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Fall-related emergency department visits involving alcohol among older adults☆

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Abstract

Problem: Falls are the leading cause of injury deaths among adults aged 65 years and older. Characteristics of these falls may vary with alcohol use.

Objective: Describe and compare characteristics of older adult fall-related emergency department (ED) visits with indication of alcohol to visits with no indication.

Methods: Using nationally-representative 2015 National Electronic Injury Surveillance System-All Injury Program data, we compared demographic characteristics for fall-related ED visits by indication of alcohol consumption. Alcohol-indicated ED visits were matched on age group, sex,

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Declaration of interest
None.

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treatment month, and treatment day to ED visits with no alcohol indication using a 1:4 ratio and injury characteristics (i.e., diagnosis, body part injured, disposition) were compared.

Results and discussion: Of 38,640 ED records, 906 (1.9%) indicated use of alcohol. Fall-related ED visits among women were less likely to indicate alcohol (1.0%) compared to ED visits among men (3.8%). ED visits indicating alcohol decreased with age from 4.1% for those 65–74 years to 1.5% for those 75–84 and <1% for those 85+. After controlling for age-group, sex, and month and day of treatment, 17.0% of ED visits with no alcohol indication had a traumatic brain injury compared to 34.8% of alcohol-indicated ED visits.

Practical applications: Alcohol-indicated fall ED visits resulted in more severe head injury than those that did not indicate alcohol. To determine whether alcohol use should be part of clinical risk assessment for older adult falls, more routinely collected data and detailed information on the amount of alcohol consumed at the time of the fall are needed.

Keywords

Aged; Accidental falls; Alcohol drinking; Wounds and injuries; Emergency service; Hospital

1. Introduction

Unintentional falls among older adults, aged 65 years and older, are a significant public health issue. In the United States, falls result in over 32,000 deaths, three million emergency department (ED) visits, and more than 950,000 hospitalizations per year (Centers for Disease Control and Prevention, 2020), and cost $50 billion in annual healthcare expenses (Florence et al., 2018).

Alcohol use among older adults has increased over time (Glover & Gold, 2017; Moos, Schutte, Brennan, & Moos, 2009). Given how alcohol is absorbed and metabolized in the body, alcohol use could be an especially important risk factor for older adult falls and severe fall injury. Aging is associated with physiological changes including decreased renal function, less efficient enzymatic activity, and low body water volume (Heuberger, 2009). Because of these changes, older adults metabolize and eliminate alcohol at slower rates, leading to a higher concentration of alcohol in the blood than a similar amount would yield among younger adults (Barry & Blow, 2016; National Institute on Alcohol Abuse and Alcoholism, 2020). Alcohol also impairs gait and balance (Sullivan, Rosenbloom, Deshmukh, Desmond, & Pfefferbaum, 1995), reduces cognitive function (Sullivan et al., 1995), and can interact with certain medications exacerbating drowsiness and unsteadiness (Holton, Gallagher, Fahey, & Cousins, 2017; Moore, Whiteman, & Ward, 2007), all of which are risk factors for a fall (Ambrose, Paul, & Hausdorff, 2013).

The association between alcohol use and falls among older adults remain unclear. Most studies examined average alcohol consumption (e.g., drinks per day, drinks per week) rather than alcohol consumption at the time of the fall (Bergen, Stevens, Kakara, & Burns, 2019; Cawthon et al., 2006; Chang & Do, 2015; Grundstrom, Guse, & Layde, 2012; Mukamal et al., 2004; Reid, Boutros, O'Connor, Cadariu, & Concato, 2002; Tait, French, Burns, Byles, & Anstey, 2013), which makes it difficult to determine if alcohol is a risk factor for falls.

