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Relationship of Ethanol, Cannabinoids, Benzodiazepines, and Opioids to Serious Injuries from Falls in Adults Aged 55 and Older

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AI Declaration

We did not use generative AI in the writing of this manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Abstract

Background: Falls among adults aged 55 and older lead to significant morbidity and mortality. The contribution of alcohol and other sedating drugs (including benzodiazepines, cannabinoids, opioids, and ethanol) is difficult to quantitate in acute care environments due to inconsistent clinical practice.

Objectives: This goal of this study was to assess the effect of recent substance use on adverse clinical outcomes among adults aged 55+ undergoing trauma evaluation after a fall.

Methods: We conducted a retrospective observational study of adults (55+) evaluated at a Level 1 trauma center from May 2020 to July 2021. We paired archival data from the study site's trauma registry and electronic health records (EHR) to toxicological analyses of each cohort member's bio-banked blood sample for ethanol, benzodiazepines, cannabinoids, and opioids. Regression models were used to analyze the relationship between substance use and adverse outcomes, adjusting for injury severity score (ISS).

Results: Among 274 adults aged 55+, detection rates were 21.2% for opioids, 18.6% for ethanol, 13.9% for ben zodiazepines, and 9.1% for cannabinoids. Injuries identified included 16.4% spinal fractures, 9.5% extremity fractures, 7.7% hip/thigh/pelvic fractures. Intracranial hemorrhages were more likely if the patient had been recently taking a benzodiazepine (aOR = 3.92), while extremity fractures were more common with opioid use (aOR = 7.67). No associations were found for spinal fractures, hip/thigh/pelvis fractures, or death.

Conclusion: In this study, nearly 20% of adults 55+ presenting for fall-related trauma recently used substances that impair psychomotor function. Screening for substance use in routine clinical care may reduce severity of fall-related injuries.

Keywords

Substance use; Older adults; Geriatrics; Falls; Alcohol use

Introduction

Unintentional falls impose a substantial healthcare burden with approximately three million older adults (ages 65 and older) treated in an emergency department (ED) and one million hospitalized due to a fall each year (1). Falls among older adults are a leading cause of mortality in the United States; in 2023, falls resulted in about 41,000 deaths among older adults (1). One-year mortality after ED presentation for patients above age 65 exceeds 15% (2,3). While older adults are generally at highest risk of fall related injuries and death, falls among adults aged 55–64 are also common and resulted in one million ED visits, and over 200,000 hospitalizations in 2022, with 3000 deaths in 2023 (1).

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Numerous factors are associated with increased risk of falls or adverse outcomes from a fall in the aging population including frailty, comorbid illness, and medication use (4–6). Several medication classes are associated with an increased risk of falls, particularly among older adults, due to side effects such as sedation, confusion or impaired balance (7). These include psychotropic medications (e.g., benzodiazepines, antidepressants, antipsychotics) that impact cognition, antihypertensive and cardiac medications that may lead to orthostatic hypotension, and analgesics (e.g., opioids, non-steroidal anti-inflammatory drugs) which can contribute to drowsiness and dizziness (8–10). Experts have indicated the need to differentiate agents in their contributions to fall-related injuries and deaths (10,11). Multiple studies characterize broad efforts at deprescribing fall-risk increasing medications (12–14). In these interventions, the focus is often on prescribed medications without universal emphasis on alcohol or cannabis use despite increasing prevalence of use among older adults (15,16).

For our study, we focus on benzodiazepines, cannabinoids, opioids, and ethanol as these substances can contribute to fall risk by impairing balance and cognition (17,18). To date, the role of these substances in contributing to morbidity and mortality from falls among adults aged 55+ adults remains under-researched. Patients presenting to the ED do not routinely undergo testing for alcohol or drugs and may not be forthcoming about substance use due to fear of stigma (19).

We aimed to examine the contribution of these substances to adverse fall outcomes among adults aged 55 and older who underwent a trauma team evaluation after a fall. To address gaps in prior research and obtain systematic information on substance use across patients, we used comprehensive data collection methods, including medical record review and toxicology screenings, to assess the type and impact of substance use on fall-related injuries. The findings from this investigation may help guide decision-making on the evaluation, treatment, and disposition from the ED for adults aged 55–64 and older adults (65 +) who sustained a fall and were recently using these substances. This information can be useful for guiding future injury prevention initiatives.

Methods

Study Design and Setting

This investigation was a retrospective, observational, longitudinal study of a cohort of adults aged (55+) who underwent a trauma team evaluation in a Level 1 Trauma Center after a fall from May 2020 to July 2021. Cohort members were followed from their initial emergency medical services (EMS) evaluation (when applicable) through discharge from the ED, transfer to another facility, or during their hospitalization from the index ED visit. The investigation involved a combination of data downloaded from a trauma registry and electronic health records (EHR) and toxicological analyses of individual blood samples that had been collected as part of a prior study (20). The study was approved by the Advarra Institutional Review Board (IRB) (#00022129; central IRB) and the study site’s IRB.

