportion of these injuries. One hypothesis to explain the noise-induced hearing injuries is that paratroopers' noise exposures may be more substantial than those of non-paratroopers. Though a very small portion of overall injuries, the paratroopers experienced twice as many "internal organ and blood vessel"-related diagnoses as non-paratroopers. The most frequent diagnoses in this category were concussion and TBI. This finding supports previous data indicating that unique operational paratroopers' injuries include ACT head trauma injuries (APHC 2019, Knapik 2014b, USARC 2015, Hay 2006, Craig 1999).

The ACT injuries most frequently addressed in the paratrooper injury literature (APHC 2019) included MSK sprains/joint damage, strains/tears, fractures, and dislocations. The current study found that these ACT injury types represent a relatively small proportion of the overall number of injuries experienced by both paratroopers and non-paratroopers. Sprains were only slightly more common among paratroopers (5.8% compared to 5.2%). Strains/tears made up 3.7% of mechanical injuries in both populations. Fractures made up less than 3% and dislocation less than 0.5% of all mechanical injuries in both populations. However, out of all fractures, the proportion of ACT fractures (compared to CMT stress fractures) was higher among paratroopers (96% ACT) than non-paratroopers (85% ACT). As previously indicated, the higher proportion of ACT injuries in the paratrooper population supports long-held assumptions regarding the risk of injury attributed to the direct impact on the body during the landing after a parachute jump (APHC 2019, Ekeland 1997, Bricknell 1997).

6.3 Comparison of direct medical injury costs

6.3.1 Average injury cost per Soldier

Direct costs included Army payments for providers, diagnostics, medical equipment, medications, and dispensed medicines at all MTFs and non-MTFs. This study found the average direct medical cost per Soldier to be somewhat higher (14.8%) for the unexposed non-paratroopers compared to paratroopers (annual estimates $944/non-paratrooper and $822/paratrooper). As shown by the calculation of the number of encounters/injury (Table 11), paratroopers appear to require slightly fewer encounters for each injury, which may help to explain this cost estimate. This makes sense according to the theory of the "healthy worker effect," since paratroopers are particularly fit/healthy and thus likely respond more rapidly to medical care. Another aspect to consider is the motivation that paratroopers may have to ensure rapid rehabilitation in order to resume paratrooper duties (and thus return to receiving HDIP).

6.3.2 Average cost of injury encounters by subcategories

In both populations the direct medical costs of ACT injury encounters were notably higher than those of CMT injury encounters (3.4 times higher among non-paratroopers and 4.1 times higher among paratroopers). This finding was particularly relevant since paratroopers were shown to have a higher proportion of ACT injuries than non-paratroopers. However, given the much larger proportion of CMT injuries in both populations, more than two-thirds (68%) of the non-paratroopers' costs and over one-half (54%) of the paratroopers costs were attributed to CMT injuries.

Encounters for amputations, though relatively rare, were the most costly in both populations, followed by internal organ injuries. The encounters for ACT internal organ head injuries (concussions and TBI), which were ranked as one of the top five body sites injured among paratroopers, averaged $1,126 per encounter. It is not clear why the average cost for similar injury diagnoses among non-paratroopers was higher ($1,497 per encounter). It may be because the average cost of encounters is influenced by the number of encounters required to address incident injuries, and that paratroopers may have required additional visits for their head injuries. This would imply that non-paratroopers receive fewer follow-up visits for concussions/TBI's than paratroopers. Though the level of data did not allow assessment of the discrepancy, it was considered a plausible indication of the potential for more severe concussions/TBI cases among paratroopers. In comparison, average costs for ACT fracture encounters were slightly higher for paratroopers (paratroopers' $1,174 /encounter versus non-paratroopers' $1,087/encounter). It was not clear whether this discrepancy was significant and, if so, whether it was due to a greater complexity of the fractures among paratroopers or that paratroopers required fewer follow-ups for these injuries.

Average encounter costs for CMT joint injuries were relatively expensive (paratroopers' $1,560/encounter versus non-paratroopers' $1,835/encounter). In the paratrooper population, the CMT upper extremity joint injury encounter costs were notably higher than those for non-paratroopers ($1,876 vs $857). Especially notable was the cost difference for shoulder joint injury encounters, which was much higher for paratroopers ($3,004) vs. non-paratroopers ($729). This may be because paratroopers' shoulder injuries are more severe or complex.

6.3.3 Average cost of mechanical injuries by subcategories

Another, perhaps more appropriate, metric for average direct medical cost is the average cost of for *injury incidents* (also referred to as *injuries*). The average cost of a mechanical injury was almost 20% higher among the unexposed non-paratroopers ($1000/injury non-paratroopers versus $837/injury paratroopers). As with encounter costs, ACT MSK injury costs are the most expensive in both populations and were two to three times higher than costs of CMT injuries. When evaluating costs by gender, slightly different patterns appeared. Interestingly, the cost of injuries among women was lower than the cost of injuries among men for both populations, with the exception of ACT injuries among female paratroopers (which were higher than the associated costs for men among both paratrooper and non-paratrooper populations).

6.4 Comparison of Number of Encounters per Injury

The findings of this study show similar patterns of injury visits among both paratrooper and non-paratrooper populations which each require between two and four encounters per injury, on average. However, in general, paratroopers appear to seek slightly fewer medical care encounters per injury.

6.5 Study Limitations

6.5.1 Limited exposure details

This study's large population of Active Duty Soldiers and inclusion criteria of over a year and a half of HDIP provides a reasonable representation of "paratrooper exposure." However, using Jump Pay as a surrogate for exposure does not allow for a more detailed analyses of several extrinsic risk factors that can have substantial impacts on paratrooper injury risk (APHC 2019). For example, though Bricknell et al. (1997) reported an average paratrooper injury rate of 6 injuries/1000 jumps, the impact of various risk factors on the injury rate was described as follows: 1.8 injuries/1,000 daytime jumps from a plane with no combat equipment; 8.5 injuries/1,000 daytime jumps from plane with combat equipment; and 10 injuries/1,000 nighttime jumps from a plane with combat equipment. The 2019 APHC review verified that these rates are still relevant today (APHC 2019) and reflect frequently described risk factors related to paratrooper injuries. The literature described the leading risk factor as improper landing technique followed by time of day (night/dusk), and carrying/wearing combat gear (APHC 2019).

6.5.2 Analytical limitations

Though appropriate for this epidemiological investigation, univariate and multivariate regression models only evaluated the direct impact of the selected demographic variables on the injury outcome. This study did not access information regarding Soldiers' specific job duties, body size, fitness measures, or behavioral factors (e.g., smoking, nutrition, sleep). Analyses of these additional factors may have helped to explain differences associated with non-modifiable intrinsic factors of race, gender, and or age/rank. Though interaction and effect measure analyses (Appendix F) suggested the higher mechanical injury risk may be more strongly associated with parachuting exposure than intrinsic demographic factors, this finding was inconsistent with RR and OR of injured soldiers. Further analyses of the individual population datasets may help to clarify

6.5.3 Cost analyses

Cost data reflects the medical fees paid by the Army for the selected injury diagnoses at all MTFs and non-MTFs. The quality of care was assumed to be equivalent at all facilities. However, there is variation in coding as well as the specified diagnostics and treatments by providers at different facilities. This may have had a notable influence on the paratrooper cost estimates since the majority of paratroopers are expected to have been treated at the Womack Army Medical Center at Fort Bragg. In comparison, the non-paratrooper population received

care from a larger variety of MTFs (including small clinics) as well as civilian network facilities funded through TRICARE. The enormous size of the cost datasets and nature of the line level data captured prevented further evaluation of the types of variation attributed to specific facilities.

Though indirect costs (i.e., costs associated with restricted or lost duty time (LDT), lost cost of training, and transportation costs) were not calculated, these other costs can be around five times greater than direct costs (Hauschild 2019). The wide range of days of limited duty described by previous studies (17 to 135 days LDT for mechanical energy injuries) hindered accurate comparisons between the paratrooper and non-paratrooper population in this study (Hauschild 2019).

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

► Paratroopers' injury risk is greater than that of non-paratroopers.

Descriptive, univariate, and multiple regression analyses demonstrate that paratrooper exposure increases a Soldier's risk of incurring injuries. While this appears true for all injury types, paratroopers proportionally have more ACT injuries than non-paratroopers (Active Duty Soldiers who do not parachute). This finding supports the assumption that paratroopers' duties are inherently more hazardous than the duties of non-paratroopers. Though demographic characteristics such as female gender, African-American ethnicity (Black race), and more senior age/rank independently increase risk of injury, these factors affect the likelihood of a Soldier being a paratrooper more than they affect the likelihood of a paratrooper being injured. The lack of readily available exposure details for the populations studied prevented an assessment of potentially modifiable risk factors such as environmental conditions, training procedures, and equipment.

► Paratroopers have more ACT injuries, but injury distribution is similar to non-paratroopers.

In general, there are more similarities than differences between the injury patterns and associated costs between paratroopers and non-paratroopers. The distribution of injuries among both the paratrooper and non-paratrooper populations in this study was similar to that of the Active Duty Army, overall. For example, 97% of all injuries were caused by mechanical energy transfers and were primarily CMT injuries (>70% CMT among paratroopers and >75% among non-paratroopers). However, both male and female paratroopers have a higher proportion of ACT injuries compared to that of the non-paratroopers. Though the paratroopers had lower rates of injury-related MSK LTE, those with these chronic conditions were less likely to be able to maintain active jump status so were less likely to have been included in this study's paratrooper population.

► Body regions and specific anatomical sites most frequently injured are the same.

Both non-paratroopers and paratroopers most frequently experienced injuries to the lower back, the knee, and the shoulder. Most of these injuries were CMT injuries. Though parachute injury literature (APHC 2019) has indicated the ankle to be to most frequently injured site, this study found ACT injuries to the hand/fingers to be the most frequently injured site among both populations. As far as ACT ankle injuries, sprained ligament of the ankle was the only ACT diagnosis among the 10 leading specific diagnoses in both study populations. Given similar frequencies of ACT hand/finger and ankle injuries between the paratrooper and non-paratrooper populations, the proportion of these injuries than can be attributed to unique parachuting activities may not be substantial. Since this study reflects injuries that have occurred since the implementation of the new T-11 parachute, it is possible that this new parachute design has reduced ankle injuries since the majority of the literature reflected previous designs (e.g., T-10 parachute).

►Though a small portion of overall injuries, paratroopers' incidents of ACT head and CMT shoulder injuries are notable in comparison to those among non-paratroopers.

Injuries that appear to be more unique to paratroopers based on this study include head injuries, such as concussions and TBI, and CMT upper-extremity joint (especially shoulder) injuries. Though the attribution to specific paratrooper activity could not be determined from this study, paratrooper injury literature suggests there is a relationship between paratrooper exposure and these types of injuries (APHC 2019).

►Average direct medical costs for mechanical injuries are slightly less for paratroopers.

Though paratroopers experience a greater proportion of ACT injuries (which on average cost 2 to 4 times more than CMT injuries), the average cost of a mechanical injury is less for paratroopers ($837/injury) than non-paratroopers ($1,000/injury). This results in a higher overall average direct cost among non-paratroopers ($90,000/1,000 Soldiers) compared to paratroopers ($80,000/1,000 Soldiers). This could be attributed to the "healthy worker effect," a theory supported by the paratroopers' slightly lower average number of medical encounters per injury (though it is hypothesized that paratrooper's may require more follow up encounters for certain unique types of injuries, such as head trauma/TBI injuries). The reason for fewer overall average encounters per injury is plausibly a factor of paratroopers' motivations to maintain their paratrooper status and the corresponding incentive pay.

► Medical costs for CMT shoulder injuries may reflect unique scenarios.

Though overall medical costs tended to be similar or lower for paratroopers, the costs per type of injury showed different patterns. Specifically, slightly more than one-half (54%) of total medical costs for the paratroopers' injuries were for CMT injuries. Comparatively, over two-thirds (68%) of direct medical costs for non-paratrooper injuries were for CMT injuries. Average encounter costs for CMT joint injuries—especially shoulder injuries—were uniquely

high for paratroopers compared those of the non-paratroopers, possibly because these CMT injuries were more severe or complex.

7.2 Recommendations

Future studies should use the standardized taxonomy-based categories of injuries and body regions used in this study to ensure comparability and consistency.

Studies should aim to collect and evaluate the impact of exposure factors (e.g., such as the number jumps, environmental conditions, type of equipment worn and used) and individual factors such as MOS and fitness metrics (e.g., body mass, fitness test data). Because exposure details are often lacking in medical records, identifying these details may be best addressed through a mixed-methods qualitative and quantitative study design involving focus groups and survey-based investigations.

Additional assessment of the specific causal actions leading to injuries by type and anatomical site would help identify potential interventions. Targeted studies of ACT head and CMT shoulder injuries among paratroopers could provide insights as to potential interventions for these relatively costly injuries.

An investigation of injury-related MSK LTE among personnel with prior paratrooper exposure may better determine whether any association exists between paratrooper exposures and chronic injury-related MSK conditions.

8 POINT OF CONTACT

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APPENDIX A

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APPENDIX B

Taxonomic distribution of incident injuries

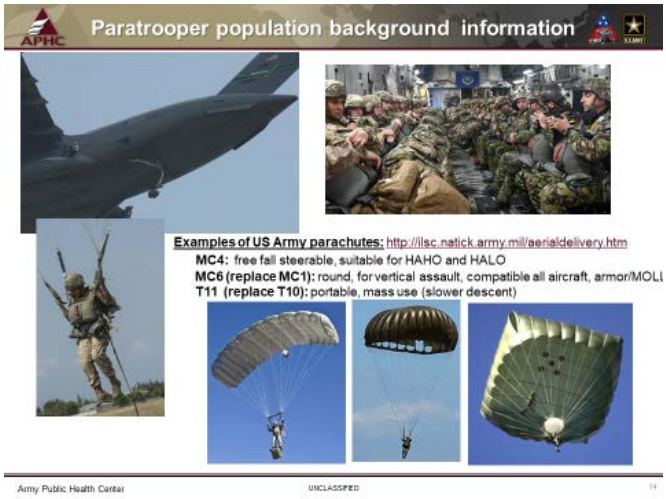
Unexposed (Non-Paratrooper), Low Exposure, and Paratrooper (High exposure) Populations

Active Duty Army
January 2016 to December 2018

Table B1. Demographics of Unexposed, Low exposure, and Exposed Paratrooper Cohorts

		Active Duty Army Soldiers January 2016 to December 2018					
		UNEXPOSED **Non-Paratroopers** Comparison Cohort		LOW EXPOSURE (Excluded cohort) ≤18 months jump pay*		EXPOSED **Paratroopers** >18 months jump pay*	
		n	%	n	%	n	%
TOTAL		**170,715**	100	**46,536**	100	**31,621**	100
Sex	Male	142,326	**83.4**	43,732	**94.0**	29,982	**94.8**
	Female	28,389	**16.6**	2,804	**6.0**	1,639	**5.2**
Age	<25	60,278	**35.3**	13,534	**29.1**	6,609	**20.9**
	25-34	66,352	**38.9**	22,833	**49.1**	16,849	**53.3**
	35-44	32,183	**18.9**	8,238	**17.7**	6,898	**21.8**
	45+	11,881	**7.0**	1,931	**4.1**	1,265	**4.0**
Rank	Junior Enlisted (E1-E4)	84,887	**49.7**	19,242	**41.3**	8,798	**27.8**
	Junior Officer (O1-O3)	14,578	**8.5**	5,950	**12.8**	2,354	**7.4**
	Senior Enlisted (E5-E9)	57,083	**33.4**	18,434	**39.6**	19,076	**60.3**
	Senior Officer (O4-O10)	9,345	**5.5**	2,154	**4.6**	982	**3.1**
	Warrant Officer (W1-W5)	4,822	**2.8**	756	**1.6**	411	**1.3**
Race	White	113,331	**66.4**	36,058	**77.5**	23,408	**74.0**
	Black	39,089	**22.9**	6,080	**13.1**	4,852	**15.3**
	Other	11,571	**6.8**	2,422	**5.2**	1,721	**5.4**
	Unknown	6,724	**3.9**	1,976	**4.2**	1,640	**5.2**

