

# Trends and outcomes of Alcoholic Intoxication in Trauma Patients

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## Research Article

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# Abstract

## Background:

We sought to investigate the rate and trends of alcohol intoxication in different ages and sexes during last decade.

## Methods:

Multivariate analysis was used to compare alcohol intoxication in different sexes and age groups and to investigate the trends present during the 2007-2019 period using TQP database.

## Results:

We found 1,000,578 intoxicated trauma patients admitted to level I-III trauma centers during 2007-2019 within TQP database. Overall, 21.7% of intoxicated patients were women. The rate of intoxicated women increased significantly from 20.6% in 2007 to 33% in 2019. Intoxicated women have a significantly higher rate of self-inflicted trauma compared to intoxicated men (10.4% vs. 2.4%,  $P<0.01$ ). Overall, 29.7% of intoxicated trauma patients had chronic alcohol abuse and the rate increased by age. Chronic alcohol abuse was higher in men (30.1% vs. 28.2%, OR: 1.09, CI: 1.08-1.10,  $P<0.01$ ) and elderly patients (age $\geq$ 65) (39.8% vs. 28.9%, OR: 1.62, CI: 1.60-1.65,  $P<0.01$ ). Overall mortality for intoxicated trauma patients was 2.8%. Mortality of intoxicated men was higher than women (2.9% vs. 2.2%, OR: 1.32, CI: 1.28-1.37,  $P<0.01$ ). Elderly intoxicated patients (age $\geq$ 65) had a significantly higher mortality (4.9% vs. 2.6%, OR: 1.91, CI: 1.84-1.98,  $P<0.01$ ). Also, elderly men had twice the mortality risk compared to elderly women (5.7% vs. 3%, OR: 1.96, CI: 1.80-2.14).

## Conclusion:

There is a gradual increase in the rate of alcoholic intoxication in women with trauma during 2007-2019. Intoxicated women have a significantly higher rate of self-inflicted trauma compared to intoxicated men. Elderly patients with alcoholic intoxication, especially men, have a higher mortality. Further studies are needed to investigate preventive strategies for the increasing rate of alcoholic intoxication in women.

## Introduction

Alcohol abuse is a highly debated and researched topic in various medical fields, from its relationship with poor mental health/depression<sup>1</sup> to its association with liver disease and development of cirrhosis<sup>2</sup>. Excessive alcohol use in the United States was estimated to cause an average of 80,000 deaths each year and cost states a median of \$2.9 billion in 2006<sup>3</sup>. Also, usage of emergency departments and hospitalizations was highest among those with alcohol-related disorders when compared to other substance-related disorders<sup>4</sup>. Looking at hospital emergency department data, alcohol usage has shown to be a main risk factor for morbidity and mortality in relation to both intentional and unintentional injury

<sup>5</sup>, particularly in violence-related injuries <sup>5</sup>. Despite all this information, there is a large information gap when it comes to trend data on alcohol usage <sup>6</sup>. The study of intoxicated trauma patients to understand the trends and creative preventive strategies is critical.

Recent literature reports that adults aged 60 years and over, also known as the baby-boom cohort, trend higher in alcohol and prescription drugs usage, with more visits to the emergency room and treatment admissions <sup>7</sup>. This is important to note since the elderly population is particularly vulnerable to alcohol-related issues; specifically, aging can cause pharmacologic and physiologic changes that can lead to alcohol having more profound effects <sup>8</sup>. The interaction between alcohol and prescription/over the counter drugs also presents a unique challenge in the elderly, as well <sup>8</sup>. In studies done from face-to-face interviews looking at alcohol use, high-risk drinking, and DSM-IV AUD, the data was further broken down to show that women and older adults have had an increase in alcohol use <sup>6</sup>. While past studies had shown that male alcohol consumption and use disorder was higher compared to females, newer studies are showing that younger populations have less of a gender gap, with frequent binge drinking increasing in younger females <sup>9</sup>. With recent reports of incidence of alcohol use rising <sup>10</sup>, more research needs to be done to make up for this public health dilemma <sup>6</sup>. However, there is limited information regarding this topic. To create prevention strategies and public health policies that are effective and up to date to current health practices for alcoholic intoxicated trauma patients, recent data needs to be targeted towards focusing on different sexes and ages. Using data from the past decade, we investigated the rates and trends of alcohol intoxication in intoxicated trauma patients between different ages and sexes.

## Methods

A retrospectively maintained data of trauma patients admitted to a trauma center was queried for patients with a detectable alcohol in blood level between January 1, 2007, and December 31, 2019. The study hypothesis was that there is a gradual increase in the rate of alcohol intoxication in female trauma patients during last decade, especially among elderly women. Primary endpoints were to identify rate and trend of alcohol intoxication in different sexes and ages during the last decade. Secondary endpoint was to compare outcomes of alcohol intoxication in different sexes and ages in trauma patients.

