HHS Public Access

Author manuscript

Saf Sci. Author manuscript; available in PMC 2018 April 30.

Published in final edited form as:

Saf Sci. 2018 April ; 104: 239–245. doi:10.1016/j.ssci.2018.01.015.

Work-related nonfatal injuries in Alaska's aviation industry, 2000–2013

Samantha L. Case, MPH[a], **Kyle M. Moller, PhD**[b,*], **Nancy A. Nix, MD**[c], **Devin L. Lucas, PhD**[a], **Elizabeth H. Snyder, PhD**[c], and **Mary B. O'Connor, MS**[a]

[a]Western States Division, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, 4230 University Drive, Suite 310, Anchorage, Alaska, 99508, USA

[b]Western States Division, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, 315 E Montgomery Avenue, Spokane, Washington, 99207, USA

[c]Department of Health Sciences, University of Alaska Anchorage, 3211 Providence Drive, BOC3-220, Anchorage, Alaska, 99508, USA

Abstract

Aviation is a critical component of life in Alaska, connecting communities off the road system across the state. Crash-related fatalities in the state are well understood and many intervention efforts have been aimed at reducing aircraft crashes and resulting fatalities; however, nonfatal injuries among workers who perform aviation-related duties have not been studied in Alaska. This study aimed to characterize hospitalized nonfatal injuries among these workers using data from the Alaska Trauma Registry. During 2000–2013, 28 crash-related and 89 non-crash injuries were identified, spanning various occupational groups. Falls were a major cause of injuries, accounting for over half of non-crash injuries. Based on the study findings, aviation stakeholders should review existing policies and procedures regarding aircraft restraint systems, fall protection, and other injury prevention strategies. To supplement these findings, further study describing injuries that did not result in hospitalization is recommended.

Keywords

occupational safety; aviation; injury; accident; trauma registry

1. Introduction

Aviation is a critical part of Alaskan life and a major contributor to Alaska's economy, generating approximately 47,000 on-site and off-site jobs, or about 10% of Alaskan employment (Northern Economics, 2009). Alaska's remote geography necessitates the use of air transportation to deliver people, food, cargo, and mail across the state. There are an

*Corresponding author. KMoller@cdc.gov.

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estimated 3,693 pilots certificated to fly commercially in the state (Federal Aviation Administration, 2015), flying roughly 835,000 hours annually (Alaska Air Carriers Association, 2014). Pilots in Alaska face unique work-related risks when flying, including challenging terrain, unfavorable and quickly changing weather, and remote locations (National Transportation Safety Board, 1995). Furthermore, organizational pressures to fly in inclement weather or other potentially unsafe situations to sustain productivity and profits have been identified in Alaskan aviation operations (Bearman, Paletz, Orasanu, & Brooks, 2009). Aircraft crashes have been consistently recognized as one of the leading causes of work-related fatalities in Alaska (Garrett & Conway, 1998; Lincoln, Somervell, & O'Connor, 2011). During 1990–2009, 35% of the nation's commuter and air taxi crashes and 20% of fatalities occurred in Alaska (National Institute for Occupational Safety and Health, 2015a).

Characteristics and risk factors associated with work-related aviation fatalities in the U.S. have been well-documented (Centers for Disease Control and Prevention, 2002; Centers for Disease Control and Prevention, 2011; Garrett & Conway, 1998; Garrett, Conway, & Manwaring, 1998; Grabowski, Baker, & Li, 2005; Krebs, Li, & Baker, 1995; Wiant, Baker, Marine, Vancil, & Keefer, 1991). Data for 2014 indicate that nationally, 82 aircraft pilots and flight engineers died from work-related injuries, resulting in a mortality rate of 64 deaths per 100,000 full-time equivalent workers (FTEs), over 19 times higher than the national average for all workers and only lower than the fatality rates for loggers and fishermen (Bureau of Labor Statistics, 2015b). To reduce the fatality rate in this high-risk industry, studies have analyzed pilot safety and factors influencing crash prevention and survival, with research in Alaska being no exception. As a result, although still high, the number and rate of crashes and work-related fatalities in Alaska has decreased (Mode, O'Connor, Conway, & Hill, 2012).

According to the Bureau of Labor Statistics (2015a), approximately 452,700 people are employed in the air transportation industry nationwide. Occupations within the industry include aircraft mechanics, service technicians, pilots, flight engineers, ramp agents, and travel clerks (Bureau of Labor Statistics, 2015a). Nationally, workers in the air transportation industry experienced work-related nonfatal injuries and illnesses at a rate of 7.5 per 100 FTEs in 2013, more than twice the national rate for all workers (Bureau of Labor Statistics, 2015a).