Figures B1-B3. APHC parachuting injuries investigation team discussion slides, 2017



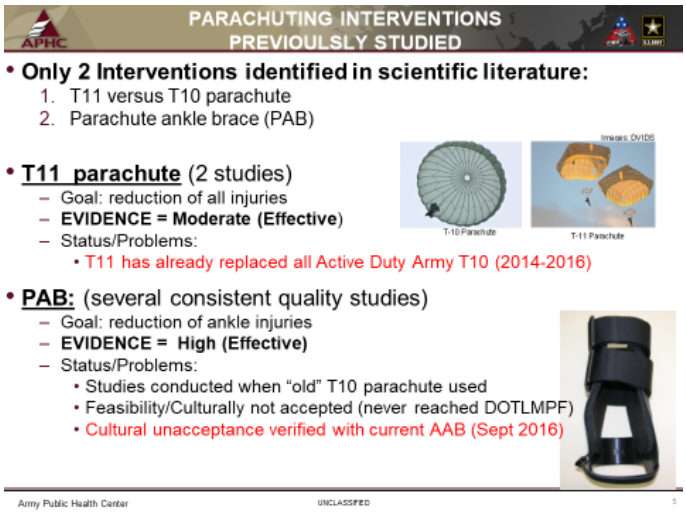


Table B2. Unexposed (non-paratrooper) Soldiers' (N=170,715) injuries (n=500,093) by causal energy types, Jan 2016-Dec 2018

Exposure/Energy Category	Injury /Energy SubCategory	Body System	%total Injuries	Gender		# Injury Incidents among Age groups				# Injury Incidents among Rank groups				
				% among men	% among women	<25	25-34	35-44	≥45	E1-E4	E5-E9	O1-O3	O4-O7	W01-W05
Mechanical	Acute Trauma	ALL ACUTE	20.9%	21.7%	17.7%	40,487	37,824	19,765	6,202	47,246	41,549	6,874	5,700	2,928
		Non MSK	9.1%	9.4%	7.8%	18,693	16,040	8,018	2,579	21,154	17,726	2,952	2,281	1,223
		MSK	11.8%	12.3%	9.9%	21,794	21,784	11,747	3,623	26,092	23,823	3,922	3,419	1,705
	Cumulative (Cumltv)	ALL CUMLTV	75.8%	75.2%	78.1%	112,102	129,276	98,396	39,083	145,195	165,288	24,312	29,050	15,108
		Non MSK	5.7%	6.0%	4.7%	4,954	8,183	9,940	5,503	6,865	14,942	1,775	3,390	1,617
		MSK	70.1%	69.2%	73.4%	107,148	121,093	88,456	33,580	138,330	150,346	22,537	25,660	13,491
		ALL MSK	81.8%	81.5%	83.3%	128,942	142,877	100,203	37,203	164,422	174,169	26,459	29,079	15,196
	All MECHANICAL		96.6%	96.9%	95.8%	152,589	167,100	118,161	45,285	192,441	206,837	31,186	34,750	18,036
Environ-mental	Thermal/Radiant		0.4%	0.4%	0.4%	1,194	469	121	31	1,302	363	115	28	11
	Pressure		0.0%	0.0%	0.0%	13	35	13	6	10	32	8	12	5
	Cold		0.0%	0.0%	0.0%	119	94	22	2	135	83	15	1	3
	Electrical		0.0%	0.0%	0.0%	3	0	3	0	3	1	0	0	2
	All ENVIRONMENTAL		0.4%	0.4%	0.4%	1,329	598	159	39	1,450	479	138	41	21
Poisons	Drugs		0.1%	0.1%	0.2%	384	194	51	18	467	157	11	6	6
	Chemicals		0.1%	0.1%	0.1%	216	133	49	9	233	133	24	4	13
	Toxins		0.1%	0.1%	0.1%	244	271	106	32	276	266	59	33	19
	All POISONS		0.3%	0.3%	0.4%	844	598	206	59	976	556	94	43	38
Non-Environmental	Nuclear/Radiation		0.0%	0.0%	0.0%	1	0	0	0	1	0	0	0	0
	Thermal (burns)		0.2%	0.2%	0.3%	533	445	151	53	602	432	74	51	23
	Electrical		0.0%	0.0%	0.0%	8	6	3	1	11	5	1	1	0
	All NON-ENVIRONMENTAL		0.2%	0.2%	0.3%	542	451	154	54	614	437	75	52	23
Other	Operative/Medical Accidents		0.0%	0.0%	0.0%	3	9	6	1	3	12	2	2	0
	Operative/Medical Complictns		0.9%	0.8%	1.1%	1,155	1,587	1,180	515	1,540	2,117	312	316	152
	Unspecified/Multiple Injuries		0.4%	0.4%	0.4%	861	752	369	126	956	822	147	123	61
	Lack of essential element(s)		0.0%	0.0%	0.0%	74	36	10	1	79	26	10	4	2
	Abuse /Intentional		0.6%	0.5%	0.9%	1,346	1,198	398	64	1,749	1,118	59	41	39
	Other foreign body/food		0.1%	0.1%	0.1%	92	107	55	13	108	110	24	17	8
	Other Rxn to external cause		0.4%	0.3%	0.6%	706	663	358	120	784	775	146	94	48
	All OTHER		2.4%	2.2%	3.1%	4,237	4,352	2,376	840	5,219	4,980	700	597	310
UNEXPOSED	TOTAL INJURIES	500,093	100%	100%	100.0%	159,541	173,099	121,056	46,277	200,700	213,289	32,193	35,483	18,428
	# injuries among genders			395,151	104,942									

NOTES:
* Based on counts of Incident Injuries, using selected ICD-10-CM Injury codes [APHC 2018] in DX 1, apply a 60-day incident rule to injury diagnosis of the same type (e.g. acute fracture, cumulative MSK tissue damage) and specific body region (anatomical site, i.e. foot).

Red box highlights injuries caused by MECHANICAL ENERGY TRANSFER, which are the vast majority of all injuries

Table B3. Low exposure Soldiers' (N=46,536), injuries (n=123,310) by causal energy types, Jan 2016-Dec 2018

Exposure/Energy Category	Injury /Energy SubCategory	Body System	%total Injuries	Gender		# Injury Incidents among Age groups				# Injury Incidents among Rank groups				
				% among men	% among women	<25	25-34	35-44	≥45	E1-E4	E5-E9	O1-O3	O4-O7	W01-W05
Mechanical	Acute Trauma	ALL ACUTE	24.0%	24.2%	22.1%	10,338	13,240	5,049	1,015	11,086	13,568	3,106	1,403	480
		Non MSK	11.0%	11.0%	10.6%	5,059	5,914	2,125	423	5,262	6,083	1,369	584	223
		MSK	13.1%	13.2%	11.6%	5,279	7,326	2,924	592	5,824	7,485	1,737	819	257
	Cumulative (Cumltv)	ALL CUMLTV	72.4%	72.3%	73.2%	24,255	38,707	20,891	5,382	28,505	42,840	9,895	5,758	2,246
		Non MSK	5.3%	5.4%	4.0%	1,191	2,535	2,043	783	1,418	3,669	649	579	238
		MSK	67.1%	66.9%	69.2%	23,064	36,172	18,848	4,599	27,087	39,171	9,246	5,179	2,008
		ALL MSK	80.1%	80.1%	80.8%	28,343	43,498	21,772	5,191	32,911	46,656	10,983	5,998	2,265
	All MECHANICAL		96.4%	96.5%	95.3%	34,593	51,947	25,940	6,397	39,591	56,408	13,001	7,161	2,726
Environ-mental	Thermal/Radiant		0.6%	0.6%	0.6%	444	294	40	6	491	188	91	12	2
	Pressure		0.0%	0.0%	0.0%	7	16	6	1	6	14	6	3	1
	Cold		0.1%	0.1%	0.1%	49	37	5	0	39	39	13	0	0
	Electrical		0.0%	0.0%	0.0%	6	2	2	0	2	8	0	0	0
	All ENVIRONMENTAL		0.7%	0.7%	0.7%	506	349	53	7	538	249	110	15	3
Poisons	Drugs		0.1%	0.1%	0.2%	85	47	17	1	99	40	8	2	1
	Chemicals		0.1%	0.1%	0.0%	33	30	13	3	37	35	4	3	0
	Toxins		0.2%	0.2%	0.2%	95	97	35	3	85	93	39	7	6
	All POISONS		0.4%	0.4%	0.4%	213	174	65	7	221	168	51	12	7
Non-Environmental	Nuclear/Radiation		0.0%	0.0%	0.0%	0	0	0	0	0	0	0	0	0
	Thermal (burns)		0.2%	0.2%	0.3%	128	119	19	6	133	108	21	7	3
	Electrical		0.0%	0.0%	0.0%	3	2	0	0	2	1	2	0	0
	All NON-ENVIRONMENTAL		0.2%	0.2%	0.3%	131	121	19	6	135	109	23	7	3
Other	Operative/Medical Accidents		0.0%	0.0%	0.0%	1	1	3	0	0	2	2	0	1
	Operative/Medical Complictns		0.9%	0.9%	1.1%	299	520	240	62	381	557	103	59	22
	Unspecified/Multiple Injuries		0.5%	0.5%	0.6%	243	268	89	25	233	293	65	25	9
	Lack of essential element(s)		0.0%	0.0%	0.0%	16	14	4	0	18	8	6	2	0
	Abuse /Intentional		0.4%	0.3%	0.8%	165	217	78	7	187	247	15	9	9
	Other foreign body/food		0.1%	0.0%	0.1%	13	40	12	2	19	33	10	3	2
	Other Rxn to external cause		0.4%	0.3%	0.6%	180	189	72	11	156	197	68	22	9
	All OTHER		2.2%	2.2%	3.2%	917	1,249	498	107	994	1,337	269	120	52
Low Exposure	TOTAL # INJURIES	123,310	100%	100.0%	100.0%	36,360	53,840	26,575	6,524	41,479	58,271	13,454	7,315	2,791
	# injuries among genders			113,918	9,392									

Red box highlights injuries caused by MECHANICAL ENERGY TRANSFER, which are the vast majority of all injuries

Table B4. Paratroopers' (N=31,621) incident injuries (n=96,338) by causal energy types, Jan 2016-Dec 2018

Exposure/Energy Category	Injury /Energy SubCategory	Body System	%total Injuries	Gender		# Injury Incidents among Age groups				# Injury Incidents among Rank groups				
				% among men	% among women	<25	25-34	35-44	≥45	E1-E4	E5-E9	O1-O3	O4-O7	W01-W05
Mechanical	Acute Trauma	ALL ACUTE	26.3%	26.4%	25.3%	8,851	11,485	4,334	694	8,017	15,020	1,357	616	354
		Non MSK	12.6%	12.6%	12.5%	4,568	5,373	1,874	294	4,054	7,023	622	259	151
		MSK	13.8%	13.8%	12.8%	4,283	6,112	2,460	400	3,963	7,997	735	357	203
	Cumulative (Cumltv)	ALL CUMLTV	70.4%	70.4%	70.0%	17,539	29,779	16,866	3,620	17,467	42,612	4,017	2,532	1,184
		Non MSK	4.6%	4.7%	3.1%	698	1,710	1,484	513	692	3,167	221	207	118
		MSK	65.8%	65.7%	66.9%	16,841	28,069	15,382	3,107	16,775	39,445	3,796	2,325	1,066
		All MSK	79.6%	79.6%	79.6%	21,124	34,181	17,842	3,507	20,738	47,442	4,531	2,682	1,269
	All MECHANICAL		96.7%	96.8%	95.3%	26,390	41,264	21,200	4,314	25,484	57,632	5,374	3,148	1,538
Environ-mental	Thermal/Radiant		0.5%	0.5%	0.4%	269	194	35	2	270	202	24	3	2
	Pressure		0.0%	0.0%	0.0%	12	11	4	1	7	15	4	2	0
	Cold		0.1%	0.1%	0.1%	34	40	4	0	33	35	10	0	0
	Electrical		0.0%	0.0%	0.0%	0	2	1	0	0	3	0	0	0
	All ENVIRONMENTAL		0.6%	0.6%	0.5%	315	247	44	3	310	255	38	5	2
Poisons	Drugs		0.1%	0.1%	0.1%	42	26	9	1	52	25	1	0	0
	Chemicals		0.1%	0.1%	0.0%	34	29	9	0	30	37	3	0	2
	Toxins		0.2%	0.2%	0.3%	63	86	20	0	55	101	8	2	3
	All POISONS		0.3%	0.3%	0.5%	139	141	38	1	137	163	12	2	5
Non-Environmental	Nuclear/Radiation		0.0%	0.0%	0.0%	0	1	0	0	0	1	0	0	0
	Thermal (burns)		0.3%	0.3%	0.4%	96	115	37	6	72	165	14	2	1
	Electrical		0.0%	0.0%	0.0%	2	1	3	0	1	4	1	0	0
	All NON-ENVIRONMENTAL		0.3%	0.3%	0.4%	98	117	40	6	73	170	15	2	1
Other	Operative/Medical Accidents		0.0%	0.0%	0.0%	1	1	0	1	1	2	0	0	0
	Operative/Medical Complictns		0.7%	0.7%	1.0%	180	306	165	34	166	461	27	19	12
	Unspecified/Multiple Injuries		0.5%	0.5%	0.7%	195	222	73	9	159	299	31	8	2
	Lack of essential element(s)		0.0%	0.0%	0.0%	9	14	2	0	7	15	1	1	1
	Abuse /Intentional		0.4%	0.4%	0.8%	140	191	50	8	123	255	7	4	0
	Other foreign body/food		0.1%	0.1%	0.1%	19	15	13	8	17	30	4	4	0
	Other Rxn to external cause		0.3%	0.3%	0.7%	119	155	34	8	104	184	17	9	2
	All OTHER		2.0%	2.0%	3.3%	663	904	337	68	577	1,246	87	45	17
High Exposure	TOTAL INJURIES	96,338	100.0%	100%	100%	27,605	42,673	21,659	4,392	26,581	59,466	5,526	3,202	1,563
	# injuries among genders			90,309	6,029									

Red box highlights injuries caused by MECHANICAL ENERGY TRANSFER, which are the vast majority of all injuries

APPENDIX C

Mechanical energy incident injuries body region, site and injury types

Unexposed Non-Paratroopers and Paratrooper Cohorts

Active Duty Army
January 2016 to December 2018

Table C1a. Non-paratroopers' mechanical injuries: percentages by body site and injury type; Jan 2016-Dec 2018