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Trauma Registry and EHR Data

Injury Severity Scores (ISS) were obtained from the study site's trauma registry. ISS ranges from 0 to 75. Zero reflects no apparent injury, and 75 reflects a fatal injury. If an encounter was not entered into this repository, a manual chart review and ISS calculation were conducted by one of the study physicians, who is board-certified in trauma and critical care. Study data abstracted from the EHR included patient demographic characteristics (sex, race, ethnicity), medical history, pertinent timestamps (ED triage, admission, discharge), home medications, initial ED laboratory test results, and final disposition (admission, discharge, transfer, etc.). In addition, trained study staff conducted manual EHR abstraction for the administration of benzodiazepines and opioids in the hospital and pre-hospital settings (via EMS ambulance run reports).

Toxicology Data

Blood specimens from each cohort member's initial sampling upon ED arrival were bio-banked and stored refrigerated before being frozen at −80 °C. All samples were analyzed for ethanol, cannabinoids, benzodiazepines, and opioids (illicit and prescription) at the Center for Forensic Science Research and Education (Willow Grove, PA). Benzodiazepines and opioids restricted to medical settings and unlikely to be obtained by patients elsewhere (e.g., midazolam, etc.) were not included in subsequent analyses examining the contribution of benzodiazepines and opioids to fall-related outcomes.

Blood ethanol concentrations were acquired via gas chromatography flame ionization detection (GC-FID). Comprehensive toxicological analysis was conducted for >1200 drug targets, and qualitative drug results for benzodiazepines, cannabinoids, and opioids were acquired via liquid chromatography quadrupole time-of-flight mass spectrometry (LC-QTOF-MS; see Supplementary Material for list). Cannabinoid testing included, but was not limited to, assessing for the presence of delta-9 tetrahydrocannabinol (THC) and metabolites (11-hydroxy-delta-9 tetrahydrocannabinol and 11-nor-9-carboxy-delta-9 tetrahydrocannabinol). Benzodiazepine testing included, but was not limited to, evaluating for the presence of diazepam, alprazolam, lorazepam, and clonazepam, in addition to their metabolites (e.g., nordiazepam, alpha-hydroxy alprazolam, 7-amino clonazepam). Opioid testing included, but was not limited to, assessing for the presence of tramadol, fentanyl, hydrocodone, dihydrocodeine, oxycodone, morphine, codeine, methadone, beta-h-fentanyl, and 4-anilino-N-phenethyl-piperidine (4-ANPP), among appropriate metabolites (e.g., norfentanyl, noroxycodone, etc.).

Propensity Score Analysis

Numerous factors contribute to falls and fall-related adverse clinical outcomes (21). Many factors are not obtainable (e.g., walking on a slippery floor, transient vertigo, etc.) from the data sources available to this retrospective study or are not known (e.g., frailty, imbalance, etc.) about cohort members. Previous researchers have compiled factors associated with either risk for falls or adverse fall-related clinical outcomes among adults aged 65 + (4,5,8,9). However, these factors have not been categorized by their relative contribution or importance to fall risk or adverse consequences of a fall. Further, the list of covariates that could affect the relationship between the exposures of interest (substance use) and

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fall outcome is lengthy, and including them in regression analyses for a cohort of 274 participants is not feasible.

To overcome this problem, we conducted propensity score analyses that calculated the propensity of adults aged 55+ to present to the ED for a trauma evaluation after a fall, as opposed to presenting for other mechanisms of injury. We used propensity score adjustment to control for potential confounding in estimating the effect of the exposures of interest on the outcome (22,23). The propensity score was defined as the probability of presenting to the ED for a trauma evaluation for a fall, as opposed to other mechanisms of injury, conditional on the covariates. The propensity scores were used in the models as a moderator of baseline characteristics for examining the relationship between exposures of interest and the outcomes.

The propensity score calculations included the 274 fall cohort members and 1286 adults aged 55+ who underwent a trauma team evaluation for serious injury after another mechanism of injury at this facility from January 2020 to December 2021. In addition to demographic characteristics, the propensity score components included medical history, medications, and abnormal clinical laboratory findings that previous research has associated with either fall risk or adverse clinical outcomes from a fall among adults aged 55+. Except for age and race, all factors were entered into the propensity score model as binary variables (present vs. absent) without any attempt to assign greater weight importance to any variable. Propensity scores were calculated according to age, sex, race, past medical history, medications, and laboratory abnormalities. The resultant propensity scores for the fall cohort were included in the subsequent clinical outcomes analyses.