Studies of nonfatal injuries have highlighted the various work-related hazards and injuries experienced by aviation workers. Grabowski, Baker, and Li (2005) analyzed data from the National Transportation Safety Board (NTSB) collected during 1983–2004 on major airlines, commuter air carriers, and air taxis, and reported a ground crew injury rate of 0.47 injuries per 1 million aircraft departures. Fatalities were most often the result of moving aircraft equipment (e.g., propellers), while nonfatal injuries occurred most often due to collisions with vehicles, including tugs, buses, and sweepers. Nearly two-thirds of injuries were classified as serious, meaning the worker was hospitalized for more than 48 hours. These findings from Grabowski et al. (2005) highlight the hazardous work of ground crew workers. Additional studies have found that ground crew personnel, particularly baggage handlers, most commonly experience injuries from slips, trips, and falls and musculoskeletal injuries from overexertion and heavy lifting (Korkmaz et al., 2006; Ribak, Cline, & Froom, 1995).

Research by Hobbs and Williamson (2002) found that thirty percent of aircraft maintenance workers reported sustaining at least one injury within the previous year. Skill-based errors, defined as those that occur while performing tasks of habit or routine, were identified as the leading predictor of injury (Hobbs & Williamson, 2002). According to Neitzel, Seixas, Harris, and Camp (2008), aviation mechanics were found to be exposed to fall hazards while working on ladders, lifts, and the aircraft itself at heights ranging from 4–30 feet, and are sometimes noncompliant with fall protection standards.

Reported flight attendant injuries have been primarily due to turbulent conditions or emergency evacuations; however, in non-turbulent conditions, flight attendants were injured from slips, trips, and falls, or from pushing, pulling, or lifting during cabin service (Griffiths & Powell, 2012). McNeely et al. (2014) also explored the health of flight attendants. Results from a survey administered to flight attendants with two airlines in the U.S. found that, compared to the general population, flight attendants suffered more fatigue, depression, and other adverse health conditions (McNeely et al., 2014), which can impact safety and increase the risk of injury (Federal Aviation Administration, 2007).

Nonfatal injuries can have considerable negative effects on workers. The impacts on health status, medical costs, and productivity from nonfatal injuries can be substantial. For example, the Alaska Division of Workers' Compensation (2014) received over 19,000 reports of work-related injury and illness in 2013 and paid out $279.4 million in compensation benefits. In addition to significant financial burdens, nonfatal injuries can negatively affect the general well-being of the injured person and their social circle. A study by van der Sluis, Eisma, Groothoff, and ten Duis (1998) documented long-term consequences of severe injuries that included changes in cognitive function, behavior, employment status, and participation in recreational activities.

In Alaska, occupational safety research and initiatives have historically concentrated on preventing fatal injuries. Consequently, relatively little is known about the nonfatal work-related injuries that occur in Alaska’s aviation industry, particularly when not crash-related. A prior analysis of data from the Alaska Trauma Registry (ATR) collected during 1991–1995 showed that 69 work-related, nonfatal injuries occurred within the air transportation industry at an average annual rate of 0.19 injuries per 100 workers (Husberg, Conway, Moore, & Johnson, 1998). While this study identified high-risk industries for targeted safety recommendations, it did not provide an in-depth analysis of the types of injuries sustained by aviation workers, and did not differentiate crash-related injuries from non-crash injuries.

The main barrier to understanding the burden of nonfatal injuries within the Alaska aviation industry has been the difficulty of obtaining incidence data. The Alaska Occupational Injury Surveillance System (AOISS) is a database that has recorded all work-related fatalities that have occurred in the state since 1990, but it does not include nonfatal injuries (National Institute for Occupational Safety and Health, n.d.). Further, the NTSB has an accident database that is publicly available and contains information on injuries sustained while the aircraft is in flight, or with the intention to fly; however, this does not include injuries that occur while the aircraft engine is not running (e.g., maintenance, fueling) (Grabowski et al., 2005). The use of trauma registry data, as has been done previously, can offer insight into the most serious injuries that occur and require hospitalization, and to whom they occur. In addition, further detailed examination of these data, including the use of narrative fields, may enhance understanding of the work-related hazards faced by workers in the aviation industry.