SITE	Fracture		Dis-location	Sprain/Joint Damage		Strain/ Tear		MSK Tissue Damage, Other		Internal organ	Open wound	Nerve		Contusion Superficial		Tissue damage, other		% total injurie	%CMT injuries "--" if < 1%
	ACT	CMT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	ACT	ACT	CMT	ACT	CMT	ACT	CMT		
TBI	132	0	0	0	0	0	0	0	0	3053	0	2	0	0	0	0	0	--	
Other head	0	0	0	3	0	102	0	14	12	5	1489	0	0	1366	2	2524	0	1.1	
Face	561	0	16	4	0	0	0	0	0	0	625	0	0	324	13	426	0	--	
Eye	89	0	0	0	0	0	0	0	0	0	461	8	0	2026	1	1069	0	--	
Ear	0	0	0	0	0	0	0	0	0	0	136	11	0	120	3	155	11379	2.4	2.4
Neck	28	0	0	0	0	1838	0	17	0	3	37	4	0	190	3	619	0	--	
Head/Neck, Oth	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	--	
Back, Upper	47	2	5	676	0	0	0	1	18345	22	0	9	2805	0	0	0	0	4.5	4.4
Back, Middle	76	1	0	166	0	0	0	1	6747	17	0	3	167	0	0	0	0	1.5	1.4
Back, Lower	154	8	10	898	0	2563	0	39	68914	13	0	4	7839	0	0	1292	0	17.0	16.0
Back, Other	0	1	0	0	0	0	0	0	12599	0	0	0	206	0	0	0	0	2.6	2.6
Chest	247	0	19	415	0	1026	0	22	0	90	76	3	352	986	2	715	0	--	
Abdomen	0	0	0	0	0	487	0	10	0	254	0	1	0	0	0	194	0	--	
Pelvis	97	293	1	152	0	65	0	2	0	38	216	0	0	731	15	161	0	--	
Trunk, Other	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	--	
Shoulder	274	0	746	2123	79	2357	627	1693	33418	4	35	13	0	399	2	1145	0	8.9	7.1
Arm, Upper	130	2	210	0	0	781	80	137	518	2	128	20	0	368	4	0	0	--	
Elbow	0	0	38	235	9	0	0	46	6483	0	91	2318	0	493	3	224	0	2.1	1.3
Arm, Lower	573	1	7	0	0	260	171	130	778	5	356	24	0	412	1	1801	0	--	
Wrist	487	0	0	1479	47	0	0	58	10785	3	202	97	2558	279	3	0	0	3.3	2.8
Hand, Finger	2382	5	301	1041	26	446	440	244	8599	36	4326	6	0	2636	75	0	0	4.3	1.9
Arm, Other	0	0	0	0	0	0	0	0	2608	0	0	99	110	0	0	7	0	--	
Hip	95	43	13	2187	243	798	0	73	22895	1	13	10	0	229	0	297	0	5.6	4.8
Leg, Upper	93	345	0	0	0	2343	5	142	6635	1	199	29	0	559	5	142	0	2.2	1.4
Knee	146	0	201	5961	124	0	0	727	59638	0	195	0	0	1175	4	0	0	14.0	12.0
Leg, Lower	665	578	0	0	0	3379	2	1526	12763	9	420	43	0	1057	12	1985	0	4.6	2.8
Ankle	485	27	65	8186	128	67	0	1219	27944	0	47	0	0	292	68	0	0	8.0	5.8
Foot, Toe	1669	145	51	945	22	0	0	969	29096	2	710	516	0	1981	2260	0	0	8.0	6.5
Leg, Other	0	0	0	0	0	0	0	0	9868	0	0	138	696	0	0	0	0	2.2	2.2
System-wide	0	0	0	0	0	0	0	62	0	0	0	0	0	0	0	0	1	--	
Multiple	0	0	0	0	0	0	0	1	160	0	0	0	0	0	0	0	0	--	
Unspecified	0	62	0	35	26	30	6	55	8011	0	0	0	0	0	0	237	0	1.8	1.7
% ACT vs CMT	85%	15%	100%	97%	2.8%	93%	7.4%	2.0%	98%	100%	100%	19%	81%	86%	14%	53%	47%		
% of total injuries‡	2.1%		0.3%	5.2%		3.7%		73%		0.7%	2%	3.7%		3.7%		5.0%			

‡Total incident mechanical injuries n = 483,250; Total Soldiers 170,715; Injury types not shown are Amputations and Crush each type is <1% of mechanical injuries

% Injuries are rounded to 2 significant digits (resulting totals may therefore not add up exactly to 100%

Table C1b. Paratroopers' mechanical injuries: percentages by body site and injury type; Jan 2016-Dec 2018

SITE	Fracture		Dis-location	Sprain/Joint Damage		Strain/ Tear		MSK Tissue Damage, Other		Internal organ	Open wound	Nerve		Contusion Superficial		Tissue damage, other		% total injurie	%CMT injuries "--" if < 1%
	ACT	CMT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	ACT	ACT	CMT	ACT	CMT	ACT	CMT		
TBI	26	0	0	0	0	0	0	0	0	1446	0	1	0	0	0	0	0	1.6	
Other head	0	0	0	0	0	21	0	1	2	0	384	0	0	258	1	1159	0	2.0	
Face	163	0	4	1	0	0	0	0	0	0	205	0	0	79	3	118	0	--	
Eye	18	0	0	0	0	0	0	0	0	0	131	0	0	513	1	302	0	--	
Ear	0	0	0	0	0	0	0	0	0	0	97	1	0	24	0	32	2334	2.7	2.5
Neck	6	0	0	0	0	427	0	3	0	0	8	0	0	39	0	150	0	--	
Head/Neck, Oth	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	--	
Back, Upper	15	0	2	160	0	0	0	0	3687	6	0	0	390	0	0	0	0	4.6	4.4
Back, Middle	45	1	0	46	0	0	0	0	1539	4	0	0	24	0	0	0	0	1.8	1.7
Back, Lower	111	1	4	161	0	594	0	12	13491	6	0	2	1062	0	0	464	0	17.0	16.0
Back, Other	0	0	0	0	0	0	0	0	2006	0	0	0	17	0	0	0	0	2.2	2.2
Chest	72	0	4	119	0	210	0	6	0	23	15	1	79	216	0	176	0	1.0	
Abdomen	0	0	0	0	0	119	0	8	0	65	0	0	0	0	0	64	0	--	
Pelvis	39	4	1	37	0	16	0	2	0	14	54	0	0	235	2	79	0	--	
Trunk, Other	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	--	
Shoulder	92	0	223	492	18	454	100	236	7059	1	7	1	0	94	0	328	0	9.8	7.7
Arm, Upper	25	0	38	0	0	213	5	35	108	0	25	11	0	99	3	0	0	--	
Elbow	0	0	10	61	2	0	0	13	1432	0	27	267	0	114	2	50	0	2.1	1.5
Arm, Lower	173	0	1	0	0	48	23	30	147	3	95	10	0	105	0	354	0	1.1	
Wrist	128	0	0	290	7	0	0	6	1907	1	45	12	207	47	2	0	0	2.8	2.3
Hand, Finger	619	2	80	221	7	88	46	46	1667	12	1122	3	0	449	10	0	0	4.7	1.9
Arm, Other	0	0	0	0	0	0	0	0	507	0	0	11	11	0	0	1	0	--	
Hip	21	1	3	391	30	139	0	6	3082	0	5	3	0	85	0	87	0	4.1	3.3
Leg, Upper	28	8	0	0	0	533	0	32	1147	0	53	1	0	132	0	30	0	2.1	1.1
Knee	33	0	25	1257	25	0	0	116	10125	0	70	0	0	204	0	0	0	13.0	11.0
Leg, Lower	297	51	0	0	0	674	0	152	1752	1	141	13	0	225	1	588	0	4.2	1.9
Ankle	221	5	11	1852	16	4	0	323	5853	0	16	0	0	59	12	0	0	9.0	6.3
Foot, Toe	472	24	23	216	6	0	0	250	4647	1	185	68	0	387	182	0	0	7.0	5.2
Leg, Other	0	0	0	0	0	0	0	0	1828	0	0	21	62	0	0	0	0	2.1	2.0
System-wide	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	--	
Multiple	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	--	
Unspecified	0	6	0	4	6	3	0	9	1019	0	0	0	0	0	0	58	0	1.2	1.1
% ACT vs MT	96%	3.8%	100%	98%	2.2%	95%	4.7%	2.0%	98%		100%	19%	81%	94%	6%	63%	37%		
% total injuries	2.9%		0.5%	5.8%		4.0%		69%		1.7%	2.9%	2.4%		3.8%		6.8%			

Total incident mechanical injuries n = 93,176; Total Soldiers N=31,621; Injury types not shown are Amputations and Crush each type is <1% of mechanical injuries
% Injuries are rounded to 2 significant digits (resulting totals may therefore not add up exactly to 100%)

PHIP No. 12-01-1219, Comparison of Injuries: Paratroopers vs Non-Paratrooper Soldiers

Table C2a. Non-paratroopers' mechanical injuries (n=483,250) by types; N=170,715, Jan 2016 to Dec 2018

Injury type	Head & Neck		Spine & Back		Torso		Upper Extremity		Lower Extremity		Other			
	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	Total	% Total
MSK tissue damage, other	31	12	41	106,605	34	0	2,308	63,189	4,656	168,839	118	8,171	354,004	73.3%
Sprain/joint damage	7	0	1,740	0	567	0	4,878	161	17,279	517	35	26	25,210	5.2%
Tissue damage, other	4,793	11,379	1,292	0	1,070	0	3,177	0	2,424	0	237	1	24,373	5.0%
Nerve	34	0	16	11,017	4	352	2,577	2,668	736	696	0	0	18,100	3.7%
Contusion/superficial	4,026	22	0	0	1,717	17	4,587	88	5,293	2,349	0	0	18,099	3.7%
Strain/tear	1,940	0	2,563	0	1,578	0	3,844	1,318	6,587	7	30	6	17,873	3.7%
Fracture	810	0	277	12	344	293	3,846	8	3,153	1,138	0	62	9,943	2.1%
Open wound	2,748	0	0	0	292	0	5,138	0	1,584	0	0	0	9,762	2.0%
Internal organ & blood vessel	3,061	0	52	0	410	0	50	0	13	0	0	0	3,586	0.7%
Dislocation	16	0	15	0	20	0	1,302	0	330	0	0	0	1,683	0.3%
Crush	2	0	0	0	4	0	399	0	127	0	0	0	532	0.1%
Amputation	1	0	0	0	1	0	68	0	15	0	0	0	85	0.0%
Total	17,469	11,413	5,996	117,634	6,041	662	32,174	67,432	42,197	173,546	420	8,266	483,250	100%
% Total	3.6%	2.4%	1.2%	24.3%	1.3%	0.1%	6.7%	14.0%	8.7%	35.9%	0.1%	1.7%		

NOTES:
Colors denote: pink= leading ACT, purple= leading CMT

Table C2b. Paratroopers' mechanical injuries (n=93,176) by types; N=31,621, Jan 2016 to Dec 2018

Injury type	Head & Neck		Spine & Back		Torso		Upper Extremity		Lower Extremity		Other		Total	% Total
	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT		
MSK tissue damage, other	4	2	12	20,723	16	0	366	12,827	879	28,434	18	1,027	64,308	69.0%
Tissue damage, other	1,761	2,334	464	0	319	0	733	0	705	0	58	0	6,374	6.8%
Sprain/joint damage	1	0	367	0	156	0	1,064	34	3,716	77	4	6	5,425	5.8%
Strain/tear	448	0	594	0	345	0	803	174	1,350	0	3	0	3,717	4.0%
Contusion/superficial	913	5	0	0	451	2	908	17	1,092	195	0	0	3,583	3.8%
Fracture	213	0	171	2	111	4	1,037	2	1,072	89	0	6	2,707	2.9%
Open wound	825	0	0	0	69	0	1,321	0	470	0	0	0	2,685	2.9%
Nerve	6	0	2	1,493	1	79	315	218	106	62	0	0	2,282	2.4%
Internal organ & blood vessel	1,446	0	16	0	109	0	17	0	2	0	0	0	1,590	1.7%
Dislocation	4	0	6	0	5	0	352	0	62	0	0	0	429	0.5%
Crush	1	0	0	0	2	0	34	0	25	0	0	0	62	0.1%
Amputation	0	0	0	0	0	0	9	0	5	0	0	0	14	0.0%
Total	5,622	2,341	1,632	22,218	1,584	85	6,959	13,272	9,484	28,857	83	1,039	93,176	100%
% Total	6.0%	2.5%	1.8%	23.8%	1.7%	0.1%	7.5%	14.2%	10.2%	31.0%	0.1%	1.1%		

NOTES:
Colors denote: pink= leading ACT, purple= leading CMT

Table C3a. Non-paratroopers' mechanical injuries (n= 483,250) by gender and types; N=170,715, Jan 2016 to Dec 2018

Men

Injury type	Head & Neck		Spine & Back		Torso		Upper Extremity		Lower Extremity		Other		Total	% Total
	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT		
MSK tissue damage, other	24	10	33	83,941	29	0	2,089	52,703	3,720	128,442	99	5,793	276,883	72.3 %
Tissue damage, other	3,915	10,487	1,068	0	942	0	2,721	0	2,001	0	181	1	21,316	5.6%
Sprain/joint damage	6	0	1,358	0	439	0	4,108	135	13,956	402	28	17	20,449	5.3%
Strain/tear	1,422	0	2,103	0	1,273	0	3,256	1,086	5,274	6	30	6	14,456	3.8%
Nerve	29	0	13	8,873	4	281	2,091	1,821	557	534	0	0	14,203	3.7%
Contusion/superficial	3,221	17	0	0	1,365	10	3,624	69	4,032	1,554	0	0	13,892	3.6%
Open wound	2,513	0	0	0	233	0	4,361	0	1,341	0	0	0	8,448	2.2%
Fracture	740	0	233	6	292	95	3,396	6	2,628	677	0	33	8,106	2.1%
Internal organ & blood vessel	2,508	0	45	0	348	0	42	0	12	0	0	0	2,955	0.8%
Dislocation	9	0	13	0	19	0	1,198	0	260	0	0	0	1,499	0.4%
Crush	2	0	0	0	4	0	340	0	106	0	0	0	452	0.1%
Amputation	0	0	0	0	1	0	67	0	14	0	0	0	82	0.0%
Total	14,389	10,514	4,866	92,820	4,949	386	27,293	55,820	33,901	131,615	338	5,850	382,741	100%
% Total	3.8%	2.7%	1.3%	24.3%	1.3%	0.1%	7.1%	14.6%	8.9%	34.4%	0.1%	1.5%		

Women

Injury type	Head & Neck		Spine & Back		Torso		Upper Extremity		Lower Extremity		Other		Total	% Total
	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT		
MSK tissue damage, other	7	2	8	22,664	5	0	219	10,486	936	40,397	19	2,378	77,121	76.7%
Sprain/joint damage	1	0	382	0	128	0	770	26	3,323	115	7	9	4,761	4.7%
Contusion/superficial	805	5	0	0	352	7	963	19	1,261	795	0	0	4,207	4.2%
Nerve	5	0	3	2,144	0	71	486	847	179	162	0	0	3,897	3.9%
Strain/tear	518	0	460	0	305	0	588	232	1,313	1	0	0	3,417	3.4%
Tissue damage, other	878	892	224	0	128	0	456	0	423	0	56	0	3,057	3.0%
Fracture	70	0	44	6	52	198	450	2	525	461	0	29	1,837	1.8%
Open wound	235	0	0	0	59	0	777	0	243	0	0	0	1,314	1.3%
Internal organ & blood vessel	553	0	7	0	62	0	8	0	1	0	0	0	631	0.6%