Statistical Analyses

Demographic characteristics, medical history, home medications, and clinical laboratory test results upon ED arrival were summarized for fall cohort members and adults ages 55 and older who underwent a trauma evaluation for other mechanisms of injury; these data were included in the propensity score analyses (Supplement). All analyses were conducted in Stata 17.0 (StataCorp; College Station, TX).

Negative binomial regression models were constructed to examine clinical outcomes through hospitalization (e.g., injury types such as fractures or intracranial hemorrhage; disposition after treatment including admission, transfer to intensive care unit [ICU], and discharge to home, hospice or skilled nursing facility). Logistic regression models for the outcomes of intracranial hemorrhage, hip/pelvic fractures, and spinal fractures; and linear regression models for ED and hospital length of stay were developed. Variables included in these models were the aforementioned propensity score (propensity for presenting for a trauma evaluation after a fall, as opposed to other types of trauma), injury severity score (from the initial trauma team evaluation), and the four classes of substances tested for in the toxicological analyses (ethanol, benzodiazepines, cannabinoids, and opioids).

The models evaluated each of the respective outcomes (e.g., admission) as a function of whether each substance was detected vs. not detected (i.e., binary variable). The relationship assessed in the model between substance detected and each outcome was adjusted for

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propensity score (i.e., propensity to present to the ED for a fall instead of another type of trauma) and ISS. The ISS were re-categorized as zero to four. The ISS distribution for the fall group was: 9% zero, 49% one, 21% two, 14% three, and 7% four. An ISS of zero was the reference category (i.e., no apparent injury) was the reference. Separate models were formed for each of the four substance classes.

Results

The fall cohort consisted of 274 patients. Most participants were ≥65 years old, and the majority were male and non-Hispanic White (Table 1). The three most common medical conditions identified were atrial fibrillation, diabetes, and osteoarthritis (Table 2), and the three most frequent medications found were anti-convulsants, non-diuretic anti-hypertensives, and anticoagulants (including antiplatelet and antithrombotic) (Table 3). Among patients in the fall cohort with laboratory abnormalities, most participants had hyperglycemia or anemia (Table 4). Supplemental Tables 1–4 depict comparisons of the fall cohort to the non-fall cohort concerning demographic characteristics and fall-related medical history, medications, and laboratory abnormalities, respectively. As compared to individuals treated for fall related injuries, adults treated for non-fall injuries were more likely to be male, younger than 65, and less likely to have hearing loss or urinary incontinence. The two cohorts had no differences in fall-related medications or laboratory abnormalities.

Ethanol, Benzodiazepines, Cannabinoids, and Opioids Detected Among Fall Cohort

After accounting for drugs administered by emergency medical services or clinical providers at the hospital prior to blood being obtained, prevalence rates of substances detected were 21.2% (95% CI, 16.5–26.5%) opioids, 18.6% (95% CI, 14.2–23.7%) ethanol, 13.9% (95% CI, 10.0–18.5%) benzodiazepines, and 9.1% (95% CI, 6.0–13.2%) cannabinoids. Ethanol concentrations ranged from 30 to 320 mg/dL, with a median concentration of 180 mg/mL and a mean concentration of 170 mg/dL. Multiple substances were detected in some blood samples: 2.3% had benzodiazepines and opioids, 2.0% had cannabinoids and opioids, 1.0% had ethanol and benzodiazepines, and 0.7% had cannabinoids and benzodiazepines (Data not shown).

Adverse Clinical Outcomes Among Fall Cohort

As shown in Table 5, 42.7% of the fall cohort sustained a fracture, and of these 117 participants with a fracture, 45 (38.5%) had a spinal fracture, and 26 (22.2%) had an extremity fracture. Approximately 17% had an intracranial hemorrhage, and of these 46 participants, 31 (67.4%) had a subarachnoid hemorrhage. Most patients were admitted to the hospital, although few required an intensive care unit stay. Among the 188 (68.6%) admitted to the hospital, 15 (7.8%) were discharged to a rehabilitation center or skilled nursing facility. There were 28 deaths (10.2%) either during the ED visit or hospitalization among the fall cohort. Mean ED length of stay (LOS) exceeded one day (60.2 h), the median was 63 h (IQR 41–70 h), and the range was 27–137 h. Among the 192 admitted to the hospital, the mean hospital LOS was 12 days, the median was 7.6 days (IQR 5.3–10.6), and the range was 1.4–185.1 days.

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Associations Between Adverse Fall Outcomes and Ethanol, Benzodiazepines, Cannabinoids, and Opioids Detected Among Fall Cohort

The prevalence of ethanol, benzodiazepines, cannabinoids, and opioids detected by adverse fall outcomes are portrayed in Table 6. As shown, the occurrence of adverse clinical outcomes (hip/thigh/pelvis fractures, intracranial hemorrhages, ED length of stay, hospital admission, hospital length of stay and death) was similar whether or not ethanol was detected. As shown in the models (Table 7), benzodiazepine use was associated with greater odds of an intracranial hemorrhage and longer ED LOS. Opioids were associated with greater odds of extremity fractures and admission to the hospital. Any substance use was also associated with extremity fractures and ED LOS. Odds of hospital admission and hospital admission LOS were lower when ethanol was present. There were no associations with any of the adverse fall outcomes for cannabinoids.