The goal of this study was to support safety improvements for aviation workers in Alaska by determining the burden and nature of nonfatal injuries in Alaska's aviation industry that required hospitalization.

2. Materials and Methods

2.1 Data Source

Data for this study were obtained from the ATR. The registry is managed by the State of Alaska after receiving case data from acute care facilities in Alaska. To supplement employment information, a coding team from NIOSH separately coded the industry and occupation fields with North American Industry Classification System (NAICS) and Standard Occupation Classification (SOC) codes. The data analyzed in this study were from two datasets that contained patient and injury data from 1991–2009 and 2010–2013 respectively. The datasets were kept as two separate files for the duration of the study. The descriptive statistics in the study were calculated separately and merged after matching variables between the datasets.

2.2 Case Definition

For this study, a case was defined as any nonfatal work-related traumatic injury resulting in hospitalization, sustained by a worker in the aviation industry, including aviation support services, throughout Alaska during 2000–2013. Patients who were noted as deceased in the dataset were excluded from the analysis. Workers could have experienced multiple injuries; however, only the primary and most severe injury was considered in the analysis. Aviation-related workers spanned a variety of industries and occupations as defined by existing classification mechanisms. The population of interest in the study included all workers that performed aviation-related duties, including preparing aircraft for departure, handling and loading bags, and performing aircraft maintenance. It has been estimated that about 20 workers are involved with a single flight, including dispatchers, gate agents, ramp agents, fuelers, and other employees (Fig. 1).

2.3 Case Identification

The datasets were refined to include only cases that fit the case definition. First, cases were excluded if they were not identified as work-related, or resulted in a fatality as previously described. Next, census industry, census occupation, NAICS, and SOC codes present in the dataset were reviewed to identify any potential aviation-related codes. This process was meant to be extremely broad to reduce the chance of deleting cases. A list of aviation-related terms (e.g., hangar, aircraft, plane, pilot) was then developed and used to perform key word searches within the narrative fields of the datasets to capture additional potential cases. Cases that were a positive match for any of the key words were kept for further review to determine if they met the inclusion criteria for the study. A complete list of keywords and codes used for case identification can be found in Appendix A.

After the initial process of identifying potential cases, each case was manually reviewed. Two variables were added to the dataset: case (Yes, No) and confidence in making that determination (High, Medium, and Low). This process was repeated independently by two investigators to measure agreement in inclusion and exclusion classifications. Initial case determinations were compared to identify discrepancies, with final determinations made after discussion. Cases with low confidence were not included in the final dataset. Once cases were finalized, an additional variable was added to indicate if the injury was crash-related as determined from case narrative fields (Yes, No).

2.4 Data Analysis

Data analysis was performed using Stata version 13.1 (StataCorp, 2013). After cases were identified, descriptive statistics were calculated to explore variables of interest, such as worker demographics (age, sex, race/ethnicity), incident data (date, city, external cause of injury, drugs/alcohol), and injury characteristics (injury severity, injury diagnosis, traumatic brain injury, spinal cord injury, condition upon discharge, disability, hospital days). External cause of injury and injury diagnosis were determined by the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. Injury severity was ascertained by using the Abbreviated Injury Scale (AIS), which is primarily a measure of the threat to life. Severity ranges from minor, coded 1, to unsurvivable, coded 6 (Segui-Gomez & Lopez-Valdes, 2012). Data suppression was used on some variables with low counts to maintain confidentiality if reporting the data could lead to patient identification. Missing data were excluded from percent distributions. Injury rates were calculated for the air transportation industry (NAICS 481) using workforce estimates obtained from the State of Alaska Department of Labor & Workforce Development.

3. Results

During 2000–2013, 4,651 nonfatal work-related injuries were identified in the ATR. Of these, 117 were sustained by aviation workers, averaging just over eight hospitalized workers per year (Fig. 2).

Annual injury counts ranged from a low of 4 in 2006 to a high of 12 in 2001. No crash-related injuries were identified in 2003. Injuries occurred in all months of the year and were evenly split between seasons. Eighty-nine injured workers were involved in the air transportation industry specifically (NAICS 481); with a period denominator of 88,493 workers (average 6,321 workers annually), the traumatic injury rate was 0.1 per 100 workers during the study period.

3.1 Demographics

Nonfatal injuries occurred across the state in all boroughs. Injuries most frequently occurred in Anchorage (n=47, 41%), followed by Fairbanks (n=10, 9%), Ketchikan (n=8, 7%), and Bethel (n=7, 6%).