Dislocation	7	0	2	0	1	0	104	0	70	0	0	0	184	0.2%
Crush	0	0	0	0	0	0	59	0	21	0	0	0	80	0.1%
Amputation	1	0	0	0	0	0	1	0	1	0	0	0	3	0.0%
Total	3,080	899	1,130	24,814	1,092	276	4,881	11,612	8,296	41,931	82	2,416	100,509	100%
% Total	3.1%	0.9%	1.1%	24.7%	1.1%	0.3%	4.9%	11.6%	8.3%	41.7%	0.1%	2.4%		

NOTES:
Colors denote: pink= leading ACT, purple= leading CMT

Table C3b. Paratroopers' mechanical injuries (n=93,176) by gender and types; N=31,621, Jan 2016 to Dec 2018

Men

Injury type	Head & Neck		Spine & Back		Torso		Upper Extremity		Lower Extremity		Other		Total	% Total
	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT		
MSK tissue damage, other	4	2	11	19,528	16	0	356	12,118	834	26,434	18	922	60,243	68.9%
Tissue damage, other	1,635	2,295	446	0	305	0	694	0	666	0	56	0	6,097	7.0%
Sprain/joint damage	1	0	328	0	145	0	1,006	34	3,488	73	4	6	5,085	5.8%
Strain/tear	399	0	562	0	328	0	767	163	1,264	0	3	0	3,486	4.0%
Contusion/superficial	840	4	0	0	413	2	841	14	993	155	0	0	3,262	3.7%
Open wound	798	0	0	0	64	0	1,260	0	445	0	0	0	2,567	2.9%
Fracture	204	0	159	2	104	3	1,002	2	996	82	0	6	2,560	2.9%
Nerve	6	0	2	1,428	1	76	310	185	95	58	0	0	2,161	2.5%
Internal organ & blood vessel	1,348	0	15	0	104	0	16	0	2	0	0	0	1,485	1.7%
Dislocation	4	0	6	0	5	0	342	0	56	0	0	0	413	0.5%
Crush	1	0	0	0	1	0	33	0	24	0	0	0	59	0.1%
Amputation	0	0	0	0	0	0	9	0	5	0	0	0	14	0.0%
Total	5,240	2,301	1,529	20,958	1,486	81	6,636	12,516	8,868	26,802	81	934	87,432	100%
% Total	6.0%	2.6%	1.7%	24.0%	1.7%	0.1%	7.6%	14.3%	10.1%	30.7%	0.1%	1.1%		

Women

Injury type	Head & Neck		Spine & Back		Torso		Upper Extremity		Lower Extremity		Other		Total	% Total
	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT		
MSK tissue damage, other	0	0	1	1,195	0	0	10	709	45	2,000	0	105	4,065	70.8%
Sprain/joint damage	0	0	39	0	11	0	58	0	228	4	0	0	340	5.9%
Contusion/superficial	73	1	0	0	38	0	67	3	99	40	0	0	321	5.6%
Tissue damage, other	126	39	18	0	14	0	39	0	39	0	2	0	277	4.8%

PHIP No. 12-01-1219, Comparison of Injuries: Paratroopers vs Non-Paratrooper Soldiers

Strain/tear	49	0	32	0	17	0	36	11	86	0	0	0	231	4.0%
Fracture	9	0	12	0	7	1	35	0	76	7	0	0	147	2.6%
Nerve	0	0	0	65	0	3	5	33	11	4	0	0	121	2.1%
Open wound	27	0	0	0	5	0	61	0	25	0	0	0	118	2.1%
Internal organ & blood vessel	98	0	1	0	5	0	1	0	0	0	0	0	105	1.8%
Dislocation	0	0	0	0	0	0	10	0	6	0	0	0	16	0.3%
Crush	0	0	0	0	1	0	1	0	1	0	0	0	3	0.1%
Total	382	40	103	1,260	98	4	323	756	616	2,055	2	105	5,744	100%
% Total	6.7%	0.7%	1.8%	21.9%	1.7%	0.1%	5.6%	13.2%	10.7%	35.8%	0.03%	1.8%		

NOTES:
Colors denote: pink= leading ACT, purple= leading CMT

APPENDIX D

Leading Injury and Injury-Related MSK Long Term Effect Diagnoses

Unexposed Non-Paratroopers and Paratrooper Cohorts

Active Duty Army
January 2016 to December 2018

Table D1a. Non-paratroopers' (N=170,715) leading injury diagnoses codes, Jan 2016-Dec 2018

ICD-10 CM	ICD-10 Definition	Body Region 1	Body Region 2	Injury type	Mechanical Category	Total #	% of Total injuries	Male #	% of Male injuries	Female #	% of Female injuries
M545	Low back pain	Spine & Back	Back, Lower	Msk Tissue Damage, Other	Overuse MSK	64,620	12.9%	51,681	13.1%	12,939	12.3%
M25561	Pain in right knee	Lower Extremity	Knee	Msk Tissue Damage, Other	Overuse MSK	25,968	5.2%	20,679	5.2%	5,289	5.0%
M25562	Pain in left knee	Lower Extremity	Knee	Msk Tissue Damage, Other	Overuse MSK	21,000	4.2%	17,116	4.3%	3,884	3.7%
M542	Cervicalgia	Spine & Back	Back, Upper	Msk Tissue Damage, Other	Overuse MSK	17,389	3.5%	13,069	3.3%	4,320	4.1%
M25511	Pain in right shoulder	Upper Extremity	Shoulder	Msk Tissue Damage, Other	Overuse MSK	16,242	3.2%	13,810	3.5%	2,432	2.3%
M25571	Pain in right ankle and joints of right foot	Lower Extremity	Ankle	Msk Tissue Damage, Other	Overuse MSK	13,730	2.7%	10,795	2.7%	2,935	2.8%
M25512	Pain in left shoulder	Upper Extremity	Shoulder	Msk Tissue Damage, Other	Overuse MSK	13,461	2.7%	11,636	2.9%	1,825	1.7%
M25572	Pain in left ankle and joints of left foot	Lower Extremity	Ankle	Msk Tissue Damage, Other	Overuse MSK	11,778	2.4%	9,387	2.4%	2,391	2.3%
M25551	Pain in right hip	Lower Extremity	Hip	Msk Tissue Damage, Other	Overuse MSK	11,762	2.4%	7,057	1.8%	4,705	4.5%
M549	Dorsalgia, unspecified	Spine & Back	Back, Other	Msk Tissue Damage, Other	Overuse MSK	10,908	2.2%	8,296	2.1%	2,612	2.5%
M722	Plantar fascial fibromatosis	Lower Extremity	Foot, Toe	Msk Tissue Damage, Other	Overuse MSK	10,384	2.1%	7,951	2.0%	2,433	2.3%
M25552	Pain in left hip	Lower Extremity	Hip	Msk Tissue Damage, Other	Overuse MSK	8,678	1.7%	5,301	1.3%	3,377	3.2%
M79671	Pain in right foot	Lower Extremity	Foot, Toe	Msk Tissue Damage, Other	Overuse MSK	7,102	1.4%	5,433	1.4%	1,669	1.6%
M546	Pain in thoracic spine	Spine & Back	Back, Middle	Msk Tissue Damage, Other	Overuse MSK	6,489	1.3%	5,032	1.3%	1,457	1.4%
M79672	Pain in left foot	Lower Extremity	Foot, Toe	Msk Tissue Damage, Other	Overuse MSK	5,798	1.2%	4,462	1.1%	1,336	1.3%
M25531	Pain in right wrist	Upper Extremity	Wrist	Msk Tissue Damage, Other	Overuse MSK	5,546	1.1%	4,191	1.1%	1,355	1.3%
M5416	Radiculopathy, lumbar region	Spine & Back	Back, Lower	Nerve	Overuse non-MSK	4,490	0.9%	3,759	1.0%	731	0.7%
M79661	Pain in right lower leg	Lower Extremity	Leg, Lower	Msk Tissue Damage, Other	Overuse MSK	4,457	0.9%	3,353	0.8%	1,104	1.1%
M79604	Pain in right leg	Lower Extremity	Leg, Other	Msk Tissue Damage, Other	Overuse MSK	4,267	0.9%	3,305	0.8%	962	0.9%
H903	Sensorineural hearing loss, bilateral	Head & Neck	Ear	Tissue Damage, Other	Overuse non-MSK	4,266	0.9%	4,055	1.0%	211	0.2%
M25532	Pain in left wrist	Upper Extremity	Wrist	Msk Tissue Damage, Other	Overuse MSK	4,079	0.8%	3,157	0.8%	922	0.9%
M25569	Pain in unspecified knee	Lower Extremity	Knee	Msk Tissue Damage, Other	Overuse MSK	3,992	0.8%	3,160	0.8%	832	0.8%
M791	Myalgia	Other	Unspecified	Msk Tissue Damage, Other	Overuse MSK	3,474	0.7%	2,453	0.6%	1,021	1.0%
M79605	Pain in left leg	Lower Extremity	Leg, Other	Msk Tissue Damage, Other	Overuse MSK	3,236	0.6%	2,520	0.6%	716	0.7%
M79662	Pain in left lower leg	Lower Extremity	Leg, Lower	Msk Tissue Damage, Other	Overuse MSK	2,939	0.6%	2,216	0.6%	723	0.7%
S93401	Sprain of unspecified ligament of right ankle, initial encounter	Lower Extremity	Ankle	Sprain/Joint Damage	Traumatic MSK	2,788	0.6%	2,189	0.6%	599	0.6%
M5412	Radiculopathy, cervical region	Spine & Back	Back, Upper	Nerve	Overuse non-MSK	2,661	0.5%	2,148	0.5%	513	0.5%
M79641	Pain in right hand	Upper Extremity	Hand, Finger	Msk Tissue Damage, Other	Overuse MSK	2,588	0.5%	2,107	0.5%	481	0.5%
S39012	Strain of muscle, fascia and tendon of lower back, initial encounter	Spine & Back	Back, Lower	Strain/Tear	Traumatic MSK	2,563	0.5%	2,103	0.5%	460	0.4%

Table D1b. Paratroopers' (N=31,621) leading injury diagnoses codes, Jan 2016-Dec 2018

ICD-10 CM	ICD-10 Definition	Body Region 1	Body Region 2	Injury type	Mechanical Category	Total #	% of Total injuries	Male #	% of Male injuries	Female #	% of Female injuries
M545	Low back pain	Spine & Back	Back, Lower	Msk Tissue Damage, Other	Overuse MSK	12,983	13.5%	12,294	13.6%	689	11.4%
M25561	Pain in right knee	Lower Extremity	Knee	Msk Tissue Damage, Other	Overuse MSK	4,364	4.5%	4,144	4.6%	220	3.6%
M25562	Pain in left knee	Lower Extremity	Knee	Msk Tissue Damage, Other	Overuse MSK	3,851	4.0%	3,618	4.0%	233	3.9%
M542	Cervicalgia	Spine & Back	Back, Upper	Msk Tissue Damage, Other	Overuse MSK	3,557	3.7%	3,283	3.6%	274	4.5%
M25511	Pain in right shoulder	Upper Extremity	Shoulder	Msk Tissue Damage, Other	Overuse MSK	3,334	3.5%	3,179	3.5%	155	2.6%
M25512	Pain in left shoulder	Upper Extremity	Shoulder	Msk Tissue Damage, Other	Overuse MSK	2,974	3.1%	2,829	3.1%	145	2.4%
M25571	Pain in right ankle and joints of right foot	Lower Extremity	Ankle	Msk Tissue Damage, Other	Overuse MSK	2,841	2.9%	2,656	2.9%	185	3.1%
M25572	Pain in left ankle and joints of left foot	Lower Extremity	Ankle	Msk Tissue Damage, Other	Overuse MSK	2,535	2.6%	2,395	2.7%	140	2.3%
M549	Dorsalgia, unspecified	Spine & Back	Back, Other	Msk Tissue Damage, Other	Overuse MSK	1,767	1.8%	1,647	1.8%	120	2.0%
M25551	Pain in right hip	Lower Extremity	Hip	Msk Tissue Damage, Other	Overuse MSK	1,521	1.6%	1,306	1.4%	215	3.6%
M546	Pain in thoracic spine	Spine & Back	Back, Middle	Msk Tissue Damage, Other	Overuse MSK	1,516	1.6%	1,441	1.6%	75	1.2%
M722	Plantar fascial fibromatosis	Lower Extremity	Foot, Toe	Msk Tissue Damage, Other	Overuse MSK	1,284	1.3%	1,209	1.3%	75	1.2%
M79671	Pain in right foot	Lower Extremity	Foot, Toe	Msk Tissue Damage, Other	Overuse MSK	1,252	1.3%	1,155	1.3%	97	1.6%
M25552	Pain in left hip	Lower Extremity	Hip	Msk Tissue Damage, Other	Overuse MSK	1,224	1.3%	1,050	1.2%	174	2.9%
M79672	Pain in left foot	Lower Extremity	Foot, Toe	Msk Tissue Damage, Other	Overuse MSK	1,158	1.2%	1,066	1.2%	92	1.5%
M25531	Pain in right wrist	Upper Extremity	Wrist	Msk Tissue Damage, Other	Overuse MSK	952	1.0%	859	1.0%	93	1.5%
H903	Sensorineural hearing loss, bilateral	Head & Neck	Ear	Tissue Damage, Other	Overuse non-MSK	845	0.9%	841	0.9%	4	0.1%
S060X0	Concussion without loss of consciousness, initial encounter	Head & Neck	Tbi	Internal Organ & Blood Vessel	Traumatic non-MSK	793	0.8%	728	0.8%	65	1.1%
M79604	Pain in right leg	Lower Extremity	Leg, Other	Msk Tissue Damage, Other	Overuse MSK	738	0.8%	680	0.8%	58	1.0%
M25532	Pain in left wrist	Upper Extremity	Wrist	Msk Tissue Damage, Other	Overuse MSK	724	0.8%	664	0.7%	60	1.0%
M25569	Pain in unspecified knee	Lower Extremity	Knee	Msk Tissue Damage, Other	Overuse MSK	723	0.8%	685	0.8%	38	0.6%
S93401	Sprain of unspecified ligament of right ankle, initial encounter	Lower Extremity	Ankle	Sprain/Joint Damage	Traumatic MSK	661	0.7%	625	0.7%	36	0.6%
S93402	Sprain of unspecified ligament of left ankle, initial encounter	Lower Extremity	Ankle	Sprain/Joint Damage	Traumatic MSK	647	0.7%	603	0.7%	44	0.7%
M79605	Pain in left leg	Lower Extremity	Leg, Other	Msk Tissue Damage, Other	Overuse MSK	601	0.6%	560	0.6%	41	0.7%
S39012	Strain of muscle, fascia and tendon of lower back, initial encounter	Spine & Back	Back, Lower	Strain/Tear	Traumatic MSK	594	0.6%	562	0.6%	32	0.5%
M79661	Pain in right lower leg	Lower Extremity	Leg, Lower	Msk Tissue Damage, Other	Overuse MSK	515	0.5%	478	0.5%	37	0.6%
M79641	Pain in right hand	Upper Extremity	Hand, Finger	Msk Tissue Damage, Other	Overuse MSK	501	0.5%	466	0.5%	35	0.6%
G44309	Post-traumatic headache, unspecified, not intractable	Head & Neck	Other Head	Tissue Damage, Other	Traumatic non-MSK	486	0.5%	448	0.5%	38	0.6%
M25521	Pain in right elbow	Upper Extremity	Elbow	Msk Tissue Damage, Other	Overuse MSK	474	0.5%	463	0.5%	11	0.2%

Table D2a. Non-paratroopers' (N=170,715) leading injury related MSK long term effects (LTE), Jan 2016-Dec 2018