Discussion

Ethanol, cannabinoids, benzodiazepines, and opioids are sedating substances that can negatively affect psychomotor functions and likely contribute both to the risk of falls and the greater likelihood of injury from falls among adults aged 55+ (17,18). Slowed reaction time and impaired balance resulting from the use of these substances can increase fall occurrence (10). Research on alcohol-related falls found that for every 10-gram increment in alcohol consumption, the odds of experiencing a fall-related injury increased by a factor of 1.25 (24). Comparable data are not available for cannabinoids, opioids, or benzodiazepines.

In this investigation, we examined both the frequency of adverse clinical outcomes among adults aged 55+ evaluated for serious injury after a fall and their association with recent ethanol, cannabinoid, benzodiazepine, and opioid use. Morbidity, namely extremity, hip/thigh/pelvis, spinal fractures, and intracranial hemorrhages, were diagnosed frequently in this population, and 10.2% died likely from or because of events related to their fall (e.g., intracranial hemorrhage precipitated by a fall ultimately leading to death). When injury severity (ISS) and propensity to present for a fall instead of other types of trauma were accounted for in mathematical models, benzodiazepine use was associated with greater odds of an intracranial hemorrhage and longer ED LOS, and opioid use was associated with greater odds of extremity fractures and admission to the hospital, as compared to no use of these substances.

A recent analysis of ED visits for alcohol-related falls concluded that visit rates are increasing, particularly among older men (65 +) (15). Additionally, there is evidence that substance use disorder is increasing in older adults (25). It is important to note that alcohol and other substance use may be a more prominent factor for falls in older adults due to physiological changes that occur with advancing age. Alcohol and other substance use may be a modifiable risk factor for falls among older adults, and our analysis suggests that up to 1 in 5 older adults with severe trauma may benefit from interventions that reduce the use of these substances. Alcohol use was associated with lower odds of hospital admission and LOS, which is difficult to interpret. Although it cannot be discerned from this type of study, alcohol consumers might have been more mobile and less frail, conferring less severe injuries.

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Clinicians can consider screening for commonly used sedating substances, and when appropriate, offer interventions to patients who express readiness to reduce or discontinue use. In cases where these substances are prescribed, it may also be helpful to reassess the medication regimen following a fall event to explore potential adjustments. Interventions to evaluate fall risk factors and modify fall-risk-increasing medication in the ED are effective in reducing subsequent fall-related ED visits but are not yet widespread (26). Additionally, while it is becoming more widespread to offer substance use resources and initiate medications for opioid use disorder in the ED, older adults likely require a nuanced approach due to polypharmacy and higher prevalence of comorbidities. Finally, interventions to reduce cannabinoid and benzodiazepine misuse are lacking.

Limitations

The findings from this investigation are subject to several limitations. First, the prevalence estimates might not be externally valid to adults aged 55+ who fall but do not require evaluation for a severe injury, are not evaluated in trauma centers, or are not assessed in Level 1 trauma centers with similar catchment area populations. Second, we cannot determine if the substances detected caused the fall. Although identification of these substances in blood samples supports recent use (as compared to urine drug testing, which has a longer window of detection), the timing, frequency, and chronicity of substance ingestion in relation to the fall is not known. In addition, because providers may prescribe certain benzodiazepines and opioids, we could not determine if these substances were used as prescribed or misused. Concerning elapsed time, we could not accurately ascertain the interval between fall and blood specimen acquisition in this study; additionally, patients may have been evaluated by the trauma team after transfer from another hospital, leading to variability in time to presentation.

Conclusion

Our study sheds light on the prevalence of ethanol, benzodiazepines, cannabinoids, and opioids in relation to adverse clinical outcomes among adults aged 55+ evaluated for a serious injury after a fall. At least one-third of our sample had one or more of the evaluated substances detected in their blood. Among these substances, opioids were the most detected, followed by benzodiazepines and ethanol. Fractures and intracranial hemorrhages, particularly spinal fractures and subarachnoid hemorrhages, were diagnosed in substantial percentages, and death occurred in slightly over 10% of those who had a fall. Admission was the norm, as was a post-hospitalization stay in a rehabilitation or skilled nursing facility, while ED and hospital LOS were lengthy. These findings underscore the need for initiatives to address substance use among adults aged 55+ and older adults in the context of fall prevention.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Article Summary

Why is this topic important?

Falls are a major source of preventable morbidity and mortality among adults over the age of 65. The role of substance use in these patients remains understudied.