Eighty-nine percent of injured workers were male (n=104) and 11% were female (n=13). Patients identified as white (n=96, 85%), Alaska Native (n=7, 6%), Asian (n=5, 4%), and other races and ethnicities (n=5, 4%). The median age of those injured was 42 years (20–76 years).

Because recommendations for injury prevention strategies differ, characteristics of crash and non-crash injuries are presented separately.

3.2 Crash-related injuries

Twenty-eight injuries (24%) were sustained when aviation employees were involved in crashes. The majority of injured workers were pilots (n=25, 89%) (Table 1).

Use of restraints was noted for 16 of the 28 patients involved in crashes, of which 7 used a harness, 6 used a lap belt and shoulder belt, and 3 used a lap belt only. Lack of notation does not indicate that restraint was not used, only that it was not noted.

Of these crash-related injuries, two-thirds of injuries were fractures (n=18, 67%). The other injuries sustained from crashes were internal injuries (n=4, 15%), burns (n=3, 11%), open wounds (n=1, 4%) and dislocations (n=1, 4%). Traumatic brain injuries were diagnosed in eight patients (29%), and one patient was diagnosed with a traumatic spinal cord injury. The severity of the injuries were classified as minor (n=2, 8%), moderate (n=15, 58%), serious (n=7, 27%), and severe (n=2, 8%).

Of the 28 injured patients, half were able to go directly home upon discharge. Nine patients were discharged to acute care hospitals (n=9, 32%), followed by inpatient rehabilitation centers (n=4, 14%) and burn centers (n=1, 4%). Of those whose condition upon discharge was known, over two-thirds experienced temporary disability when they were discharged (n=11, 69%). One patient was seriously disabled and required assistance upon discharge. Patients spent a median of eight days in the hospital (1–33 days).

3.3 Non-crash injuries

Most of the injuries identified from the ATR dataset were not related to aircraft crashes (n=89, 76%). Approximately half of the injuries were classified as moderate using AIS (n=39, 46%), followed by minor (n=22, 26%), serious (n=19, 22%), and severe (n=4, 5%). Only one injury was classified as critical. Table 2 shows the severity of injuries by mechanism of injury.

Falls accounted for over half of the non-crash injuries (n=47, 53%). Injuries most often resulted from falls from the aircraft while performing pre-flight checks or maintenance duties (n=17, 36%), or falls on the same level due to slipping on ice (n=11, 23%) (Table 3).

The majority of falls resulted in fractures (n=30, 64%), followed by internal injuries (n=7, 15%), and sprains (n=5, 11%). Dislocations, contusions, and open wounds were also observed in a small number of patients. While injuries ranged from minor to severe, falls most often resulted in injuries of moderate (n=22, 47%) and serious (n=15, 32%) severity.

Overexertion was the next leading cause of injuries, although only causing 11 injuries (12%). Examples of the activities that caused overexertion included lifting, pushing, and throwing. Injuries were primarily sprains and strains (n=8, 73%), but fractures, contusions, and open wounds also occurred. Overexertion injuries were classified as minor (n=8, 73%) or moderate (n=3, 27%). All other causes of injury accounted for less than 10% of all injuries.

Aircraft mechanics were the most commonly injured occupational group (n=19, 23%), followed by baggage and cargo handlers (n=17, 21%), pilots (n=15, 18%), and ramp agents (n=13, 16%) (Table 1).

Most patients were able to go directly home after treatment (n=72, 81%). However, only 12 patients were discharged with immediate full function with no restrictions. Of those with disability status known at time of discharge, most experienced some level of temporary disability, but were expected to make a full recovery (n=53, 73%). Patients spent a median of 2 days in the hospital (1–34 days).

4. Discussion

The purpose of this study was to expand the limited knowledge of injury epidemiology in Alaska’s aviation industry by reporting the burden and nature of nonfatal injuries requiring hospitalization during 2000–2013. The first step in doing so was to identify all cases of injuries that required hospitalization using ATR data. The methodology used to do so was comprehensive and included not only those typically coded as part of the air transportation industry, but also those who provide a wide range of support services in aviation (e.g., air traffic controllers, avionics technicians) in order to convey a complete assessment of safety issues that would be of benefit to aviation stakeholders. Hospitalized workers were seen in a variety of occupational groups, including aviation mechanics, pilots, and ramp agents.