Body System	Total # Diagnoses	% LTE Dx	Gender				Age				Rank				
			Male #	Male %	Female #	Female %	<25	25-34	35-44	≥45	E1-E4	E5-E9	O1-O3	O4-O7	W01-W05
Subsequent (various – fractures, etc)	23,879	32.4%	19,174	32.1%	4,705	33.8%	9,678	8,659	4,279	1,254	11,707	8,859	1,451	1,230	632
Spinal stenosis	18,659	25.4%	15,256	25.6%	3,403	24.4%	2,711	6,268	6,824	2,855	4,311	9,960	1,258	2,074	1,056
Flat foot	5,055	6.9%	3,939	6.6%	1,116	8.0%	1,643	1,710	1,221	476	2,107	2,158	300	342	148
Sequela (various – fractures, etc)	3,830	5.2%	3,068	5.1%	762	5.5%	1,266	1,528	805	231	1,750	1,496	251	234	99
Other instability	3,589	4.9%	2,954	5.0%	635	4.6%	976	1,405	919	289	1,291	1,603	276	286	133
Muscle weakness	3,283	4.5%	2,397	4.0%	886	6.4%	1,319	950	725	288	1,673	1,036	178	289	107
Joint stiffness	2,829	3.8%	2,377	4.0%	452	3.2%	770	997	753	309	877	1,247	344	254	107
Disc degeneration	1,465	2.0%	1,234	2.1%	231	1.7%	75	363	672	355	191	830	83	245	116
Derangement, meniscus	1,427	1.9%	1,254	2.1%	173	1.2%	210	462	501	254	327	750	102	188	60
Articular cartilage disorders	1,317	1.8%	1,111	1.9%	206	1.5%	231	499	446	141	353	663	125	116	60
Osteoarthritis (post-traumatic)	891	1.2%	794	1.3%	97	0.7%	70	257	361	203	152	473	72	140	54
Recurrrent Dislocation/Subluxation	726	1.0%	628	1.1%	98	0.7%	301	282	121	22	340	278	65	25	18
Spondylosis, other	677	0.9%	566	0.9%	111	0.8%	51	227	264	135	120	410	48	68	31
Chronic instability of knee	673	0.9%	571	1.0%	102	0.7%	178	284	160	51	250	320	32	45	26
Osteophyte	614	0.8%	514	0.9%	100	0.7%	48	188	282	96	85	368	47	81	33
Contracture	599	0.8%	499	0.8%	100	0.7%	119	209	192	79	167	297	42	66	27
Spondylosis without myelopathy or radiculopathy	563	0.8%	472	0.8%	91	0.7%	27	164	256	116	74	355	35	77	22
Loose body	483	0.7%	445	0.7%	38	0.3%	84	166	171	62	122	238	46	51	26
Other spondylosis	384	0.5%	333	0.6%	51	0.4%	14	71	173	126	39	212	28	68	37
Other	2,658	3.6%	2,083	3.5%	575	4.1%	390	879	939	459	632	1,423	194	285	124

NOTES:
LTE = Chronic or permanent conditions plausibly associated with prior injury;
Counts equal one diagnosis (DX1-DX9) during three year period per individual Soldier
Top 19 LTE diagnosis categories make up over 96% of the 73,601 total LTE diagnoses

Table D2b. Paratroopers' (N=31,621) leading MSK long term effects (LTE) diagnoses categories, Jan 2016-Dec 2018

Body System	Total # Diagnoses	% LTE Dx	Gender				Age				Rank				
			Male #	Male %	Female #	Female %	<25	25-34	35-44	≥45	E1-E4	E5-E9	O1-O3	O4-O7	W01-W05
Subsequent (various – fractures, etc)	4,714	40.4%	4,463	40.3%	251	41.6%	1,552	2,195	832	135	1,371	2,857	283	139	64
Spinal stenosis	2,485	21.3%	2,374	21.5%	111	18.4%	342	1,020	906	217	390	1,763	135	129	68
Joint stiffness	617	5.3%	588	5.3%	29	4.8%	150	287	160	20	148	390	44	25	10
Other instability	617	5.3%	579	5.2%	38	6.3%	151	296	152	18	159	369	53	27	9
Sequela (various – fractures, etc)	574	4.9%	536	4.8%	38	6.3%	150	272	127	25	143	367	40	18	6
Flat foot	528	4.5%	498	4.5%	30	5.0%	159	224	116	29	138	329	25	17	19
Muscle weakness	396	3.4%	357	3.2%	39	6.5%	100	166	113	17	86	272	19	13	6
Derangement, meniscus	271	2.3%	268	2.4%	3	0.5%	34	100	103	34	49	186	10	22	4
Articular cartilage disorders	235	2.0%	221	2.0%	14	2.3%	42	109	66	18	41	158	18	11	7
Disc degeneration	203	1.7%	194	1.8%	9	1.5%	6	63	88	46	14	153	15	13	8
Chronic instability of knee	128	1.1%	116	1.0%	12	2.0%	20	63	38	7	25	90	7	5	1
Recurrrent Dislocation/Subluxation	126	1.1%	124	1.1%	2	0.3%	51	57	16	2	45	59	14	6	2
Osteoarthritis (post-traumatic)	119	1.0%	112	1.0%	7	1.2%	4	39	60	16	7	84	15	9	4
Osteophyte	88	0.8%	86	0.8%	2	0.3%	7	32	39	10	13	63	4	5	3
Other	566	4.9%	548	5.0%	18	3.0%	61	215	209	92	69	429	28	25	15

NOTES:
LTE = Chronic or permanent diagnoses categories plausibly associated with prior injury
Counts equal one diagnosis (DX1-DX9) during three year period per individual Soldier
These top 14 LTE diagnosis categories make up over 95% of the 11,667 total LTE diagnoses

APPENDIX E

Univariate and multivariate logistic regression analyses
of mechanical energy incident injuries

Unexposed Non-Paratroopers and Paratrooper Cohorts

Active Duty Army
January 2016 to December 2018

Table E1. Mechanical injury univariate logistic regression for three exposure groups,† n=248,872

Characteristic	Characteristic Level	N	% with mechanical injury	OR	Lower 95% CI	Upper 95% CI	p-value
Sex	Men	216,040	71.7	1.00			
	Women	32,832	80.1	1.58	1.54	1.63	< 0.01
Age group (years)	< 25	96,662	70.9	1.00			
	25-34	98,914	70.8	1.00	0.98	1.02	0.65
	35-44	41,441	79.7	1.61	1.57	1.66	< 0.01
	45+	11,792	82.4	1.93	1.83	2.02	< 0.01
Rank group	E1-E4	112,927	68.0	1.00			
	E5-E9	94,593	79.3	1.81	1.77	1.84	< 0.01
	O1-O3	22,882	64.8	0.87	0.84	0.89	< 0.01
	O4-O10	12,481	78.8	1.75	1.67	1.83	< 0.01
	W1-W5	5,989	79.4	1.81	1.70	1.93	< 0.01
Race	White	172,797	71.0	1.00			
	Black	50,021	77.7	1.42	1.38	1.45	< 0.01
	Other	15,714	71.6	1.03	0.99	1.07	0.12
	Unknown	10,340	81.6	1.80	1.71	1.90	< 0.01
Exposure†	Unexposed	170,715	72.2	1.00			
	Low exposure	46,536	71.3	0.96	0.94	0.98	< 0.01
	High exposure (Paratroopers)	31,621	78.7	1.43	1.39	1.47	< 0.01

† includes unexposed comparison cohort of Active Duty Soldiers, a low exposure group of Soldiers who received Jump pay for 18 or less months out of the three year study period (January 2016 to December 2018), and the high exposure group of Soldiers who received 19 or more months Jump pay which was defined as this study's" "paratrooper population." Follow-on multiple regression models excluded Soldiers the low exposure group.

Table E2a. Mechanical injury univariate and multivariable logistic regression: sex, age, race, and exposure (n=193,915)

		Univariate				Multivariable			
Characteristic	**Characteristic Category**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**
Sex	Men	1.00				1.00			
	Women	1.57	1.52	1.62	< 0.01	1.62	1.57	1.67	< 0.01
Age group (years)	< 25	1.00				1.00			
	25-34	1.02	1.00	1.04	0.11	0.99	0.97	1.01	0.35
	35-44	1.67	1.62	1.72	< 0.01	1.62	1.57	1.67	< 0.01
	45+	1.99	1.89	2.10	< 0.01	1.98	1.87	2.09	< 0.01
Race	White	1.00				1.00			
	Black	1.43	1.39	1.46	< 0.01	1.36	1.33	1.40	< 0.01
	Other	1.02	0.98	1.07	0.25	1.00	0.96	1.04	0.86
Exposure	Unexposed	1.00				1.00			
	Paratroopers	1.43	1.39	1.47	< 0.01	1.57	1.52	1.62	< 0.01

Table E2b. Mechanical injury univariate and multivariable logistic regression: sex, rank, race, and exposure (n=193,972)

		Univariate				Multivariable			
Characteristic	**Characteristic Category**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**
Sex	Men	1.00				1.00			
	Women	1.57	1.52	1.62	< 0.01	1.67	1.62	1.73	< 0.01
Rank group	E1-E4	1.00				1.00			
	E5-E9	1.86	1.82	1.90	< 0.01	1.77	1.73	1.81	< 0.01
	O1-O3	0.80	0.78	0.83	< 0.01	0.79	0.77	0.82	< 0.01
	O4-O10	1.74	1.65	1.82	< 0.01	1.78	1.70	1.88	< 0.01
	W1-W5	1.77	1.66	1.90	< 0.01	1.83	1.70	1.97	< 0.01
Race	White	1.00				1.00			
	Black	1.43	1.39	1.46	< 0.01	1.34	1.31	1.38	< 0.01
	Other	1.02	0.98	1.07	0.25	1.00	0.96	1.05	0.86
Exposure	Unexposed	1.00				1.00			
	Paratroopers	1.43	1.39	1.47	< 0.01	1.36	1.32	1.40	< 0.01

Table E3. ACT MSK injury univariate logistic regression for three exposure groups[†], n=248,872

Characteristic	Characteristic Category	N	% with ACT MSK injury	OR	Lower 95% CI	Upper 95% CI	p-value
Sex	Men	216,040	25.2	1.00			
	Women	32,832	27.3	1.11	1.09	1.14	< 0.01
Age group (years)	< 25	86,600	26.9	1.00			
	25-34	103,246	24.2	0.87	0.85	0.89	< 0.01
	35-44	45,021	26.2	0.96	0.94	0.99	< 0.01
	45+	13,974	23.0	0.81	0.78	0.85	< 0.01
Rank group	E1-E4	112,927	23.2	1.00			
	E5-E9	94,593	29.1	1.36	1.33	1.39	< 0.01
	O1-O3	22,882	20.8	0.87	0.84	0.90	< 0.01
	O4-O10	12,481	26.2	1.17	1.12	1.22	< 0.01
	W1-W5	5,989	25.6	1.14	1.07	1.21	< 0.01
Race	White	172,797	24.1	1.00			
	Black	50,021	29.4	1.31	1.28	1.34	< 0.01
	Other	15,714	24.4	1.02	0.98	1.06	0.37
	Unknown	10,340	30.1	1.35	1.30	1.41	< 0.01
Exposure[†]	Unexposed	170,715	24.8	1.00			
	Low exposure	46,536	24.7	1.00	0.97	1.02	0.79
	High exposure (Paratroopers)	31,621	30.2	1.31	1.28	1.35	< 0.01

[†] includes unexposed comparison cohort of Active Duty Soldiers, a low exposure group of Soldiers who received Jump pay for 18 or less months out of the three year study period (January 2016 to December 2018), and the high exposure group of Soldiers who received 19 or more months Jump pay which was defined as this study's" "paratrooper population." Follow-on multiple regression models excluded Soldiers the low exposure group.

Table E4a. ACT MSK univariate and multivariable logistic regression: sex, age, race, and exposure, n=193,942

		Univariate				Multivariable			
Characteristic	**Characteristic Category**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**
Sex	Men	1.00				1.00			
	Women	1.10	1.07	1.13	< 0.01	1.10	1.07	1.14	< 0.01
Age group (years)	< 25	1.00				1.00			
	25-34	0.88	0.86	0.90	< 0.01	0.85	0.83	0.87	< 0.01
	35-44	0.97	0.94	0.99	0.01	0.93	0.90	0.96	< 0.01
	45+	0.81	0.77	0.85	< 0.01	0.79	0.76	0.83	< 0.01
Race	White	1.00				1.00			
	Black	1.29	1.26	1.32	< 0.01	1.31	1.28	1.34	< 0.01
	Other	1.02	0.98	1.07	0.26	1.04	1.00	1.09	0.05
Exposure	Unexposed	1.00				1.00			
	Paratroopers	1.31	1.28	1.35	< 0.01	1.38	1.34	1.42	< 0.01

Table 4b. ACT MSK univariate and multivariable logistic regression: sex, rank, race, and exposure, n=193,972

		Univariate				Multivariable			
Characteristic	**Characteristic Category**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**
Sex	Men	1.00				1.00			
	Women	1.10	1.07	1.13	< 0.01	1.13	1.10	1.17	< 0.01
Rank group	E1-E4	1.00				1.00			
	E5-E9	1.35	1.32	1.38	< 0.01	1.30	1.27	1.33	< 0.01
	O1-O3	0.83	0.80	0.86	< 0.01	0.83	0.80	0.87	< 0.01
	O4-O10	1.13	1.08	1.19	< 0.01	1.16	1.11	1.22	< 0.01
	W1-W5	1.12	1.05	1.20	< 0.01	1.14	1.06	1.21	< 0.01
Race	White	1.00				1.00			
	Black	1.29	1.26	1.32	< 0.01	1.27	1.24	1.30	< 0.01
	Other	1.02	0.98	1.06	0.26	1.02	0.98	1.07	0.26
Exposure	Unexposed	1.00				1.00			
	Paratroopers	1.31	1.28	1.35	< 0.01	1.27	1.23	1.31	< 0.01

Table E5. CMT MSK Univariate logistic regression for three exposure groups[†], n=248,872

Characteristic	Characteristic Category	N	% with CMT MSK injury	OR	Lower 95% CI	Upper 95% CI	p-value
Sex	Men	216,040	64.1	1.00			
	Women	32,832	74.9	1.68	1.63	1.72	< 0.01
Age group (years)	< 25	94,560	63.4	1.00			
	25-34	100,179	62.8	0.97	0.96	0.99	< 0.01
	35-44	42,090	73.4	1.60	1.56	1.64	< 0.01
	45+	11,984	76.8	1.91	1.83	2.00	< 0.01
Rank group	E1-E4	112,927	60.7	1.00			
	E5-E9	94,593	72.0	1.67	1.64	1.70	< 0.01
	O1-O3	22,882	56.5	0.84	0.82	0.87	< 0.01
	O4-O10	12,481	72.4	1.69	1.63	1.77	< 0.01
	W1-W5	5,989	73.2	1.76	1.66	1.87	< 0.01
Race	White	172,797	63.1	1.00			
	Black	50,021	72.0	1.50	1.47	1.53	< 0.01
	Other	15,714	64.5	1.06	1.03	1.10	< 0.01
	Unknown	10,340	75.5	1.80	1.72	1.89	< 0.01
Exposure[†]	Unexposed	170,715	65.4	1.00			
	Low exposure	46,536	63.2	0.91	0.89	0.93	< 0.01
	High exposure (Paratroopers)	31,621	69.5	1.20	1.17	1.23	< 0.01

[†] includes unexposed comparison cohort of Active Duty Soldiers, a low exposure group of Soldiers who received Jump pay for 18 or less months out of the three year study period (January 2016 to December 2018), and the high exposure group of Soldiers who received 19 or more months Jump pay which was defined as this study's" "paratrooper population." Follow-on multiple regression models excluded Soldiers the low exposure group.