What does this study attempt to show?

In this study, we attempt to show the prevalence of substance use in this population and understand the impact of substance use on adverse health outcomes.

What are the key findings?

The key findings are the prevalence of substance exposure as detected through analytical toxicology testing. Among 274 adults aged 55+, detection rates were 21.2% for opioids, 18.6% for ethanol, 13.9% for benzodiazepines, and 9.1% for cannabinoids. Intracranial hemorrhages were more likely if the patient had been recently taking a benzodiazepine (aOR = 3.92), while extremity fractures were more common with opioid use (aOR = 7.67).

How is patient care impacted?

- More than 18% of adults over age 55 who presented after a fall in this study had evidence of recent alcohol use.
- Other substances were common, with a prevalence of 21.2% for opioids, 13.9% for benzodiazepines, and 9.1% for cannabinoids.
- As part of routine fall prevention, our data underscore the need for initiatives to address substance use among adults aged 55+.

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Table 1.

Demographic Characteristics of Adults Aged 55+ Evaluated for Serious Injury After a Fall at a Level 1 Trauma Center, Level 1 Trauma Center, 2020–2021.

n = 274	Number	Percent %
Sex		
Female	98	35.8
Male	176	64.2
Race		
Asian, non-Hispanic/Latino	3	1.1
Black or African American, non-Hispanic/Latino	0	0.0
Hispanic/Latino	17	6.2
Not Provided/Specified	13	4.7
White, non-Hispanic/Latino	241	88.0
Age groups (years)		
55–59	32	11.7
60–64	40	14.6
65–69	23	8.4
70–74	41	15.0
75–79	28	10.2
80–84	29	10.6
85–89	42	15.3
≥90	39	14.2

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Table 2.

Medical History of Adults Aged 55+ Evaluated for Serious Injury After a Fall at a 2020–2021.

n = 274	Number	Percent %
Medical condition		
Circulatory system diseases		
Atrial fibrillation	43	15.7
Clotting disorders	0	0.0
Coagulopathy	0	0.0
Orthostatic hypotension	1	0.4
Stroke	18	6.6
Endocrinologic disease Diabetes mellitus	36	13.1
Hearing impairment		
Hearing aid	0	0.0
Hearing loss	19	6.9
Incontinence		
Bowel incontinence	0	0.0
Mix incontinence	0	0.0
Urine incontinence	4	1.5
Mental/behavioral disorders		
Alzheimer dementia	4	1.5
Depression	0	0.0
Other anxiety disorders	2	0.7
Unspecified dementia	9	3.3
Musculoskeletal and connective tissue diseases		
Arthritis	0	0.0
Gout	11	4.0
Osteoarthritis	22	8.0
Osteoporosis	5	1.8
Polyosteoarthritis	1	0.4
Rheumatoid arthritis	2	0.7
Neoplasms		
Bladder cancer	0	0.0
Chronic lymphocytic leukemia	1	0.4
Esophageal cancer	0	0.0
Gastric adenocarcinoma	0	0.0
Hepatocellular adenocarcinoma	0	0.0
Hodgkin lymphoma	0	0.0
Lung cancer	1	0.4
Multiple myeloma	0	0.0
Rectal adenocarcinoma	1	0.4
Renal cancer	0	0.0
Unspecified cancer	6	2.2
Urethra cancer	0	0.0

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n = 274	Number	Percent %
Urothelial cancer	0	0.0
Neurological diseases		
Dizziness	4	1.5
Parkinson disease	7	2.6
Vertigo	1	0.4
Visual impairment		
Binocular diplopia	0	0.0
Blindness	1	0.4
Glaucoma	8	2.9
Other secondary cataracts	0	0.0
Visual impairment	0	0.0
Visual loss	0	0.0

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Table 3.

Outpatient Medications Prescribed to Adults Aged 55+ Evaluated for Serious Injury After a Fall at a Level 1 Trauma Center, 2020–2021.

Medication Category	Number (n = 274)	Percent %
Cardiovascular		
Non-diuretic anti-hypertensives	72	26.3
Antiplatelets	42	15.3
Antithrombotics	67	24.5
Diuretics	46	16.8
Central nervous system		
Anticholinergics		0.0
Anticonvulsants	76	27.7
Antidepressants	61	22.3
Antihistamines	16	5.8
Antipsychotics	1	0.4
Benzodiazepines	20	7.3
Nonbenzodiazepine receptor agonist hypnotics (“Z-drugs”)	4	1.5
Opioids	18	6.6
Endocrinologic		
Insulin	13	4.7
Sulfonylureas	5	1.8
Musculoskeletal		
Skeletal muscle relaxants	5	1.8
Substance use treatment		
Naltrexone	1	0.4

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Table 4.