The second step was to conduct a descriptive analysis of those injuries to report injury characteristics and rates. The analysis highlighted several causes of injuries and occupational groups at risk for injuries that could benefit from targeted interventions, aligning with findings from previous aviation safety research discussed in the introduction. Falls led to a substantial proportion of non-crash injuries during the study period, affecting all occupational groups. Prior research has been conducted to study fall hazards among aviation mechanics and evaluate the impact of safety culture and knowledge on compliance issues. Neitzel et al. (2008) performed site visits to two aircraft maintenance facilities. The researchers observed and recorded details of various working conditions to understand fall protection standards in place, including work at height, type of work, and equipment used to perform the work. Participants were recruited to complete a questionnaire regarding general knowledge and beliefs related to safety issues and safety culture. Differences in safety culture were found between the two sites; the site with a more advanced safety culture had fewer observed noncompliance issues with regard to fall hazards than the site with a less developed safety culture (Neitzel et al., 2008). The findings from that study suggest that there is a need to prioritize safety at work, particularly when workers are at risk for falls. Workers should be trained on the risks of working at height so they can accurately assess risks while performing various job tasks and determine what can be done to mitigate those risks.

Overexertion due to lifting, pulling, and similar activities contributed to a fair amount of injuries across many occupational groups, consistent with other studies (Griffiths & Powell, 2012; Kanumuri, Zautke, & Dorevitch, 2015; Korkmaz et al., 2006). In particular, workers who often handle baggage and cargo are exposed to ergonomic hazards, including lifting heavy items and repetitive motions, resulting in muscular sprains and strains. This includes pilots in smaller operations who load the aircraft with passenger luggage or cargo, stressing a need to consider human factors engineering solutions outside of traditional baggage and cargo handler roles in Alaska aviation operations.

The distribution of injuries suggested that aircraft mechanics, baggage and cargo handlers, and pilots were injured most frequently; however, rates for specific occupations were not calculated as SOC codes were missing in some cases, and the high number of SOC codes used meant that cases were widely distributed amongst them.

While there were year-to-year fluctuations in the number of hospitalized workers, no discernable trend was observed over the study period, and the count data over time were too low to conduct any statistical analysis for trend. The rate of nonfatal injuries in the air transportation industry during the study period was lower than that calculated by Husberg et al. (1998) (0.1 injuries per 100 workers vs. 0.19 injuries per 100 workers, respectively). Because the authors did not discuss aviation-related injuries in detail, it is unclear if this difference is due to a reduction in risk among all aviation workers, a reflection of the decrease in Alaskan aviation crashes, differences in case definition, or other reasons.

Similar in-depth studies on hospitalizing injuries in other high-risk industries in Alaska have been conducted using the ATR. During 1991—1999, the construction industry in Alaska had an average rate of 0.39 injuries per 100 workers. Similar to aviation, falls were a primary cause of injuries (Husberg, Fosbroke, Conway, & Mode, 2005). Conversely, logging in Alaska had a much higher average rate of 2.1 injuries per 100 workers during 1991—2014, with injuries most frequently caused by falling objects and cutting instruments (Springer, Lucas, Castrodale, & McLaughlin, 2017). Although aviation does not have the highest risk of hospitalizing injuries in Alaska, important hazards were identified that caused serious injuries and potential disability to these workers. By using these results, evidence-based, relevant injury prevention strategies can be implemented.

Based on the major findings of the study, primary prevention efforts to reduce aircraft crashes need to continue in Alaska. Secondary prevention strategies must also be developed. The most protective restraint systems should be installed and used by all flight crew and passengers on board. Further investigation into the specific types of restraint systems in place and used during all crash-related injuries is warranted. The use of helmets during off-airport operations (e.g., landing on gravel bars) may reduce the incidence of traumatic brain injury among crash victims.

For non-crash injuries, aviation companies should review their policies on fall protection when working at height. Companies should review and apply fall protection standards, such as those outlined by 29 CFR 1910 for general industry (Occupational Safety & Health Administration, n.d.-b). These standards describe specifications and practices for working with ladders, lifts, and other platforms. Precautionary systems (e.g., guardrails, safety nets) or personal fall arrest systems should be implemented when applicable. Specifically, harnesses should be used while working at height on aircraft to prevent injury from falls. In addition, as slips and trips on the ground contributed to fall-related injury, companies should be vigilant in identifying and resolving slip and trip hazards, including ice. To prevent falls on board the aircraft, cabin crew should be seated with restraints when not providing cabin service, particularly during rough air or forecast turbulence.