Table E6a. CMT MSK univariate and multivariable logistic regression: sex, age, race, and exposure (n=193,919)

		Univariate				Multivariable			
Characteristic	**Characteristic Category**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**
Sex	Men	1.00				1.00			
	Women	1.67	1.63	1.72	< 0.01	1.68	1.63	1.73	< 0.01
Age group (years)	< 25	1.00				1.00			
	25-34	0.99	0.97	1.01	0.47	0.98	0.96	1.00	0.02
	35-44	1.65	1.61	1.70	< 0.01	1.61	1.57	1.66	< 0.01
	45+	1.96	1.86	2.05	< 0.01	1.94	1.84	2.04	< 0.01
Race	White	1.00				1.00			
	Black	1.51	1.48	1.55	< 0.01	1.43	1.40	1.47	< 0.01
	Other	1.06	1.02	1.10	< 0.01	1.02	0.98	1.06	0.30
Exposure	Unexposed	1.00				1.00			
	Paratroopers	1.20	1.17	1.23	< 0.01	1.33	1.30	1.37	< 0.01

Table E6b. CMT MSK univariate and multivariable logistic regression: sex, rank, race, and exposure (n=193,972)

		Univariate				Multivariable			
Characteristic	**Characteristic Category**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**
Sex	Men	1.00				1.00			
	Women	1.67	1.63	1.72	< 0.01	1.73	1.68	1.78	< 0.01
Rank group	E1-E4	1.00				1.00			
	E5-E9	1.71	1.67	1.74	< 0.01	1.67	1.63	1.70	< 0.01
	O1-O3	0.79	0.76	0.82	< 0.01	0.78	0.76	0.81	< 0.01
	O4-O10	1.69	1.61	1.77	< 0.01	1.75	1.67	1.83	< 0.01
	W1-W5	1.73	1.62	1.84	< 0.01	1.79	1.67	1.91	< 0.01
Race	White	1.00				1.00			
	Black	1.51	1.48	1.55	< 0.01	1.41	1.38	1.44	< 0.01
	Other	1.06	1.02	1.10	< 0.01	1.03	0.99	1.07	0.15
Exposure	Unexposed	1.00				1.00			
	Paratroopers	1.20	1.17	1.23	< 0.01	1.17	1.14	1.20	< 0.01

Table E7. MSK LTE univariate logistic regression for three exposure groups† (n=248,872)

Characteristic	Characteristic Category	N	% with MSK LTE injury	OR	Lower 95% CI	Upper 95% CI	p-value
Sex	Men	216,040	26.4	1.00			
	Women	32,832	31.9	1.31	1.28	1.34	< 0.01
Age group (years)	< 25	85,669	23.5	1.00			
	25-34	104,575	24.5	1.06	1.04	1.08	< 0.01
	35-44	45,376	35.8	1.82	1.78	1.87	< 0.01
	45+	13,220	41.6	2.32	2.24	2.41	< 0.01
Rank group	E1-E4	112,927	21.7	1.00			
	E5-E9	94,593	32.9	1.77	1.73	1.80	< 0.01
	O1-O3	22,882	21.9	1.01	0.98	1.05	0.57
	O4-O10	12,481	37.8	2.19	2.11	2.28	< 0.01
	W1-W5	5,989	36.2	2.04	1.93	2.16	< 0.01
Race	White	172,797	25.4	1.00			
	Black	50,021	31.3	1.34	1.31	1.37	< 0.01
	Other	15,714	26.1	1.04	1.00	1.08	0.06
	Unknown	10,340	37.1	1.73	1.66	1.80	< 0.01
Exposure†	Unexposed	170,715	28.2	1.00			
	Low exposure	46,536	24.4	0.82	0.80	0.84	< 0.01
	High Exposure (Paratroopers)	31,621	25.4	0.87	0.85	0.89	< 0.01

† includes unexposed comparison cohort of Active Duty Soldiers, a low exposure group of Soldiers who received Jump pay for 18 or less months out of the three year study period (January 2016 to December 2018), and the high exposure group of Soldiers who received 19 or more months Jump pay which was defined as this study's" "paratrooper population." Follow-on multiple regression models excluded Soldiers from the low exposure group

Table E8a. MSK LTE univariate and multivariable logistic regression: sex, age, race, exposure, (n=193,940)

		Univariate				Multivariable			
Characteristic	**Characteristic Category**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**
Sex	Men	1.00				1.00			
	Women	1.30	1.26	1.33	< 0.01	1.29	1.26	1.33	< 0.01
Age group (years)	< 25	1.00				1.00			
	25-34	1.08	1.05	1.10	< 0.01	1.09	1.06	1.11	< 0.01
	35-44	1.85	1. 80	1.90	< 0.01	1.84	1.79	1.89	< 0.01
	45+	2.33	2.24	2.43	< 0.01	2.31	2.21	2.41	< 0.01
Race	White	1.00				1.00			
	Black	1.33	1.30	1.36	< 0.01	1.25	1.22	1.28	< 0.01
	Other	1.04	1.00	1.08	0.05	0.99	0.95	1.03	0.69
Exposure	Unexposed	1.00				1.00			
	Paratroopers	0.87	0.85	0.89	< 0.01	0.91	0.88	0.94	< 0.01

Table E8b. MSK LTE univariate and multivariable logistic regression: sex, rank, race, exposure, (n=193,972)

		Univariate				Multivariable			
Characteristic	**Characteristic Category**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**	**OR**	**Lower 95% CI**	**Upper 95% CI**	**p-value**
Sex	Men	1.00				1.00			
	Women	1.30	1.26	1.33	< 0.01	1.30	1.27	1.34	< 0.01
Rank group	E1-E4	1.00				1.00			
	E5-E9	1.78	1.74	1.82	< 0.01	1.81	1.77	1.86	< 0.01
	O1-O3	0.99	0.95	1.03	0.64	1.00	0.96	1.04	0.99
	O4-O10	2.21	2.12	2.30	< 0.01	2.25	2.16	2.36	< 0.01
	W1-W5	2.00	1.89	2.12	< 0.01	2.01	1.89	2.14	< 0.01
Race	White	1.00				1.00			
	Black	1.33	1.30	1.36	< 0.01	1.27	1.24	1.30	< 0.01
	Other	1.04	1.00	1.08	0.05	1.01	0.97	1.05	0.56
Exposure	Unexposed	1.00				1.00			
	Paratroopers	0.87	0.85	0.89	< 0.01	0.80	0.78	0.82	< 0.01

APPENDIX F

Interaction assessment in multivariable models:
Sex and paratrooper exposure and race and paratrooper exposure

Unexposed Non-Paratroopers and Paratrooper Cohorts

Active Duty Army
January 2016 to December 2018

APHC Paratrooper injuries investigation team interaction assessment of multivariable models: Sex and paratrooper exposure and race and paratrooper exposure

We conducted a likelihood ratio test with sex and paratrooper exposure, and the result was not statistically significant ($\chi_2(1) = 2.67$, $p = 0.10$).
Full Model:
logit P(mechanical injury) = $\alpha + \beta_1$(paratrooper exposure) + γ_1(sex) + γ_2(age group) + γ_3(race group) + δ_1(paratrooper exposure x sex)
Reduced Model:
logit P(mechanical injury) = $\alpha + \beta_1$(paratrooper exposure) + γ_1(sex) + γ_2(age group) + γ_3(race group)
H_0: $\delta_1 = 0$
H_A: $\delta_1 \neq 0$
Table 1. Likelihood ratio test of full vs. reduced model for interaction of sex and paratrooper exposure on mechanical injury

Model	Likelihood ratio	Likelihood Ratio Test statistic	Degrees of freedom	p-value
Full	3,973.4374	2.667	1	0.10
Reduced	3,970.7703			

We conducted a likelihood ratio test with race group and paratrooper exposure, and the result was not statistically significant ($\chi_2(2) = 6.07$, $p = 0.05$).
Full Model:
logit P(mechanical injury) = $\alpha + \beta_1$(paratrooper exposure) + γ_1(sex) + γ_2(age group) + γ_3(race group) + δ_1(paratrooper exposure x race group)
Reduced Model:
logit P(mechanical injury) = $\alpha + \beta_1$(paratrooper exposure) + γ_1(sex) + γ_2(age group) + γ_3(race group)
H_0: $\delta_1 = 0$
H_A: $\delta_1 \neq 0$
Table 2. Likelihood ratio test of full vs. reduced model for interaction of race group and paratrooper exposure on mechanical injury

Model	Likelihood ratio	Likelihood Ratio Test statistic	Degrees of freedom	p-value
Full	3,976.8436	6.073	2	0.05
Reduced	3,970.7703			

APPENDIX G

Direct cost data of mechanical injuries

Unexposed Non-Paratroopers and Paratrooper Cohorts

Active Duty Army
January 2016 to December 2018

Table G1. Non-paratroopers (Unexposed) – Total direct care cost ($) of mechanical injuries

REGION	FRACTURE		DISLOCATION	SPRAIN/JOINT DAMAGE		STRAIN/TEAR		MSK TISSUE DAMAGE, OTHER		AMPUTATION	CRUSH	INTERNAL ORGAN & BLOOD	OPEN WOUND	NERVE		CONTUSION/SUPERFICIAL		TISSUE DAMAGE, OTHER		OVERALL		Grand Total
	ACT	CMT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	ACT	ACT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	
HEAD & NECK	$4,437,790	$0	$9,359	$3,043	$0	$1,233,731	$0	$15,812	$1,020	$0	$1,420	$11,025,535	$2,968,991	$37,569	$0	$2,144,203	$5,913	$3,279,158	$4,739,105	$25,156,609	$4,746,039	$29,902,648
01 TBI	$1,117,015	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$10,823,776	$0	$14,200	$0	$0	$0	$0	$0	$11,954,991	$0	$11,954,991
02 OTHER HEAD	$0	$0	$0	$1,572	$0	$18,160	$0	$7,281	$1,020	$0	$0	$14,478	$1,694,466	$0	$0	$1,138,932	$428	$2,157,884	$0	$5,032,773	$1,448	$5,034,221
03 FACE	$2,612,687	$0	$9,359	$1,471	$0	$0	$0	$0	$0	$0	$272	$0	$512,001	$0	$0	$110,301	$3,863	$271,788	$0	$3,517,879	$3,863	$3,521,742
04 EYE	$259,865	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$585,689	$3,073	$0	$777,906	$97	$505,222	$0	$2,131,756	$97	$2,131,853
05 EAR	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$78,007	$2,357	$0	$40,451	$288	$60,919	$4,739,105	$181,734	$4,739,393	$4,921,128
06 NECK	$448,222	$0	$0	$0	$0	$1,215,571	$0	$8,531	$0	$0	$1,148	$187,280	$98,828	$882	$0	$76,613	$1,237	$283,345	$0	$2,320,420	$1,237	$2,321,657
07 HEAD/NECK OTHER	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$17,056	$0	$0	$0	$0	$0	$17,056	$0	$17,056
SPINE & BACK	$1,885,006	$2,965	$252,916	$1,159,224	$0	$1,411,760	$0	$32,056	$106,756,444	$0	$0	$1,683,841	$0	$10,842	$12,235,616	$0	$0	$450,704	$0	$6,886,348	$118,995,025	$125,881,373
08 BACK, UPPER	$728,634	$39	$205,899	$659,534	$0	$0	$0	$1,855	$20,394,489	$0	$0	$1,636,234	$0	$9,160	$3,046,539	$0	$0	$0	$0	$3,241,316	$23,441,068	$26,682,383
09 BACK, MIDDLE	$502,817	$236	$90	$77,075	$0	$0	$0	$165	$4,512,228	$0	$0	$15,510	$0	$489	$204,640	$0	$0	$0	$0	$596,146	$4,717,104	$5,313,250
10 BACK, LOWER	$653,555	$2,690	$46,927	$422,615	$0	$1,411,760	$0	$30,036	$76,052,530	$0	$0	$32,097	$0	$1,194	$8,861,662	$0	$0	$450,704	$0	$3,048,887	$84,916,882	$87,965,769
11 BACK, OTHER	$0	$0	$0	$0	$0	$0	$0	$0	$5,797,196	$0	$0	$0	$0	$0	$122,775	$0	$0	$0	$0	$0	$5,919,971	$5,919,971
TORSO	$2,252,177	$57,583	$12,444	$158,801	$0	$986,435	$0	$51,519	$0	$146	$21,171	$2,926,947	$730,707	$1,879	$644,882	$1,208,776	$3,429	$650,852	$0	$9,001,855	$705,893	$9,707,748
12 CHEST	$562,129	$0	$7,048	$119,318	$0	$614,810	$0	$6,707	$0	$0	$152	$1,025,738	$249,419	$1,682	$644,882	$790,118	$342	$454,434	$0	$3,831,555	$645,224	$4,476,779
13 ABDOMEN	$0	$0	$0	$0	$0	$275,653	$0	$15,059	$0	$146	$0	$1,300,824	$0	$197	$0	$0	$0	$139,951	$0	$1,731,829	$0	$1,731,829
14 PELVIS	$1,690,048	$57,583	$5,396	$39,484	$0	$95,972	$0	$29,753	$0	$0	$21,019	$283,693	$481,289	$0	$0	$418,657	$3,087	$56,467	$0	$3,121,778	$60,670	$3,182,448
15 TRUNK, OTHER	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$316,692	$0	$0	$0	$0	$0	$0	$0	$316,692	$0	$316,692
UPPER EXTREMITY	$13,031,141	$2,942	$2,922,046	$8,502,160	$750,344	$3,840,876	$8,835,158	$11,954,763	$58,667,041	$1,293,842	$231,798	$187,453	$4,338,114	$4,194,534	$3,129,903	$1,759,729	$11,380	$1,279,964	$0	$53,536,421	$71,396,769	$124,933,190
16 SHOULDER	$2,667,132	$246	$1,736,294	$6,164,987	$425,880	$1,589,024	$8,082,873	$10,703,554	$39,079,845	$0	$8,623	$62,042	$49,490	$5,567	$0	$249,005	$353	$525,154	$0	$23,760,872	$47,589,197	$71,350,069
17 ARM, UPPER	$917,754	$464	$499,019	$0	$0	$1,633,854	$65,621	$207,092	$237,815	$14,767	$0	$12,987	$163,302	$7,435	$0	$129,315	$1,199	$0	$0	$3,585,524	$305,099	$3,890,623
18 ELBOW	$0	$0	$111,063	$196,241	$18,822	$0	$0	$31,125	$5,101,718	$0	$1,217	$0	$89,488	$3,592,780	$0	$211,583	$661	$68,973	$0	$4,302,471	$5,121,201	$9,423,673
19 ARM, LOWER	$2,809,597	$1,616	$14,958	$0	$0	$189,255	$126,745	$143,055	$296,426	$260,970	$14,204	$26,669	$517,535	$79,565	$0	$135,324	$168	$612,016	$0	$4,803,148	$424,956	$5,228,104
20 WRIST	$1,579,977	$0	$0	$1,396,932	$221,569	$0	$0	$134,873	$7,602,157	$0	$2,148	$61,598	$185,534	$198,665	$3,045,036	$148,544	$626	$0	$0	$3,708,272	$10,869,389	$14,577,661
21 HAND, FINGER	$5,056,681	$616	$560,713	$744,001	$84,073	$428,743	$559,918	$735,063	$5,239,919	$1,018,105	$205,605	$24,156	$3,332,766	$197,811	$0	$885,959	$8,373	$0	$0	$13,189,602	$5,892,899	$19,082,501
22 ARM, OTHER	$0	$0	$0	$0	$0	$0	$0	$0	$1,109,161	$0	$0	$0	$0	$112,710	$84,867	$0	$0	$73,822	$0	$186,532	$1,194,028	$1,380,560
LOWER EXTREMITY	$12,535,977	$1,103,356	$955,536	$32,361,949	$10,221,864	$4,388,393	$1,911	$1,974,922	$112,617,758	$1,063,834	$224,176	$140,838	$2,245,959	$773,810	$737,738	$2,105,623	$301,554	$1,032,641	$0	$59,803,659	$124,984,181	$184,787,840
23 HIP	$727,390	$420,458	$75,391	$3,576,335	$7,876,264	$324,170	$0	$56,020	$19,227,195	$0	$421	$0	$19,056	$30,162	$0	$146,844	$0	$93,464	$0	$5,049,252	$27,523,918	$32,573,170
24 LEG, UPPER	$1,595,861	$231,002	$0	$0	$0	$1,313,583	$1,773	$179,701	$2,255,073	$600,068	$5,283	$53,546	$489,490	$24,524	$0	$173,496	$1,376	$45,803	$0	$4,481,355	$2,489,223	$6,970,578
25 KNEE	$1,137,894	$0	$523,597	$24,652,832	$1,344,007	$0	$0	$446,028	$43,626,315	$0	$3,511	$0	$373,906	$0	$0	$571,607	$1,369	$0	$0	$27,709,375	$44,971,691	$72,681,066
26 LEG, LOWER	$2,915,415	$346,615	$0	$0	$0	$2,667,806	$139	$461,415	$7,875,065	$176,760	$111,513	$86,463	$882,983	$97,110	$0	$473,231	$1,835	$893,374	$0	$8,766,069	$8,223,655	$16,989,724
27 ANKLE	$3,394,303	$12,472	$152,905	$3,752,663	$989,623	$82,834	$0	$470,868	$16,960,586	$0	$7,513	$0	$40,956	$0	$0	$90,415	$11,364	$0	$0	$7,992,457	$17,974,046	$25,966,503
28 FOOT, TOE	$2,765,115	$92,808	$203,643	$380,119	$11,969	$0	$0	$360,890	$18,345,989	$287,006	$95,935	$829	$439,568	$444,277	$0	$650,030	$285,609	$0	$0	$5,627,411	$18,736,375	$24,363,787
29 LEG, OTHER	$0	$0	$0	$0	$0	$0	$0	$0	$4,327,535	$0	$0	$0	$0	$177,738	$737,738	$0	$0	$0	$0	$177,738	$5,065,273	$5,243,011
OTHER	$0	$19,799	$0	$57,815	$220,498	$44,719	$10,400	$241,295	$7,382,823	$0	$0	$0	$0	$0	$0	$0	$0	$161,807	$716	$505,636	$7,634,236	$8,139,872
30 SYSTEMWIDE	$0	$0	$0	$0	$0	$0	$0	$160,702	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$716	$160,702	$716	$161,418
31 MULTIPLE	$0	$0	$0	$0	$0	$0	$0	$504	$29,683	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$504	$29,683	$30,187
32 UNSPECIFIED	$0	$19,799	$0	$57,815	$220,498	$44,719	$10,400	$80,089	$7,353,140	$0	$0	$0	$0	$0	$0	$0	$0	$161,807	$0	$344,430	$7,603,837	$7,948,268
Grand Total	$34,142,091	$1,186,644	$4,152,301	$42,242,993	$11,192,706	$11,905,913	$8,847,470	$14,270,367	$285,425,087	$2,357,822	$478,564	$15,964,613	$10,283,771	$5,018,634	$16,748,139	$7,218,331	$322,276	$6,855,127	$4,739,821	$154,890,529	$328,462,143	$483,352,672