We identified trauma patients with positive blood alcohol level whose data were submitted to the American College of Surgeons Trauma Quality Improvement Program (ACS TQIP) during the study period of 1/1/2007 to 12/31/2019 using the Participant Use Data Files (PUF) files. ACS TQIP is a nationally validated surgical outcomes registry extracted from medical records by trained surgical clinical reviewers in more than 850 participating trauma centers across the United States<sup>11</sup>. The TQIP is the representative dataset for trauma research at the ACS and includes validated data submitted on pediatric and adult patients from Level I, II, III, IV, V or undesignated trauma centers in the United states to elevate the quality of care for trauma patients in trauma centers<sup>11</sup>. The TQP remains the full and exclusive copyrighted property of the American College of Surgeons. The American College of Surgeons is not responsible for any claims arising from works based on the original Data, Text, Tables, or Figures. We used the variable

“ALCOHOL” during 2007–2016 and variable “ALCOHOL SCREEN” during 2017–2019 within TQP database to identify patients with a positive blood alcohol level and who were intoxicated. Intoxicated patients were defined as having a blood alcohol content of more than 0.08%. We excluded patients with missing data for variables of age, sex, and alcohol intoxication status from the study. This study uses de-identified data from ACS TQP database that is not considered Human Subjects Research and was exempt from IRB approval<sup>11</sup>.

The database was queried for all adult patients (> 18 years of age) with alcohol intoxication who were admitted to level I-III trauma centers. Variables of interest included demographic variables (age, sex, race), comorbidities (diabetes, hypertension, steroid use, etc.), mechanism of trauma (blunt trauma, penetrating trauma, fall, etc.), injury type (self-inflicted, assault, etc.), and mortality of the patients. The rates of patients’ races, sexes, and age groups were calculated for each year and trends were subsequently identified. Also, mortality of patients in different sexes and age groups were compared. All variables considered in this study were defined per the TQP User Guide definition, which is available online<sup>11</sup>.

## Statistical Analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) software, Version 23 (SPSS Inc., Chicago, IL). The patient population was divided into male and female, different races, and age groups of  $18 \leq \text{age} \leq 24$ ,  $25 \leq \text{age} \leq 34$ ,  $35 \leq \text{age} \leq 44$ ,  $45 \leq \text{age} \leq 54$ ,  $55 \leq \text{age} \leq 64$ ,  $65 \leq \text{age} \leq 74$ ,  $75 \leq \text{age} \leq 84$ , and  $\text{age} \geq 85$ . Descriptive statistics were used to calculate the rate of alcohol intoxication for each group of patients. The proportion of alcoholic intoxicated patients in each group was trended over time. The Pearson’s Chi-squared test and the student t-test were used to determine the difference in rate of alcohol intoxication in different races, sexes, and ages. The Odds Ratio (OR) and Confidence Interval (CI) calculated for each analysis with a p-value < 0.05 were considered to be significant. Multivariable analysis using logistic regression was used for mortality analysis. Difference in mortality of each group of patients was investigated with the Pearson’s Chi-squared test and the student t-test. Adjusted for mortality analyses were done for comorbid and demographic variables. Variables with an unadjusted p-value < 0.05 from univariate analyses were used to build a multivariable logistic regression model to identify independent risk factors for mortality.

## Results

A total of 1,363,644 trauma patients who had a detectable alcohol in blood identified during 2007–2019 within the TQP database. Of these, 1,000,578 patients (73.4%) had illegal alcohol level (intoxicated patients). Overall, 20.6% of patients were women. The most common comorbidities were chronic alcohol abuse (29.7%) followed by smoking (26.6%) and hypertension required medication (16.1%). The most common race was white (62.7%) followed by African American (18.8%), American Indians (2.4%), and Asian (0.9%). Demographic of the patients reported in Table 1.

Table 1  
Demographics of patient population of the study

<b>Variables</b>	<b>Number of patients (Percent)</b>	
	<b>Total#1000578</b>	
<b>Age</b>	18 ≤ age ≤ 24	170,834(17.1%)
	25 ≤ age ≤ 34	247,006(24.7%)
	35 ≤ age ≤ 44	185,261(18.3%)
	45 ≤ age ≤ 54	193,409(19.3%)
	55 ≤ age ≤ 64	129,523(12.9%)
	65 ≤ age ≤ 74	51,697(5.2%)
	75 ≤ age ≤ 84	19,426(1.9%)
	Age ≥ 85	3,422(0.3%)
<b>Sex</b>	Female	206,082(20.6%)
<b>Race</b>	White	627,688(62.7%)
	Black of African American	188,099(18.8%)
	American Indians	24,060(2.4%)
	Asian	8,559(0.9%)
	Native Hawaiian or Pacific Islander	2,878(0.3%)
	Other	149,291(14.9%)
<b>Comorbidity</b>	Diabetes Mellitus	47,812(4.8%)
	Hypertension requiring medication	161,302(16.1%)
	Congestive heart failure	8417(0.8%)
	Steroid use	2401(0.2%)
	Respiratory disease	23758(2.4%)
	Alcoholism	297105(29.7%)
	Chronic renal disease	42459(4.2%)
	Bleeding disorders	14564(1.5%)
	Disseminated cancer	1647(0.2%)
	Smoking	266538(26.6%)
	Stroke	5920(0.6%)