Employees should be trained on proper lifting techniques and ergonomic strategies to prevent overexertion injuries. OSHA provides potential solutions for overexertion injuries, specifically for baggage and cargo handlers (Occupational Safety & Health Administration, n.d.-a). OSHA recommends two-hand lifts and stretching exercises to prevent strains and other musculoskeletal injuries. Actual baggage weights should be listed for the safety of all handlers. For large or heavy baggage or other items, the assistance of a second handler would reduce the burden while lifting. In addition, vacuum lifting assisting devices and automatic baggage moving systems have been evaluated as potential interventions that may reduce risk of musculoskeletal disorders among baggage handlers (National Institute for Occupational Safety and Health, 2015b). Finding ergonomic solutions for workers who handle heavy baggage or other objects is necessary to prevent injuries.

The findings in the study can be used to educate companies and workers on the occupational safety issues in the industry and provide the foundation for the development of interventions or policy changes to address such issues and reduce the rate and number of injuries sustained by aviation workers. Collaboration and building partnerships with stakeholders, including aviation companies, safety organizations, and regulatory entities, is encouraged to generate injury prevention approaches. Additionally, since Alaska is located in the circumpolar north, these results may be applicable to aviation operations in other Arctic countries such as Canada, Russia, and in Scandinavia. While searches of the peer-reviewed literature on trauma registries and work-related injuries in other northern countries revealed little about aviation injuries in these areas (Dudarev, Karnachev, & Odland, 2013; Kristiansen et al., 2010; Koehoorn et al., 2015), some of the study findings (e.g., slips on ice) may be applicable to these locales or inspire similar research in the future.

Future research efforts should include an analysis of Workers' Compensation data to supplement these findings and describe injuries that did not result in hospitalization. Future research could also involve the collection of self-reported injury data from the industry via survey or interviews. By doing so, information on causal factors and job tasks performed could be identified to further understand the work-related hazards in the industry. Further,

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self-reported injury data could help resolve issues of underreporting that is known to occur with work-related injuries and illnesses (Rosenman et al., 2006). Because many aviation operations occur in rural locations throughout Alaska, future studies could assess associations between injury outcomes and time to treatment with the appropriate data. Lastly, when interventions are developed in the industry to prevent nonfatal injuries, future studies should include an evaluation of the interventions to determine temporal changes in injury rates and counts.

This study is among the first to describe nonfatal work-related injuries sustained among aviation workers in Alaska. The study was meant to be inclusive of the variety of workers that perform aviation-related duties that may not be identified as such using industry and occupation codes alone. It provides the foundation for injury prevention research in the aviation industry going forward. This type of examination is novel in Alaska's aviation industry and contributes important industry-wide results to aviation companies as they review their own injury logs and safety policies and procedures.

This study is subject to several limitations. The case definition included industries and occupations outside those defined by NAICS and SOC as air transportation related. For example, the NAICS code for air transportation is 481; support services for aviation, including air traffic control, fall under NAICS code 488 and therefore would not be included if using traditional surveillance methods. However, only cases that did fall in the air transportation industry were available for rate calculations due to low counts in other industries. Calculating these rates would be misleading and an underestimate; if only a small proportion of an industry contributes to aviation-related services, the respective denominator currently available (workers in the industry) would be disproportionately high due to the true number of workers involved in those services. Additionally, because the ATR only capture hospitalized injuries, the numbers and period rate calculation presented in this paper underestimate the true burden of nonfatal injuries. Cases may have been missed if they contained incorrect or incomplete information that resulted in their exclusion during the case identification process (e.g., not coded as work-related; lacked sufficient employment information). Further study is needed to determine the incidence of non-hospitalized injuries. Lastly, in the event of multiple injuries per patient, the most severe injuries were prioritized. Additional analyses could be conducted to include these injuries for further study.

Trauma registries are primarily used for internal quality improvement and care management (Chen & Warner, 2012). As such, they are limited in some aspects with regard to surveillance and epidemiology. Existing data, as discussed by Cheng and Phillips (2014), may not contain all the variables desired to answer research questions. In the ATR, information on causal factors, if captured at all, was limited to the narrative fields. Analysis of self-reported injury data or reviewing reports submitted to the Aviation Safety Action Program, the Federal Aviation Administration's Voluntary Disclosure Reporting Program, or companies' internal reporting systems may be better able to determine the circumstances around injuries and identify modifiable risk factors. Company-specific approaches, such as safety observations during normal operations or implementing a near-miss reporting system, may also be useful in understanding injury hazards.