Table G2. Paratroopers (Exposed) – Total direct care cost ($) of mechanical injuries

REGION	FRACTURE		DISLOCATION	SPRAIN/JOINT DAMAGE		STRAIN/TEAR		MSK TISSUE DAMAGE, OTHER		AMPUTATION	CRUSH	INTERNAL ORGAN & BLOOD	OPEN WOUND	NERVE		CONTUSION/SUPERFICIAL		TISSUE DAMAGE, OTHER		OVERALL		Grand Total
	ACT	CMT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	ACT	ACT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	
HEAD & NECK	$797,718	$0	$5,527	$143	$0	$215,007	$0	$1,571	$0	$329	$997	$3,725,087	$836,793	$5,581	$0	$485,991	$1,777	$1,333,829	$545,258	$7,408,573	$547,035	$7,955,609
01 TBI	$211,659	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,724,921	$0	$1,190	$0	$0	$0	$0	$0	$3,937,771	$0	$3,937,771
02 OTHER HEAD	$0	$0	$0	$0	$0	$5,140	$0	$133	$0	$0	$0	$166	$350,397	$0	$0	$235,462	$126	$1,109,860	$0	$1,701,157	$126	$1,701,283
03 FACE	$536,297	$0	$5,527	$143	$0	$0	$0	$0	$0	$0	$0	$0	$174,923	$0	$0	$25,682	$1,533	$47,381	$0	$789,953	$1,533	$791,486
04 EYE	$46,712	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$201,344	$33	$0	$148,311	$118	$118,955	$0	$515,355	$118	$515,473
05 EAR	$0	$0	$0	$0	$0	$0	$0	$0	$0	$329	$0	$0	$52,401	$157	$0	$5,690	$0	$10,507	$545,258	$69,085	$545,258	$614,343
06 NECK	$3,049	$0	$0	$0	$0	$209,868	$0	$1,438	$0	$0	$997	$0	$57,727	$0	$0	$70,847	$0	$47,126	$0	$391,052	$0	$391,052
07 HEAD/NECK OTHER	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,201	$0	$0	$0	$0	$0	$4,201	$0	$4,201
SPINE & BACK	$687,066	$457	$2,598	$176,097	$0	$250,786	$0	$4,534	$13,802,058	$0	$0	$91,696	$0	$593	$1,218,470	$0	$0	$147,921	$0	$1,361,290	$15,020,985	$16,382,275
08 BACK, UPPER	$75,381	$0	$1,493	$100,236	$0	$0	$0	$0	$2,472,883	$0	$0	$56,730	$0	$0	$308,556	$0	$0	$0	$0	$233,841	$2,781,439	$3,015,280
09 BACK, MIDDLE	$85,521	$187	$0	$18,464	$0	$0	$0	$0	$674,476	$0	$0	$28,972	$0	$0	$33,172	$0	$0	$0	$0	$132,957	$707,835	$840,792
10 BACK, LOWER	$526,163	$270	$1,105	$57,397	$0	$250,786	$0	$4,534	$9,934,325	$0	$0	$5,994	$0	$593	$872,313	$0	$0	$147,921	$0	$994,492	$10,806,908	$11,801,400
11 BACK, OTHER	$0	$0	$0	$0	$0	$0	$0	$0	$720,373	$0	$0	$0	$0	$0	$4,429	$0	$0	$0	$0	$0	$724,803	$724,803
TORSO	$333,750	$1,162	$2,395	$29,420	$0	$186,886	$0	$23,134	$0	$0	$1,172	$988,735	$956,695	$2,173	$112,239	$433,615	$376	$164,020	$0	$3,121,997	$113,777	$3,235,773
12 CHEST	$85,534	$0	$1,193	$24,497	$0	$132,319	$0	$6,842	$0	$0	$248	$426,980	$774,081	$2,173	$112,239	$170,830	$0	$69,668	$0	$1,694,365	$112,239	$1,806,604
13 ABDOMEN	$0	$0	$0	$0	$0	$48,707	$0	$15,860	$0	$0	$0	$318,115	$0	$0	$0	$0	$0	$39,044	$0	$421,726	$0	$421,726
14 PELVIS	$248,217	$1,162	$1,202	$4,923	$0	$5,860	$0	$432	$0	$0	$924	$107,934	$182,614	$0	$0	$262,786	$376	$55,308	$0	$870,199	$1,538	$871,737
15 TRUNK, OTHER	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$135,706	$0	$0	$0	$0	$0	$0	$0	$135,706	$0	$135,706
UPPER EXTREMITY	$3,778,934	$978	$592,389	$1,496,479	$197,102	$827,839	$931,036	$1,072,574	$8,158,452	$60,735	$31,121	$12,001	$1,084,095	$558,669	$236,850	$425,667	$4,348	$233,136	$0	$10,173,639	$9,528,766	$19,702,405
16 SHOULDER	$485,195	$0	$354,388	$1,058,056	$117,709	$337,273	$857,998	$827,381	$5,187,046	$0	$3,437	$0	$16,175	$0	$0	$101,157	$0	$118,761	$0	$3,301,821	$6,162,753	$9,464,574
17 ARM, UPPER	$86,339	$0	$48,663	$0	$0	$374,524	$2,167	$37,801	$32,363	$0	$0	$0	$18,121	$2,522	$0	$55,933	$588	$0	$0	$623,904	$35,118	$659,022
18 ELBOW	$0	$0	$11,090	$39,141	$14,019	$0	$0	$5,312	$827,182	$0	$0	$0	$40,214	$295,702	$0	$65,145	$409	$13,012	$0	$469,616	$841,609	$1,311,226
19 ARM, LOWER	$1,439,291	$0	$0	$0	$0	$16,708	$9,427	$65,676	$58,997	$0	$900	$869	$142,040	$6,979	$0	$31,012	$0	$101,363	$0	$1,804,839	$68,424	$1,873,263
20 WRIST	$316,755	$0	$0	$234,664	$40,037	$0	$0	$2,213	$1,064,038	$0	$0	$2,756	$48,764	$33,796	$219,432	$32,310	$692	$0	$0	$671,258	$1,324,200	$1,995,457
21 HAND, FINGER	$1,451,355	$978	$178,248	$164,618	$25,337	$99,335	$61,444	$134,191	$795,408	$60,735	$26,784	$8,377	$818,781	$205,459	$0	$140,110	$2,659	$0	$0	$3,287,992	$885,826	$4,173,818
22 ARM, OTHER	$0	$0	$0	$0	$0	$0	$0	$0	$193,418	$0	$0	$0	$0	$14,210	$17,418	$0	$0	$0	$0	$14,210	$210,836	$225,046
LOWER EXTREMITY	$5,378,656	$69,048	$294,955	$4,897,096	$769,751	$804,219	$105	$375,173	$14,585,133	$219,501	$15,857	$7,899	$1,069,354	$94,896	$44,431	$424,913	$37,334	$328,234	$0	$13,910,753	$15,505,802	$29,416,555
23 HIP	$125,402	$708	$35,566	$358,798	$491,793	$38,034	$0	$9,494	$1,736,156	$0	$0	$0	$4,258	$11,130	$0	$54,568	$0	$26,571	$0	$663,819	$2,228,656	$2,892,475
24 LEG, UPPER	$858,977	$18,151	$0	$0	$0	$287,534	$105	$58,963	$324,626	$107,083	$842	$4,279	$214,358	$8,693	$0	$48,195	$37	$8,983	$0	$1,597,906	$342,919	$1,940,826
25 KNEE	$278,166	$0	$60,699	$3,712,602	$103,061	$0	$0	$51,309	$5,988,429	$0	$397	$0	$143,282	$0	$0	$95,928	$0	$0	$0	$4,342,384	$6,091,490	$10,433,874
26 LEG, LOWER	$1,837,462	$34,951	$0	$0	$0	$475,924	$0	$67,941	$793,685	$112,418	$1,064	$2,725	$166,120	$9,531	$0	$93,047	$229	$292,680	$0	$3,058,911	$828,866	$3,887,777
27 ANKLE	$1,501,789	$6,699	$35,284	$721,129	$166,996	$2,728	$0	$117,506	$2,782,567	$0	$0	$0	$417,832	$0	$0	$25,730	$1,586	$0	$0	$2,821,999	$2,957,849	$5,779,848
28 FOOT, TOE	$776,861	$8,538	$163,406	$104,566	$7,901	$0	$0	$69,960	$2,315,965	$0	$13,553	$896	$123,503	$49,338	$0	$107,446	$35,482	$0	$0	$1,409,529	$2,367,885	$3,777,415
29 LEG, OTHER	$0	$0	$0	$0	$0	$0	$0	$0	$643,706	$0	$0	$0	$0	$16,204	$44,431	$0	$0	$0	$0	$16,204	$688,137	$704,341
OTHER	$0	$18,999	$0	$213	$5,841	$25,564	$0	$34,801	$1,203,589	$0	$0	$0	$0	$0	$0	$0	$0	$36,649	$0	$97,227	$1,228,429	$1,325,656
30 SYSTEMWIDE	$0	$0	$0	$0	$0	$0	$0	$33,108	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$33,108	$0	$33,108
31 MULTIPLE	$0	$0	$0	$0	$0	$0	$0	$0	$35,134	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$35,134	$35,134
32 UNSPECIFIED	$0	$18,999	$0	$213	$5,841	$25,564	$0	$1,693	$1,168,455	$0	$0	$0	$0	$0	$0	$0	$0	$36,649	$0	$64,119	$1,193,295	$1,257,414
Grand Total	$10,976,124	$90,644	$897,865	$6,599,447	$972,695	$2,310,301	$931,141	$1,511,787	$37,749,232	$280,565	$49,147	$4,825,419	$3,946,937	$661,912	$1,611,990	$1,770,186	$43,834	$2,243,788	$545,258	$36,073,478	$41,944,794	$78,018,273

Table G2a. Non-paratroopers (Unexposed) – Direct care cost ($) of mechanical injury encounters by category

Injury/Energy SubCategory	Body System	Total $ Cost of Injury Encounters	% MECH	Total Injury Encounters	AVG Cost per Injury Encounter	$ Cost Female Injury Encounters	% MECH	FEMALE Encounters	AVG Cost per Female Injury Encounter	$ Cost Male Injury Encounters	% MECH	MALE Encounters	AVG Cost per Male Injury Encounter
All Mechanical		$483,352,672	100%	1,730,717	$279	$84,956,057	18%	363,356	$234	$398,396,615	82%	1,367,361	$291
ACUTE	All Acute	$154,890,529	32%	209,134	$741	$18,572,235	22%	32,802	$566	$136,318,294	34%	176,331	$773
	MSK	$109,528,886		126,474	$866	$12,835,626		19,401	$662	$96,693,261		107,073	$903
	NON-MSK	$45,361,642		82,659	$549	$5,736,609		13,401	$428	$39,625,033		69,258	$572
CUMULTV	All Cumultv	$328,462,143	68%	1,521,583	$216	$66,383,822	78%	330,554	$201	$262,078,321	66%	1,191,029	$220
	MSK	$306,651,907		1,450,966	$211	$62,781,422		318,103	$197	$243,870,485		1,132,863	$215
	NON-MSK	$21,810,236		70,617	$309	$3,602,400		12,451	$289	$18,207,836		58,166	$313
	All MSK	$416,180,793	86%	1,577,441	$264	$75,617,047	89%	337,504	$224	$340,563,746	85%	1,239,937	$275

Table G2b. Paratroopers (Exposed) – Total direct care cost ($) of mechanical injury encounters by category