Laboratory Abnormalities Detected Among Adults Aged 55+ Evaluated for Serious Injury After a Fall at a Level 1 Trauma Center, 2020–2021.

Laboratory Abnormalities	Number (n = 274)	Percent %
Albumin		
Hypoalbuminemia (<3.8 g/dL)	69	25.2
Anemia		
Anemia in females (<12 g/dL)	84	30.7
Anemia in males (<13 g/dL)	134	48.9
Severe anemia <8 g/dL	0	0.0
Glucose		
Hyperglycemia		
Hyperglycemia 1 (>99 mg/dL)	221	80.7
Hyperglycemia 2 (>200 mg/dL)	37	13.5
Hyperglycemia 3 (>248/mg/dL)	21	7.7
Hypoglycemia		
Hypoglycemia (70 mg/dL)	0	0.0
Non severe hypoglycemia (<54 mg/dL)	0	0.0
Severe hypoglycemia (<36 mg/dL)	0	0.0
Potassium		
Hyperkalemia (>5.1 mmol/L)	12	4.4
Hypokalemia (<3.5 mmol/L)	0	0.0
Sodium		
Hypernatremia (>144 mmol/L)	9	3.3
Hyponatremia (<135 mmol/L)	45	16.4
Mild hyponatremia (130–134 mmol/L)	32	11.7
Moderate hyponatremia (120–129 mmol/L)	12	4.4
Severe hyponatremia (<120 mmol/L)	1	0.4

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Table 5.

Outcomes Among Adults Aged 55+ Evaluated for Serious Injury After a Fall at a Level 1 Trauma Center, 2020–2021.

	n = 274	Number	Percent %
Injuries			
Extremity fractures*		26	9.5
	Lower extremities	4	1.5
	Upper extremities	22	8.0
	Hip, thigh, pelvis fractures	21	7.7
Spinal fractures*		45	16.4
	Cervical fractures	14	5.1
	Lumbar/sacral fractures	7	2.6
	Thoracic fractures	29	10.6
Intracranial hemorrhage*		46	16.8
	Subarachnoid hematoma	31	11.3
	Subdural hematoma	3	1.1
	Other	21	7.7
Potential outcomes Disposition			
	Admission	188	68.6
	To ICU	4	1.5
	Discharge to home	47	17.2
	Discharge to home with services	9	3.3
Discharge to facility			
	Home with hospice	0	0.0
	Hospice Facility	0	0.0
	Inpatient Rehabilitation facility	4	1.5
	Skilled nursing facility	11	4.0
Mortality			
	Death during hospitalization	25	9.1
	Death in the Emergency department	3	1.1
Length of stay		Median	IQR
	Emergency department (Median (IQR)) in hours	63	41–70

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n = 274	Number	Percent %
Hospitalization (Median (IQR)) in hours	182	127–255

ICU = Intensive Care Unit; IQR = Interquartile Range.

*Individuals may have had more than one injury in this category. The sum may be larger than 100% because a patient may have more than one of the grouped fractures per encounter.

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Table 6.

Substance Use in Relationship to Adverse Clinical Outcomes among Older Adults Evaluated for Serious Injury After a Fall at a Level 1 Trauma Center, 2020–2021.