5. Conclusions

Understanding occupational safety in Alaska is a public health priority, and addressing nonfatal injuries is a critical part of improving worker safety and health. Previously, the burden of nonfatal injuries in workers performing aviation-related duties was not reported in the scientific literature. To address this research gap, this study sought to characterize nonfatal injuries resulting in hospitalization of aviation workers in Alaska. It provides a descriptive analysis and baseline data on aviation worker injuries. From this, evidence-based recommendations can be derived to prevent further injuries. Analyzing data from the ATR over a 14-year period was an effective way to determine the frequency of such injuries. The findings revealed that injuries sustained by workers involved in an aircraft crash varied, but approximately one-third of those injured sustained traumatic brain injuries. Further, the study showed that aviation workers in Alaska face hazards on the job during ground operations that put them at risk for serious injuries. Specifically, falls and overexertion were the leading causes of work-related non-crash injuries resulting in hospitalization. Aviation mechanics sustained the highest number of non-crash injuries compared with other occupational groups. Efforts to prevent serious injuries from crashes and during ground operations need to be discussed and interventions developed by aviation stakeholders to ensure all personnel face minimal risks while working.

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Appendix A

Keywords and codes used for manual case review

Keywords

agent; air* (aircraft; airline; airplane; airport); attendant; aviation; bag* (bags; baggage); cabin; cargo; carrier; cockpit; flight; fly* (flying); fuel; gate; ground; handler; hangar; helicopter (also: helo, heli); jet; luggage; maintenance; mechanic; pilot; plane; ramp; stewardess

*searched for all words that began with the same letters

Industry Codes

Census: 290; 770; 2380; 3190; 3380; 3570; 3580; 3590; 4270; 4490; 4680; 6070; 6280; 6290; 7070; 7190; 7290; 7670; 7690; 7880; 8680; 8880; 9570

NAICS: 115; 115112; 23; 237310; 32621; 326211; 3332; 3334; 3339; 333924; 3345; 334519; 334511; 3361; 3362; 3363; 336360; 336411; 336412; 336413; 336414; 336415; 336419; 4238; 423860; 4247; 424720; 4412; 44122; 481; 487; 487990; 488; 4881; 531; 531190; 5324; 533; 532411; 5413; 541360; 541370; 5615; 561599; 5617; 561720; 6114; 6115; 611512; 722; 722310; 8114; 811420; 926; 926120; 927

Occupation Codes

Census: 290; 770; 2380; 3190; 3380; 3570; 3580; 3590; 4270; 4490; 4680; 6070; 6280; 6290; 7070; 7190; 7290; 7670; 7690; 7880; 8680; 8880; 9570

SOC: 43-4180; 43-4181; 43-5010; 43-5011; 49-2091; 49-3010; 49-3011; 49-9060; 49-9061; 51-2010; 51-2011; 51-2090; 51-2091; 51-6093; 51-9120; 51-9122; 53-1000; 53-1011; 53-2000; 53-2010; 53-2011; 53-2012; 53-2020; 53-2021; 53-2030; 53-2031; 53-6050; 53-6051; 53-6099; 53-7061; 53-7062; 55-1010; 55-1011; 55-1012; 55-2010; 55-2011; 55-2012; 55-3010; 55-3011; 55-3012