Methodological differences among studies also make it challenging to draw sound conclusions. For example, one study used both cross-sectional and longitudinal analyses and found conflicting findings (Mukamal et al., 2004). In the longitudinal analysis, consumers of 14 or more drinks per week had a significantly higher fall risk, whereas the same group of drinkers had the lowest fall risk in the cross-sectional analysis. Several analyses that studied alcohol consumption 6 hours prior to an injury showed that risk of fall injury increased with increasing alcohol use (Cherpitel, Ye, Bond, Borges, & Monteiro, 2015; Taylor et al., 2010). However, these analyses were not focused on adults aged 65 and over.

Studies on fall-related injuries have found that compared to sober patients, alcohol-intoxicated patients suffer more injuries to the head (Chatha, Sammy, Hickey, Sattout, & Hollingsworth, 2018; Johnston & McGovern, 2004; Woods, Jones, & Usher, 2019). However, these studies also included younger persons (<65 years) and broader age groups (>12 years). The relationship between alcohol use at the time of the fall and severity of fall injuries may differ in older adults compared to younger persons. To our knowledge, there are no studies showing the relationship of alcohol use at the time of the fall with severity or other characteristics of older adult fall injuries.

Understanding the impact of alcohol on severity of fall injury, among older adults, may be used to inform injury prevention and management, and to put alcohol-related prevention efforts, such as alcohol screening, in place. This study's objective is to explore the demographic and injury characteristics of older adults with ED records indicating alcohol use when being treated for fall injuries. The study also compares injury characteristics between fall-related ED visits with indication of alcohol use to visits with no indication.

2. Methods

2.1. Data source

Data from the 2015 National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP) were used to determine the characteristics of fall injuries treated in EDs by indication for acute alcohol consumption. NEISS-AIP is operated by the U.S. Consumer Product Safety Commission and the Centers for Disease Control and Prevention (CDC). NEISS is comprised of a nationally representative sample of 100 hospitals with EDs selected based on size, population served (adult vs. child), and geographic location. NEISS-AIP collects injury data from a subsample of 66 out of the 100 NEISS hospital EDs, and provides information such as consumer product involvement, injury diagnosis, disposition, and a brief narrative describing the injury circumstance (U.S. Consumer Product Safety Commission, 2001).

3. Fall ED cases with indication of alcohol use

The NEISS-AIP dataset contained 38,654 records of nonfatal older adult fall-related injuries treated in EDs. To identify alcohol-indicated fall ED visits, we read and coded all 38,654 text narratives for any mention of alcohol. A fall ED visit was considered to "indicate alcohol use" if terms such as alcohol, drinking, blood alcohol concentration or BAC, ethanol or ETOH, intoxication, alcohol on breath or AOB, binge, or any types of alcoholic beverage

were mentioned. Four researchers coded the narratives. For consistency, 10% of each coder's narratives were verified, and discrepancies resolved with consensus from all four researchers (codebook in Appendix A). Previously coded narratives were recoded based on updates made to the codebook. NEISS-AIP assigns up to two product codes per case. We searched for product code 1903, alcoholic beverage, to verify alcohol involvement. When the product code and the narratives conflicted ($n = 83$), we used the narratives to determine whether a case indicated alcohol use.

4. Other analysis variables

As part of a larger study, the text narratives were also used to create new variables for residential status, and primary body part injured (Appendix A). Residential status was coded as community dwelling, residential facility, or in prison. Primary body part injured included the following categories: head, face, upper extremity, lower extremity, upper trunk, hip and pelvis, back and spine, and unknown body part. These categories were based on a modified Barell Matrix, which classifies injury by body region (Barell et al., 2002), and provided more descriptive categories than coded in NEISS-AIP (Appendix A).

We also recategorized the following NEISS-AIP variables: diagnosis, disposition, treatment month of year, and treatment day of week. The diagnosis variable included only the principal injury diagnosis, which was regrouped based on the modified Barell Matrix (Barell et al., 2002), as internal injury (including concussion), flesh wound injury (laceration, puncture wound, avulsion), superficial injury (contusion, abrasion, hematoma), fracture/dislocation, and other (e.g., strain/sprain, burn, amputation, foreign body, nerve damage, dental injury). Disposition categories were regrouped as treated/released, hospitalized/transferred, and other (observation only, left against medical advice, and unspecified). Treatment month of year was grouped into quarters and treatment day of week (Mon-Sun) was dichotomized into treatment day (weekday, weekend). Weekday was defined as occurring on Monday to Friday and weekend as occurring on Saturday or Sunday. Age group consisted of three categories: 65–74, 75–84, and 85+.