Adverse Clinical Outcomes	Ethanol			Benzodiazepine			Cannabinoids			Opioids			Any Substance		
	Not Detected (n = 223)	Detected (n = 51)	*p*-Value	Not Detected (n = 236)	Detected (n = 38)	*p*-Value	Not Detected (n = 249)	Detected (n = 25)	*p*-Value	Not Detected (n = 216)	Detected (n = 58)	*p*-Value	Not Detected (n = 150)	Detected (n = 124)	*p*-Value
	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
Hip, Thigh, pelvis fracture			0.02			0.06			0.13			0.39			0.11
No Fracture	202 (90.6)	51 (100)		215 (91.1)	38 (100)		228 (91.6)	25 (100)		201 (93.1)	52 (89.7)		135 (90.0)	118 (95.2)	
Fracture	21 (9.4)	0 *(0)		21 (8.9)	0 *(0)		21 (8.4)	0 *(0)		15 (6.9)	6 (10.3)		15 (10.0)	6 (4.8)	
Intracranial hemorrhages			0.15			0.001			0.91			0.28			0.09
Not Detected	189 (84.8)	39 (76.5)		204 (86.4)	24 (63.2)		207 (83.1)	21 (84.0)		177 (81.9)	51 (87.9)		130 (86.7)	98 (79.0)	
Detected	34 (15.2)	12 (23.5)		32 (13.6)	14 (36.8)		42 (16.9)	4 (16.0)		39 (18.1)	7 (12.1)		20 (13.3)	26 (21.0)	
Admission			0.095			0.47			0.33			0.003			0.81
Not Admitted	65 (29.1)	21 (41.2)		76 (32.2)	10 (26.3)		76 (30.5)	10 (40.0)		77 (35.6)	9 (15.5)		48 (32.0)	38 (30.6)	
Admitted	158 (70.9)	30 (58.8)		160 (67.8)	28 (73.7)		173 (69.5)	15 (60.0)		139 (64.4)	49 (84.5)		102 (68.0)	86 (69.4)	
Death on ED Encounter			0.1			0.52			0.28			0.65			0.14
Survived	197 (88.3)	49 (96.1)		213 (90.3)	33 (86.8)		222 (89.2)	24 (96.0)		193 (89.4)	53 (91.4)		131 (87.3)	115 (92.7)	
Died	26 (11.7)	2 (3.9)		23 (9.7)	5 (13.2)		27 (10.8)	1 (4.0)		23 (10.6)	5 (8.6)		19 (12.7)	9 (7.3)	
ED LOS															
Mean (SD)	59.9 (20.5)	61.3 (18.9)		59.6 (20.5)	63.9 (18.2)		60.2 (20.3)	59.6 (19.9)		60.3 (20.2)	59.8 (20.5)		59.3 (19.6)	61.2 (21.0)	
Min-Max	27–135	33–137		27–137	33–112		27–137	28–92		28–137	27–135		29–120	27–137	
Hospital LOS															
Mean (SD)	229.2 (420.6)	170.0 (224.6)		214.9 (407.2)	238.6 (282.8)		223.0 (408.6)	170.4 (140.5)		202.4 (398.8)	276.9 (362.6)		219.4 (459.8)	216.7 (291.3)	
Min-Max	30–4442	33–1336		30–4442	35–1336		30–4442	33–617		30–4442	33–2285		30–4442	33–2285	

ED = Emergency Department, LOS = length of stay, SD = standard deviation.

*Cases with zero positive cases for the substance and injury group

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Table 7.

Modeled Relationship of Substance Use to Adverse Clinical Outcomes among Older Adults Evaluated for Serious Injury After a Fall at a Level 1 Trauma Center, 2020–2021.