Injury/Energy SubCategory	Body System	Total $ Cost of Injury Encounters	% MECH	Total Injury Encounters	AVG Cost per Injury Encounter	$ Cost Female Injury Encounters	% MECH	FEMALE Encounters	AVG Cost per Female Injury Encounter	$ Cost Male Injury Encounters	% MECH	MALE Encounters	AVG Cost per Male Injury Encounter
All Mechanical		$78,018,273	100%	282,534	$276	$5,193,957	7%	18,913	$275	$72,824,315	93%	263,622	$276
ACUTE	All Acute	$36,073,478	46%	48,593	$742	$2,551,477	49%	2,987	$854	$33,522,001	46%	45,606	$735
	MSK	$22,623,983		27,032	$837	$1,438,324		1,612	$892	$21,185,659		25,420	$833
	NON-MSK	$13,449,495		21,561	$624	$1,113,153		1,375	$810	$12,336,342		20,186	$611
CUMULTV	All Cumultv	$41,944,794	54%	233,941	$179	$2,642,480	51%	15,926	$166	$39,302,314	54%	218,016	$180
	MSK	$39,743,712		225,250	$176	$2,529,050		15,497	$163	$37,214,661		209,754	$177
	NON-MSK	$2,201,082		8,691	$253	$113,430		429	$265	$2,087,653		8,262	$253
	All MSK	$62,367,695	80%	252,283	$247	$3,967,375	76%	17,109	$232	$58,400,320	80%	235,174	$248

Table G3a. Non- paratroopers (Unexposed) – Direct care cost ($) per mechanical injury encounter by injury site and type

REGION		FRACTURE		DISLOCATION	SPRAIN/JOINT DAMAGE		STRAIN/TEAR		MSK TISSUE DAMAGE, OTHER		AMPUTATION	CRUSH	INTERNAL ORGAN & BLOOD VESSEL	OPEN WOUND	NERVE		CONTUSION/SUPERFICIAL		TISSUE DAMAGE, OTHER		OVERALL		Total
		ACT	CMT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	ACT	ACT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	
HEAD & NECK		$1,381		$274	$316		$451		$360	$255		$339	$1,518	$518	$734		$371	$208	$345	$257	$732	$257	$566
	01 TBI	$2,201											$1,497		$1,313						$1,543		$1,543
	02 OTHER HEAD				$206		$227		$541	$255			$792	$525			$525	$214	$373		$445	$241	$445
	03 FACE	$1,157		$274	$736							$136		$426			$301	$209	$418		$779	$209	$777
	04 EYE	$1,198												$602	$384		$272	$97	$280		$364	$97	$363
	05 EAR													$393	$214		$253	$96	$230	$257	$287	$257	$258
	06 NECK	$1,947					$458		$280			$526	$13,553	$730	$206		$335	$309	$288		$541	$309	$541
	07 HEAD/NECK OTHER														$998						$998		$998
SPINE & BACK		$1,349	$182	$2,458	$364		$359		$497	$208			$4,695		$247	$318			$279		$644	$215	$223
	08 BACK, UPPER	$2,210	$18	$4,424	$459				$434	$247			$5,901		$258	$303					$1,521	$253	$282
	09 BACK, MIDDLE	$1,556	$236	$45	$264				$83	$225			$384		$112	$331					$897	$228	$249
	10 BACK, LOWER	$877	$205	$863	$290		$359		$516	$199			$783		$292	$325			$279		$386	$208	$211
	11 BACK, OTHER									$193						$247						$194	$194
TORSO		$1,684	$164	$383	$260		$446		$877		$134	$1,316	$1,872	$753	$249	$509	$442	$202	$296		$767	$432	$726
	12 CHEST	$697		$284	$265		$438		$224			$152	$1,841	$831	$257	$509	$471	$171	$326		$576	$509	$565
	13 ABDOMEN						$419		$750		$134		$1,630		$197				$269		$867		$867
	14 PELVIS	$3,181	$164	$707	$246		$640		$3,445			$1,393	$2,143	$718			$397	$206	$199		$1,036	$166	$942
	15 TRUNK, OTHER												$4,182								$4,182		$4,182
UPPER EXTREMITY		$933	$240	$734	$1,022	$857	$586	$998	$1,615	$208	$3,052	$354	$1,479	$443	$511	$397	$293	$120	$286		$766	$238	$337
	16 SHOULDER	$1,602	$246	$772	$1,634	$729	$527	$1,167	$1,868	$207		$340	$4,161	$461	$362		$403	$177	$307		$1,255	$242	$331
	17 ARM, UPPER	$1,580	$232	$806			$1,060	$474	$857	$264	$950		$928	$578	$202		$276	$240			$944	$292	$803
	18 ELBOW			$685	$552	$832			$370	$194		$126		$526	$484		$305	$220	$196		$465	$195	$265
	19 ARM, LOWER	$1,097	$387	$663			$382	$338	$661	$183	$8,273	$180	$2,328	$691	$1,383		$281	$168	$255		$676	$213	$575
	20 WRIST	$1,010			$564	$1,011			$504	$207		$269	$2,847	$450	$690	$399	$388	$209			$684	$244	$291
	21 HAND, FINGER	$665	$121	$605	$434	$1,697	$286	$395	$851	$228	$2,702	$385	$373	$413	$2,944		$264	$104			$526	$240	$385
	22 ARM, OTHER									$216					$350	$330			$4,122		$549	$221	$241
LOWER EXTREMITY		$1,092	$425	$853	$923	$1,973	$432	$126	$263	$184	$6,725	$917	$3,155	$648	$374	$438	$304	$111	$311		$733	$200	$262
	23 HIP	$1,056	$1,210	$530	$1,052	$2,433	$369		$366	$179		$421	$0	$595	$1,488		$384		$235		$828	$248	$278
	24 LEG, UPPER	$1,950	$423				$439	$147	$546	$168	$10,821	$309	$4,950	$901	$472		$267	$192	$233		$791	$177	$354
	25 KNEE	$1,662		$945	$1,395	$1,059			$234	$168		$465		$725			$351	$274			$1,207	$172	$256
	26 LEG, LOWER	$1,010	$292				$443	$45	$264	$233	$2,406	$2,582	$2,909	$880	$1,616		$344	$129	$327		$549	$235	$333
	27 ANKLE	$1,688	$171	$619	$298	$1,601	$325		$232	$164		$608		$393			$240	$162			$453	$173	$214
	28 FOOT, TOE	$630	$211	$1,152	$270	$211			$265	$253	$9,805	$588	$397	$347	$312		$258	$109			$442	$248	$276
	29 LEG, OTHER									$194					$347	$438					$347	$212	$214
OTHER			$225		$1,014	$5,239	$666	$283	$742	$311									$411	$239	$599	$319	$329
	30 SYSTEMWIDE								$998											$239	$998	$239	$984
	31 MULTIPLE								$504	$182											$504	$182	$184
	32 UNSPECIFIED		$225		$1,014	$5,239	$666	$283	$490	$312									$411		$505	$320	$325
Total		$1,087	$388	$788	$894	$1,835	$464	$993	$926	$199	$4,043	$520	$1,706	$515	$484	$340	$337	$113	$319	$257	$741	$216	$279

Table G3b. Paratroopers (Exposed) – Direct care cost ($) per mechanical injury encounter by injury site and type

REGION		FRACTURE		DISLOCATION	SPRAIN/JOINT DAMAGE		STRAIN/TEAR		MSK TISSUE DAMAGE, OTHER		AMPUTATION	CRUSH	INTERNAL ORGAN & BLOOD VESSEL	OPEN WOUND	NERVE		CONTUSION/SUPERFICIAL		TISSUE DAMAGE, OTHER		OVERALL		Total
		ACT	CMT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	ACT	ACT	ACT	ACT	CMT	ACT	CMT	ACT	CMT	ACT	CMT	
HEAD & NECK		$1,207		$881	$143		$375		$393		$329	$997	$1,126	$569	$507		$365	$355	$391	$161	$687	$161	$561
	01 TBI	$1,776											$1,126		$1,190						$1,149		$1,149
	02 OTHER HEAD						$223		$133				$152	$541			$584	$126	$456		$485	$126	$485
	03 FACE	$1,119		$881	$143									$490			$285	$511	$287		$719	$511	$719
	04 EYE	$861												$678	$33		$212	$118	$232		$329	$118	$329
	05 EAR										$329			$407	$157		$205		$194	$161	$324	$161	$171
	06 NECK	$361					$381		$479			$997		$1,443			$643		$188		$406		$406
	07 HEAD/NECK OTHER														$525						$525		$525
SPINE & BACK		$856	$229	$420	$292		$350		$346	$180			$1,609		$284	$295			$272		$496	$186	$196
	08 BACK, UPPER	$970		$714	$315					$190			$1,950			$256					$547	$195	$206
	09 BACK, MIDDLE	$739	$187		$328					$169			$1,496			$538					$695	$175	$198
	10 BACK, LOWER	$864	$270	$270	$252		$350		$346	$179			$701		$284	$308			$272		$468	$185	$195
	11 BACK, OTHER									$178						$138						$178	$178
TORSO		$940	$166	$235	$180		$474		$230			$230	$2,048	$3,921	$498	$381	$512	$118	$275		$975	$373	$923
	12 CHEST	$474		$196	$197		$538		$113			$248	$2,297	$7,891	$498	$381	$395		$215		$1,018	$381	$923
	13 ABDOMEN						$370		$462				$1,268						$300		$771		$771
	14 PELVIS	$1,424	$166	$294	$126		$362		$81			$226	$4,195	$1,252			$635	$118	$390		$897	$151	$889
	15 TRUNK, OTHER												$6,694								$6,694		$6,694
UPPER EXTREMITY		$988	$489	$707	$874	$1,876	$542	$1,019	$1,208	$160	$1,258	$603	$537	$465	$763	$449	$339	$239	$241		$717	$182	$296
	16 SHOULDER	$1,189		$687	$1,372	$3,004	$538	$1,131	$1,350	$160		$456	$0	$1,017			$570		$275		$925	$186	$258
	17 ARM, UPPER	$1,245		$681			$897	$271	$569	$151				$320	$189		$469	$196			$766	$155	$634
	18 ELBOW			$578	$406	$2,804			$204	$157				$791	$491		$368	$128	$200		$453	$160	$208
	19 ARM, LOWER	$1,610					$250	$310	$1,363	$139		$174	$165	$790	$685		$264		$216		$1,005	$151	$832
	20 WRIST	$676			$447	$828			$184	$159			$2,526	$620	$939	$427	$551	$346			$569	$182	$236
	21 HAND, FINGER	$731	$489	$771	$515	$2,020	$239	$527	$1,101	$165	$1,258	$688	$558	$420	$4,520		$232	$266			$570	$179	$389
	22 ARM, OTHER									$177					$552	$1,236					$552	$190	$199
LOWER EXTREMITY		$1,450	$268	$1,329	$767	$1,588	$408	$96	$285	$157	$4,938	$481	$608	$940	$303	$414	$289	$176	$367		$794	$165	$264
	23 HIP	$1,746	$100	$4,207	$667	$1,971	$235		$657	$152				$836	$271		$448		$253		$622	$190	$226
	24 LEG, UPPER	$4,115	$1,122				$445	$96	$888	$144	$107,083	$386	$654	$2,358	$966		$301	$37	$252		$1,304	$151	$556
	25 KNEE	$1,426		$671	$1,260	$874			$249	$146		$397		$920			$269				$1,099	$148	$231
	26 LEG, LOWER	$1,358	$230				$412		$351	$176	$2,923	$1,064	$833	$564	$460		$332	$229	$388		$747	$178	$444
	27 ANKLE	$2,103	$223	$1,112	$282	$1,688	$435		$240	$141				$1,598			$325	$144			$682	$149	$241
	28 FOOT, TOE	$666	$164	$1,789	$300	$428			$203	$229	$0	$470	$281	$374	$233		$228	$178			$470	$229	$283
	29 LEG, OTHER									$176					$543	$414					$543	$183	$186
OTHER			$651		$35	$173	$2,678		$997	$377									$337		$611	$377	$388
	30 SYSTEMWIDE								$2,058												$2,058		$2,058
	31 MULTIPLE								$0	$1,361											$0	$1,361	$1,310
	32 UNSPECIFIED		$651		$35	$173	$2,678		$95	$369									$337		$451	$369	$373
Total		$1,174	$304	$830	$744	$1,560	$445	$1,018	$642	$169	$2,993	$542	$1,242	$762	$623	$318	$361	$184	$344	$161	$742	$179	$276

Table G4a. Non- paratroopers (Unexposed) – Direct care cost ($) per mechanical incident injury by injury site and type

Injury/ Energy SubCategory	Body System	Total $ Cost of Injury Encounters	% MECH	Total Incident Injuries	AVG Cost per Incident Injury	$ Cost Female Injury Encounters	% MECH	FEMALE Incident Injuries	AVG Cost per Female Incident Injury	$ Cost Male Injury Encounters	% MECH	MALE Incident Injuries	AVG Cost per Male Incident Injury
All Mechanical		$483,352,672	100%	483,250	$1,000	$84,956,057	18%	100,509	$845	$398,396,615	82%	382,741	$1,041
ACUTE	All Acute	$154,890,529	32%	104,297	$1,485	$18,572,235	22%	18,561	$1,001	$136,318,294	34%	85,736	$1,590
	MSK	$109,528,886		58,961	$1,858	$12,835,626		10,396	$1,235	$96,693,261		48,565	$1,991
	NON-MSK	$45,361,642		45,336	$1,001	$5,736,609		8,165	$703	$39,625,033		37,171	$1,066
CUMULTV	All Cumultv	$328,462,143	68%	378,953	$867	$66,383,822	78%	81,948	$810	$262,078,321	66%	297,005	$882
	MSK	$306,651,907		350,364	$875	$62,781,422		77,006	$815	$243,870,485		273,358	$892
	NON-MSK	$21,810,236		28,589	$763	$3,602,400		4,942	$729	$18,207,836		23,647	$770
	All MSK	$416,180,793	86%	409,325	$1,017	$75,617,047	89%	87,402	$865	$340,563,746	85%	321,923	$1,058

Table G4b. Paratroopers (Exposed) – Direct care cost ($) per mechanical incident injury by injury site and type

Injury/ Energy SubCategory	Body System	Total $ Cost of Injury Encounters	% MECH	Total Incident Injuries	AVG Cost per Incident Injury	$ Cost Female Injury Encounters	% MECH	FEMALE Incident Injuries	AVG Cost per Female Incident Injury	$ Cost Male Injury Encounters	% MECH	MALE Incident Injuries	AVG Cost per Male Incident Injury
All Mechanical		$78,018,273	100%	93,176	$837	$5,193,957	7%	5,744	$904	$72,824,315	93%	87,432	$833
ACUTE	All Acute	$36,073,478	46%	25,364	$1,422	$2,551,477	49%	1,524	$1,674	$33,522,001	46%	23,840	$1,406
	MSK	$22,623,983		13,255	$1,707	$1,438,324		770	$1,868	$21,185,659		12,485	$1,697
	NON-MSK	$13,449,495		12,109	$1,111	$1,113,153		754	$1,476	$12,336,342		11,355	$1,086
CUMULTV	All Cumultv	$41,944,794	54%	67,812	$619	$2,642,480	51%	4,220	$626	$39,302,314	54%	63,592	$618
	MSK	$39,743,712		63,407	$626.80	$2,529,050		4,032	$627	$37,214,661		59,592	$624
	NON-MSK	$2,201,082		4405	$499.68	$113,430		188	$603	$2,087,653		4,217	$495
	All MSK	$62,367,695	80%	76,662	$814	$3,967,375	76%	4,802	$826	$58,400,320	80%	71,860	$813