We designated traumatic brain injuries (TBIs) and hip and pelvic fractures as serious injuries because falls are the leading cause of both TBIs and hip fractures among older adults (Parkkari et al., 1999; Taylor, Bell, Breiding, & Xu, 2017). A case was considered to be a TBI if the primary body part affected was the head and the principal injury diagnosis was internal injury or concussion (Sarmiento et al., 2019). A case was considered a hip and pelvic fracture when the primary body part affected was the hip or pelvis and the principal injury diagnosis was a fracture or dislocation.

5. Analysis

Analysis excluded cases in prison ($n = 9$), and cases where we were uncertain about alcohol involvement because the product codes and narratives conflicted ($n = 5$). This resulted in a final sample of 38,640 observations, which represents an estimated 3,036,479 ED visits. Frequencies, percentages, and 95% confidence intervals (CIs) were computed for demographic characteristics by alcohol consumption. All percentages and CIs were

weighted, and non-overlapping CIs were used to determine statistical significance. A linear trend test was conducted by modeling age group as a continuous variable in a logistic regression model.

To investigate injury characteristics by alcohol consumption, each alcohol-indicated fall ED visit was matched with four ED visits that did not indicate alcohol (controls). Four was the maximum number of controls available for all cases. Controls were randomly matched on age group, sex, treatment month of year, and treatment day of week (Mon-Sun) to make the two groups as similar as possible. Codes for matching were adapted from Mortensen (Mortensen, Andresen, Burcharth, Pommergaard, & Rosenberg, 2019). Weighted percentages and CIs were calculated to compare injury diagnosis, serious injuries, primary body part affected due to the injury, and disposition. All analyses were performed using SAS 9.4.

6. Results

Of the 38,640 fall-related ED visits, 906 (1.9%; CI: 1.8, 2.1) of the ED visits indicated alcohol use, representing an estimated 59,077 ED visits. Fall-related ED visits among women were less likely to indicate alcohol (1.0%; CI: 0.8, 1.1) compared to ED visits among men (3.8%; CI: 3.4, 4.2) (Table 1). ED visits indicating alcohol use decreased significantly ($p < 0.001$) with advancing age from 4.1% for those 65–74 years to 1.5% for those 75–84 and <1% for those 85+. A higher percentage of weekend visits (2.4%; CI: 2.1, 2.8) indicated alcohol use compared to weekday visits (1.7%; CI: 1.6, 1.9).

When comparing older adults of the same sex, age group, and treatment month and day, the percent of alcohol-indicated fall visits with a head injury was 50.2% (CI: 45.9, 54.5), compared to 24.5% (CI: 22.8, 26.3) for visits that did not indicate alcohol use (Fig. 1). Facial injuries were also more common for alcohol-indicated fall visits (20.2%; CI: 16.7, 23.7) compared to visits with no alcohol indication (12.5%; CI: 11.1, 13.9). Fall visits with no alcohol indication included more injuries to the upper (19.1%; CI: 17.5, 20.7) and lower extremities (16.2%; CI: 14.6, 17.7) compared to alcohol-indicated visits (11.7%; CI: 9.0, 14.3, & 5.8%; CI: 3.8, 7.8, respectively).

Injury diagnoses for alcohol-indicated fall visits compared with visits that did not indicate alcohol use were more likely to be for internal injury (35.0% vs 17.3%) or flesh wound (22.1% vs 13.8%), and less likely to be fracture/dislocation (18.0% vs 31.9%) (Table 2). Alcohol-indicated fall visits were more likely to have a diagnosis for a TBI (34.8%; CI: 30.7, 38.9) compared to fall visits with no alcohol indication (17.0%; CI: 15.4, 18.5). Fall ED visits with no indication of alcohol use were more likely to have diagnoses for hip and pelvic fractures (7.6%; CI: 6.4, 8.7) than alcohol-indicated fall visits (2.8%; CI: 1.3, 4.3). Furthermore, 31.9% of ED cases indicating alcohol were hospitalized compared to 25.8% of cases that did not indicate alcohol.