	Extremity Fracture	Hip/Pelvic Fracture	Spinal Fracture	Intracranial Hemorrhage	Admission	Death on ED Encounter	ED LOS	Hospital LOS
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	IRR* (95% CI)	IRR* (95% CI)
	n = 249	n = 223	n = 249	n = 274	n = 274	n = 274	n = 274	n = 274
Ethanol	1.0 (0.4–2.8)	-	1.0 (0.4–2.4)	1.3 (0.5–3.2)	0.4 (0.2–0.9)	0.3 (0.1–3.0)	1.0 (0.9–1.1)	0.7 (0.5–0.9)
ISS								
1	1.0 (0.2–5.0)	-	0.3 (0.1–0.9)	1.0 (0.2–4.9)	0.9 (0.3–2.1)	0.6 (0.3–8.7)	1.1 (1.0–1.3)	0.8 (0.6–1.2)
2	1.3 (0.2–6.6)	-	1.4 (0.4–4.3)	1.3 (0.2–6.7)	8.0 (2.5–25.5)	1.7 (0.3–8.7)	1.1 (0.9–1.3)	1.3 (0.9–2.0)
3	0.8 (0.1–5.3)	-	1.1 (0.3–4.0)	9.3 (1.9–45.9)	39.2 (4.1–378.5)	2.1 (0.4–12.3)	1.0 (0.9–1.2)	1.8 (1.1–2.8)
4	-	-	-	11.2 (2.1–61.1)	8.9 (1.4–55.4)	9.3 (1.6–52.8)	0.8 (0.7–1.0)	1.3 (0.8–2.2)
Benzodiazepines	1.1 (0.4–3.6)	-	0.9 (0.3–2.5)	3.9 (1.6–9.5)	1.4 (0.6–3.1)	1.2 (0.4–3.6)	1.1 (1.0–1.2)	1.1 (0.8–1.5)
ISS								
1	1.1 (0.2–5.3)	-	0.3 (0.1–0.9)	0.9 (0.2–4.4)	0.7 (0.3–1.7)	0.5 (0.1–2.6)	1.1 (1.0–1.3)	0.8 (0.5–1.2)
2	1.3 (0.2–7.1)	-	1.4 (0.4–4.3)	1.3 (0.3–6.5)	6.7 (2.2–20.8)	1.5 (0.3–7.8)	1.1 (0.9–1.3)	1.2 (0.8–1.9)
3	0.8 (0.1–5.4)	-	1.1 (0.3–3.9)	9.5 (2.1–44.3)	28.5 (3.4–238.0)	1.7 (0.3–10.1)	1.0 (0.9–1.2)	1.7 (1.1–2.7)
4	-	-	-	10.3 (2.0–53.8)	6.4 (1.2–33.4)	7.1 (1.2–41.8)	0.8 (0.7–1.0)	1.2 (0.7–2.1)
Cannabinoids	1.4 (0.4–5.3)	-	1.0 (0.3–3.7)	0.7 (0.2–2.1)	0.7 (0.3–1.8)	0.3 (0.0–1.9)	1.0 (0.9–1.1)	0.8 (0.5–1.1)
ISS								
1	1.1 (0.2–5.5)	-	0.3 (0.1–1.0)	1.1 (0.2–5.3)	0.8 (0.3–1.8)	0.5 (0.1–2.8)	1.1 (1.0–1.3)	0.8 (0.5–1.2)
2	1.3 (0.2–7.3)	-	1.4 (0.4–4.5)	1.4 (0.3–7.3)	6.9 (2.2–21.4)	1.5 (0.3–8.0)	1.1 (0.9–1.3)	1.2 (0.8–1.9)
3	0.8 (0.1–5.7)	-	1.1 (0.3–4.0)	10.1 (2.1–49.2)	29.5 (3.5–248.7)	1.8 (0.3–10.5)	1.0 (0.9–1.2)	1.7 (1.1–2.7)
4	-	-		12.9 (2.3–71.0)	7.3 (1.3–41.1)	8.8 (1.6–49.7)	0.8 (0.7–1.0)	1.3 (0.8–2.2)
Opioids	5.1 (2.1–12.2)	1.3 (0.5–3.6)	1.7 (0.8–3.8)	0.4 (0.2–1.1)	3.2 (1.4–7.4)	0.6 (0.2–2.0)	1.0 (0.9–1.1)	1.2 (0.9–1.6)
ISS								
1	1.5 (0.3–6.7)	0.5 (0.1–5.2)	0.3 (0.1–1.0)	1.0 (0.2–5.0)	0.8 (0.3–1.9)	0.5 (0.1–2.6)	1.1 (1.0–1.3)	0.8 (0.6–1.2)
2	1.4 (0.3–7.6)	6.1 (0.7–50.6)	1.4 (0.4–4.6)	1.4 (0.2–7.5)	7.1 (2.3–21.9)	1.5 (0.3–8.3)	1.1 (0.9–1.3)	1.3 (0.8–1.9)
3	0.9 (0.1–6.3)	2.1 (0.2–21.0)	1.2 (0.3–4.2)	10.2 (2.0–52.7)	31.5 (3.8–260.2)	1.7 (0.3–10.5)	1.0 (0.9–1.2)	1.7 (1.1–2.6)
4	-	2.5 (0.2–27.0)	-	13.0 (2.2–75.4)	7.0 (1.4–35.6)	7.7 (1.3–45.1)	0.8 (0.7–1.0)	1.2 (0.7–2.0)
Any substance	2.5 (1.0–62)	0.4 (0.1–1.0)	1.3 (0.7–2.6)	1.4 (0.7–2.8)	0.9 (0.5–1.7)	0.4 (0.1–1.0)	1.0 (1.0–1.1)	0.9 (0.7–1.1)

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	Extremity Fracture	Hip/Pelvic Fracture	Spinal Fracture	Intracranial Hemorrhage	Admission	Death on ED Encounter	ED LOS	Hospital LOS
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	IRR* (95% CI)	IRR* (95% CI)
	n = 249	n = 223	n = 249	n = 274	n = 274	n = 274	n = 274	n = 274
ISS								
1	1.3 (0.3–6.4)	0.6 (0.1–5.9)	0.3 (0.1–1.0)	1.0 (0.2–4.9)	0.8 (0.3–1.8)	0.6 (0.1–3.2)	1.1 (1.0–1.3)	0.8 (0.5–1.1)
2	1.5 (0.3–8.1)	7.6 (0.9–63.2)	1.5 (0.5–4.7)	1.3 (0.2–6.7)	6.9 (2.2–21.5)	1.9 (0.3–10.5)	1.1 (0.9–1.3)	1.2 (0.8–1.9)
3	1.0 (0.1–6.5)	2.5 (0.2–25.7)	1.2 (0.3–4.2)	9.4 (1.9–46.1)	29.4 (3.4–253.4)	2.1 (0.3–13.7)	1.0 (0.9–1.2)	1.7 (1.1–2.7)
4	-	3.9 (0.3–44.8)	-	10.5 (1.9–58.6)	7.0 (1.2–39.6)	12.3 (1.8–85.2)	0.8 (0.7–1.0)	1.3 (0.8–2.2)

OR = odds ratio; CI = confidence interval, ED = Emergency Department, LOS = length of stay, IRR = incidence rate; ISS = injury severity score.

Reference categories for each substance is absence of detection of that substance. Reference categories for the outcomes were absence of the injury (e.g., fracture), absence of other outcomes (e.g., admission, death), and fewer days for ED and hospital LOS.