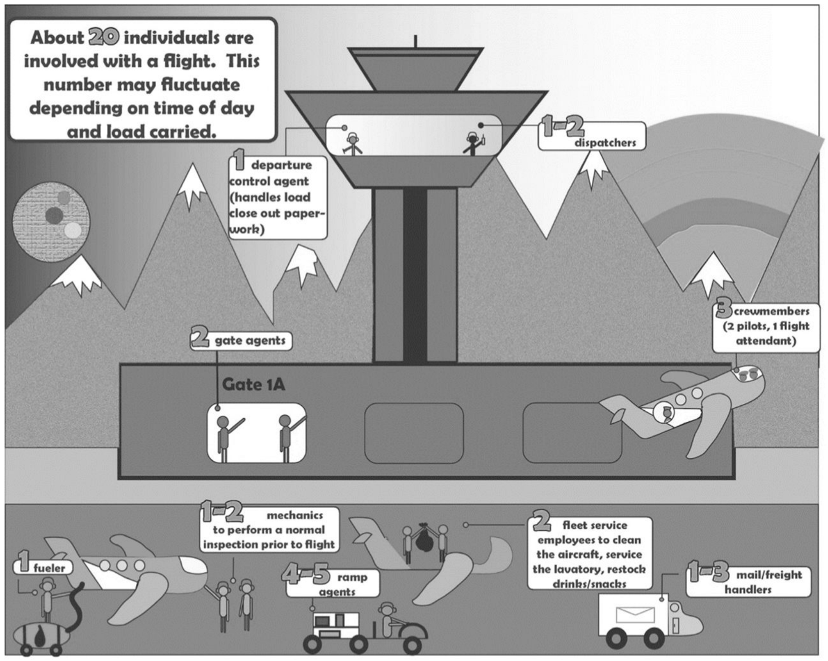

Fig. 1.

Workers involved in the departure of a flight. This illustration is based on information provided by the director of operations of a regional airline operating 37-seat turbo prop aircraft (O'Connor, 2015).

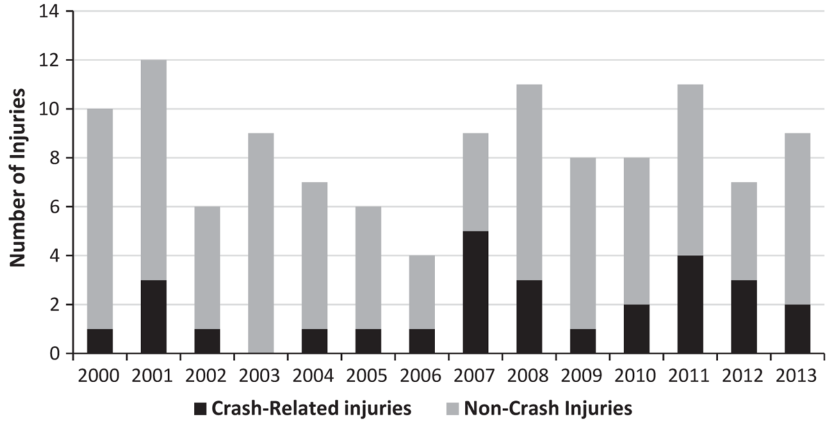

Fig. 2.

Aviation industry nonfatal work-related injuries requiring hospitalization by crash relatedness and year, Alaska, 2000–2013 (n=117).

Table 1

Aviation industry nonfatal work-related injuries requiring hospitalization by crash relatedness and occupational group, Alaska, 2000–2013 (n=117).

	Crash-Related Injuries (n=28)		Non-Crash Injuries (n=89)		Total (n=117)	
Occupation	**n**	**%[a]**	**n**	**%[a]**	**n**	**%[a]**
Pilot	25	89	15	18	40	36
Aircraft Mechanic	0	0	19	23	19	17
Cargo/Baggage Handler	1	4	17	21	18	16
Ramp Agent	0	0	13	16	13	12
Other[b]	2	7	18	22	20	18
Unknown	0	-	7	-	7	-

[a]Denominators for percent calculations excluded cases with missing data.

[b]Includes categories with <5 cases.

Table 2

Injury severity and mechanism of injury of nonfatal work-related injuries requiring hospitalization resulting from non-crash events in the Alaska aviation industry, 2000–2013 (n=89).

Mechanism of Injury	Minor	Moderate	Serious	Severe	Critical	Missing	Total
Fall	8	22	15	2	0	0	47
Overexertion	8	3	0	0	0	0	11
Struck by/against object	1	5	1	0	0	1	8
Caught in/between objects	2	4	1	1	0	0	8
Machinery	0	2	1	1	0	0	4
Aircraft accident (non-crash)	1	1	0	0	0	0	2
Poisoning	0	0	0	0	0	2	2
Fire/Explosion	0	1	1	0	0	0	2
Cut/Pierce	1	1	0	0	0	0	2
Collision	0	0	0	0	1	0	1
Electricity	0	0	0	0	0	1	1
Other	1	0	0	0	0	0	1
Total	22	39	19	4	1	4	89

Table 3

Circumstances of falls for nonfatal work-related injuries requiring hospitalization resulting from non- crash events in the Alaska aviation industry, 2000–2013.

Circumstance	Number of Injuries
Fall from aircraft	17
Slip on ice	11
Fall from ladder	3
Fall on aircraft	2
Fall from stairs	2
Fall from machinery	1
Other slip/fall	11
Total	47