7. Discussion

Our study used nationally-representative ED data to compare older adult fall injury visits by indication of alcohol consumption. Fall-related ED visits among older men were more likely

to indicate alcohol use than ED visits among older women. The percent of fall-related ED visits indicating alcohol decreased with increasing age group. Older men are more likely than older women to have three or more drinks per day and, for both sexes, such drinking pattern decreased with increasing age (Moos, Schutte, Brannan, & Moos, 2009).

Due to lower tolerance and higher sensitivity to alcohol, older adults can experience more pronounced effects from alcohol than younger adults (Barry & Blow, 2016; National Institute on Alcohol Abuse and Alcoholism, 2020). Moreover, alcohol use among older adults is increasing, and at levels exceeding the recommended limits (Glover & Gold, 2017; Moos et al., 2009). Adults of legal drinking age are recommended to limit drinks to one per day for women and up to two drinks per day for men (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). A study of Medicare beneficiaries showed that 9% of older adults consumed more than 30 drinks per month or more than three drinks in a day, increasing their risk of alcohol-related harms (Merrick et al., 2008). Among binge drinkers, older adults tended to binge drink more frequently than younger adults (Kanny, Naimi, Liu, Lu, & Brewer, 2018). Using the Nationwide Emergency Department Sample, White et al. found that the rate of ED visits, between 2006 and 2014, for acute and chronic alcohol consumption increased for those aged 65 and above (White, Slater, Ng, Hingson, & Breslow, 2018). The same study also reported adults aged 65 and over as having the second highest rate of chronic alcohol-related ED visits compared with all other age groups.

For alcohol-indicated fall ED visits, more than two-thirds of injuries were to the head and face, as compared to visits with no alcohol indication where only about a third of injuries were to the head and face, a finding consistent with previous studies (Chatha et al., 2018; Johnston & McGovern, 2004; Woods et al., 2019; Yoonhee et al., 2009). An older adult under the influence of alcohol might have reduced self-protective reflexes, which means they may not break the fall with their upper extremities, potentially making them more likely to have face and head injuries (Johnston & McGovern, 2004; Woods et al., 2019). With advancing age, older adults are at an increased risk of subdural hematoma, which increases risk of sustaining a TBI when they fall and hit their head (Karibe et al., 2017). TBIs often result in high mortality and morbidity in older adults (Peterson & Kegler, 2020; Taylor et al., 2017). Alcohol-indicated fall visits showing more TBI cases calls for proactive efforts to better understand the link between alcohol and falls.

We found that hip fractures were less likely among alcohol-indicated fall ED visits than visits with no indication of alcohol. This could simply be because people under the influence of alcohol fell landing on the head as described above and therefore those falls did not impact the hip region. Another reason could be related to the relationship between alcohol consumption and hip fracture risk. A recent meta-analysis reported that light alcohol consumption reduces the risk for hip fracture, while heavy alcohol consumption increases the hip fracture risk (Zhang, Yu, Yu, & Qu, 2015). Our study does not have information on the amount and frequency of alcohol consumed to validate these findings. A key point is that there is not sufficient evidence regarding alcohol's effect on fall-related injuries to fully understand the relationship.

The majority of studies on older adult falls and alcohol do not measure alcohol consumption prior to the fall but instead use self-reported alcohol consumption patterns (Bergen et al., 2019; Cawthon et al., 2006; Chang & Do, 2015; Grundstrom et al., 2012; Mukamal et al., 2004; Tait et al., 2013), making it difficult to support a direct relationship. The current study used narratives and codes on the ED record to identify fall injuries that were related to alcohol consumption when the fall occurred. This study identified about 2% of older adult falls as being related to alcohol consumption, Analyses may underestimate the role of alcohol in fall-related ED visits among older adults because alcohol use in relation to injury deaths is historically underreported (Castle, Yi, Hingson, & White, 2014; Smith, Branas, & Miller, 1999) and is possibly not assessed in ED visits, as most EDs do not screen all patients for alcohol consumption (Cunningham et al., 2010). Previous studies that used ED records to analyze the characteristics and outcomes of falls among older adults found a higher percent of records (11% and 20%) indicated alcohol use compared to the current study (Bell, Talbot-Stern, & Hennessy, 2000; Paniagua, Malphurs, & Phelan, 2006). These studies were conducted in one ED setting each and had smaller sample sizes.

Our study has at least six limitations. First, we used the NEISS-AIP text narratives and product codes to identify alcohol-indicated fall ED visits. These methods might not have captured all falls related to alcohol because: (a) EDs do not routinely screen patients for alcohol use on admission; (b) ED staff might not have time to test or ask about alcohol while treating serious cases; (c) patients might not reveal their alcohol use; (d) NEISS-AIP does not capture the amount of alcohol consumed; and (e) there might be a lag time between when the injury occurred and the ED visit. Second, alcohol was likely tested and recorded only for cases with noticeable evidence of intoxication, such as smell of alcohol. An undercount of ED visits related to alcohol use means that the relationship of alcohol to serious injury might have been biased the results away from the null. Third, we included all narratives that mentioned alcohol, but do not know if alcohol was a contributing cause of the injury event. Fourth, because the 2015 NEISS-AIP recorded only the principal diagnosis and we recorded only the primary body part affected, other injuries associated with alcohol-related cases were likely missed. This may have led to an underestimation of injuries, such as TBIs, if those were listed as secondary diagnoses for ED visits. Moreover, our definition might have missed cases of TBI that were classified as fracture of the head, which would be diagnosed as fracture under NEISS-AIP's general diagnosis coding scheme. Fifth, there might be other underlying characteristics such as chronic comorbidities that we did not match on that might explain the differences between cases and controls. Finally, these are cases of older adult falls that resulted in an ED visit. We do not know about cases that did not report to an ED following an alcohol-related fall.

Each year, three million older adults are treated in an ED for fall injuries (Centers for Disease Control and Prevention, 2020). The fall injuries that indicated alcohol resulted in more severe head injury than those that did not. Our limited understanding of the relationship between alcohol and older adult falls restricts fall prevention efforts. CDC's Stopping Elderly Accidents, Deaths, and Injuries (STEADI) initiative, designed to help healthcare providers practice older adult fall prevention, does not include alcohol as a risk factor due to the limited evidence (Centers for Disease Control and Prevention, 2019). Information on the amount of alcohol consumed prior to a fall could define the role of

alcohol as a risk factor for falls and related injuries, and determine whether alcohol use should be a part of clinical risk assessment for older adult falls.

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Appendix A.: Codebook for NEISS-AIP narratives

Alcohol use (2 options):

- Indication of alcohol use: if narrative includes terms such as alcohol, drinking, blood alcohol concentration or BAC, ethanol or ETOH, intoxication, alcohol on breath or AOB, binge, or any type of alcoholic beverages.
- No indication of alcohol use: if narrative does not include any terms that could associate with alcohol consumption (examples above).

Residential status (3 options):

- Community: if narrative does not specifically mention nursing home or prison. Code adult day care, senior center, and if visiting family member in a nursing home as community.
- Residential facility: if narrative includes nursing home, skilled nursing facility, extended care facility, long-term care, assisted living, hospice, rehab, detox, Alzheimer's unit, convalescent home, and group home.
- Prison: if narrative includes jail, prison, or corrections facility.

Primary body part injured (8 options):

- Head: if narrative includes head, skull, occipital or scalp for body part injured, or specifies concussion, cerebral injury, closed head injury, subdural hematoma, or intracranial or subarachnoid hemorrhage.
- Face: if narrative includes other parts of the head and face including eye, ear, face, nose, teeth, mouth, chin.
- Upper extremity: if narrative includes shoulder, rotator cuff injury, clavicle injury, upper arm, lower arm, elbow, wrist, hand, fingers.
- Lower extremity: if narrative includes injury to upper leg, thigh, knee, lower leg, ankle, foot, toes.
- Upper trunk: if narrative includes abdomen, chest, trunk, lower trunk with no specific mention of hip/pelvis/back.

- Hip and pelvis: if narrative specifies hip injury, femoral neck injury, injury to pelvis, pubic region, urogenital injuries, buttocks, ischium, sacrum, or coccyx.
- Back and spine: if narrative includes back, lower back, neck (cervical spine), and spinal injuries including thoracic, lumbar, spinal cord injuries or vertebral column injuries.
- Unknown: for narratives that do not sufficiently describe body part injured or in cases of multiple injury sites when unable to identify which is most severe.

  Note: For narratives that contain multiple injury sites, we coded for the most severe injury type.
- If the narrative contained both rib fracture and spine fracture, spine fracture was considered most severe.
- If the narrative contained both hip and spine fractures, spine fracture was considered most severe.
- If the injury reported included a complex fracture to a body part and a simple fracture to another body part, the complex fracture location was considered most severe.

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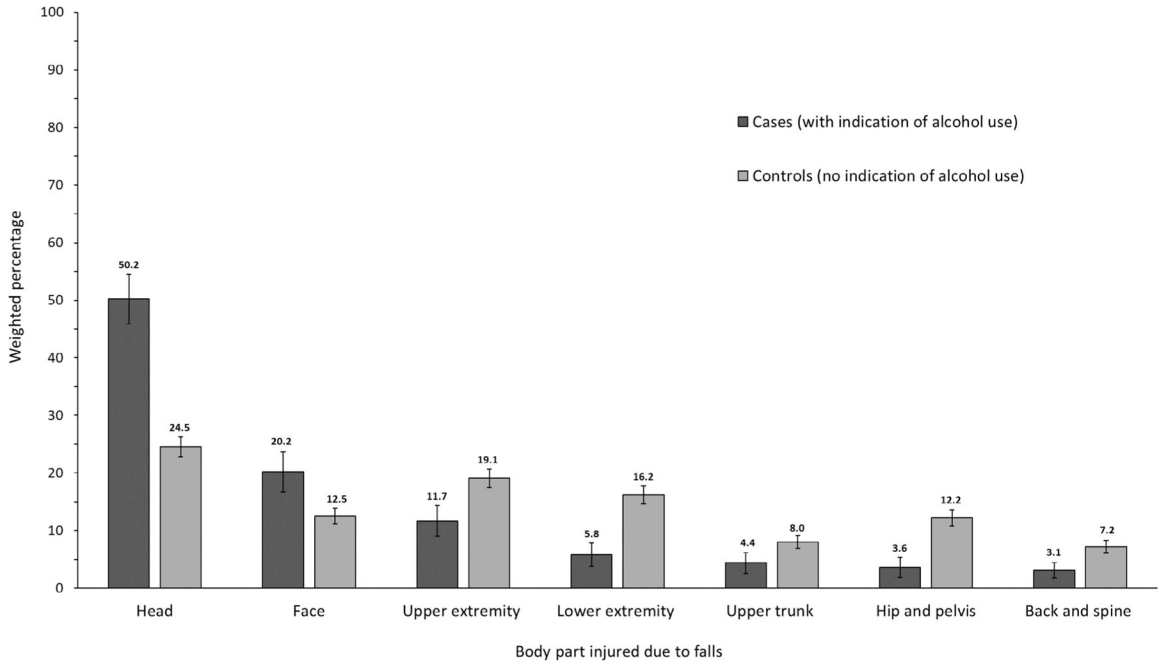

Fig. 1.

Primary body part injured for older adult fall emergency department visits by whether alcohol consumption was indicated, National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP), 2015. Error bars show 95% confidence intervals. Cases and controls matched on age group, sex, treatment month of year, and treatment day of week (Monday-Sunday) (ratio = 1:4). Data for unknown body part not shown due to unstable estimates. Refer to Appendix A for definitions of body part included in Fig. 1.

Table 1

Characteristics of adults aged ≥65 years treated in an emergency department (ED) for falls by alcohol use indication, National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP), United States, 2015.

Characteristics	Fall ED visits with indication of alcohol use			Fall ED visits with no indication of alcohol use		
	n[1]	%*	95% CI	n[1]	%*	95% CI
Total	906	1.9	1.8, 2.1	37,734	98.1	97.9, 98.2
Sex						
Women	271	1.0	0.8, 1.1	25,019	99.0	98.9, 99.2
Men	635	3.8	3.4, 4.2	12,715	96.2	95.8, 96.6
Age group						
65–74	642	4.1	3.7, 4.5	12,476	95.9	95.5, 96.3
75–84	216	1.5	1.2, 1.7	12,682	98.5	98.3, 98.8
85+	48	0.3	0.2, 0.4	12,576	99.7	99.6, 99.8
Treatment month						
Jan, Feb, Mar	228	1.9	1.6, 2.2	10,154	98.1	97.8, 98.4
Apr, May, Jun	229	1.9	1.6, 2.3	9341	98.1	97.7, 98.4
Jul, Aug, Sep	231	2.1	1.7, 2.4	9354	98.0	97.6, 98.3
Oct, Nov, Dec	218	1.9	1.6, 2.2	8885	98.1	97.8, 98.4
Treatment day^						
Weekend	306	2.4	2.1, 2.8	10,550	97.6	97.2, 97.9
Weekday	600	1.7	1.6, 1.9	27,184	98.3	98.1, 98.4

Abbreviation: CI = confidence interval.

[1] Unweighted number.

* Weighted percent.

^ Weekend (Saturday, Sunday), Weekday (Monday-Friday).

Table 2

Injury severity of adults aged ≥65 years treated in an emergency department for falls indicating alcohol use (cases) compared to matched controls not indicating alcohol use, National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP), 2015.

Injury characteristics	Cases with indication of alcohol use (*n* = 906)			Controls with no indication of alcohol use (*n* = 3624)[2]		
	n[1]	%*	95% CI	n[1]	%*	95% CI
Injury diagnosis[3]						
Internal injury	327	35.0	30.9, 39.1	695	17.3	15.8, 18.8
Flesh wound injury	181	22.1	18.4, 25.8	478	13.8	12.4, 15.2
Superficial injury	172	21.5	17.9, 25.0	852	25.1	23.3, 26.9
Fracture/dislocation	193	18.0	14.9, 21.2	1175	31.9	30.0, 33.9
Other	33	3.5	1.8, 5.1	424	11.9	10.6, 13.3
Serious injuries						
Traumatic brain injury	325	34.8	30.7, 38.9	681	17.0	15.4, 18.5
Hip and pelvic fracture	27	2.8	1.3, 4.3	263	7.6	6.4, 8.7
Disposition						
Treated/released	526	61.7	57.6, 65.8	2559	72.8	71.0, 74.6
Transferred/hospitalized	325	31.9	27.9, 35.8	1007	25.8	24.0, 27.6
Other	55	6.5	4.6, 8.3	58	1.4	0.9, 1.9

Abbreviation: CI = confidence interval.

[1] Unweighted number.

[*] Weighted percent.

[2] Matched on age group, sex, treatment month of year, and treatment day of week (Monday-Sunday) (ratio = 1:4).

[3] Injury diagnosis defined as (1) internal injury (including concussion); (2) flesh wound injury (including laceration, puncture wound, and avulsion); (3) superficial injury (including contusion, abrasion, hematoma); (4) fracture/dislocation; (5) other (e.g., strain/sprain, burn, amputation, foreign body, nerve damage, dental injury).