Variables	Number of patients (Percent)
	Total#1000578
Chemotherapy for cancer within 30 days	399(0.1%)

Overall, 206,082 (20.6%) of alcohol intoxicated patients were women. When investigating the rate of sex for intoxicated trauma patients during last decade the rate of female sex increased from %17.9 in 2007 to %22.8 in 2019 (Fig. 1). Also, the increase in rate of female sex was observed in elderly women too ( $P < 0.01$ ). (Fig. 1).

The highest rate of alcohol intoxication was observed in patients  $21 \leq \text{age} \leq 23$  (9% of all patients). The rate of alcohol intoxication was seen to decrease with an increase in age. The same pattern was observed in both male and female sexes, as well as elderly woman (Fig. 2).

Overall, 297,105 (29.7%) of intoxicated trauma patients had chronic alcohol abuse. There was no significant change in rate of chronic alcoholic abuse during the 13 years of the study (27.2% in 2007 vs. 22% in 2019). Chronic alcohol abuse was higher in men compared to women (30.1% vs. 28.2%, OR: 1.09, CI:1.08–1.10,  $P < 0.01$ ). Elderly patients (age  $\geq 65$ ) had significantly higher rate of chronic alcohol abuse (39.8% vs. 28.9%, OR:1.62, CI: 1.60–1.65,  $P < 0.01$ ). There was an increase in rate of chronic alcoholic abuse by age with a peak at the age of 55 (Fig. 3).

Overall, the most common mechanism of trauma was blunt trauma (74.4%) followed by penetrating trauma (13.1%) and burn (0.7%). Approximately, 22.3% of the patients had a fall. The rate of fall increased with age from 10% for age of 18 years to 78% for age of  $> 85$  years. Overall, 2.5% of the intoxicated patients had self-inflicted trauma. Alcohol intoxicated women had a significantly higher rate of self-inflicted trauma compared to intoxicated men (10.4% vs. 2.4%,  $P < 0.01$ ) (Fig. 4).

Overall mortality for intoxicated trauma patients was 2.8%. Mortality of intoxicated men was higher than women (2.9% vs. 2.2%, OR: 1.32, CI: 1.28–1.37,  $P < 0.01$ ). Elderly intoxicated patients (age  $\geq 65$ ) had a significantly higher mortality (4.9% vs. 2.6%, OR: 1.91, CI: 1.84–1.98,  $P < 0.01$ ). Also, elderly men had twice the mortality risk compared to elderly women (5.7% vs. 3%, OR: 1.96, CI: 1.80–2.14).

## Discussion

Our study results show a steady increase in the rate of female intoxicated trauma patients during the last decade. Recent research shows that alcohol use/misuse among women is increasing<sup>12,13</sup>. This study is the first to report of a gradual increase in rate of intoxicated traumatic females. However, there is limited data available to compare these results to. Overall, alcohol-attributable injuries are more frequent in males than in females, but the increase in rate of intoxicated traumatic females stands concerning<sup>14</sup>. The increase in traumatic events in females can be related to a new change in socioeconomic status of women during the last decade, which directly affects the well-being, mental health, behavior, and quality

of life for women<sup>15,16</sup>. Also, both sex and gender-related factors are interacting with alcohol use, which impact the risk for development of the behavioral problems and alcohol use disorders<sup>17</sup>. For example, women start drinking at a later age yet start to have alcohol-related problems sooner and at lower drinking levels than men<sup>17</sup>. Alcohol dependent females are more likely to have comorbid psychiatric disorders and are less likely to receive alcohol-related services in their lifetime in comparison to men<sup>18-21</sup>. Further studies are needed to investigate reasons behind the increase rate of female sex in intoxicated trauma patients.

We observed the highest rate of alcohol intoxication in women in patients ranging 21 to 23 years of age and who were of white race. This may indicate a great proportion of those intoxicated by alcohol to be female, young, and white. Evidence supports the association of increased estrogen level and increased alcohol use in females, with mixed findings reported in males<sup>22</sup>. In addition, many observational studies reported a rise in alcohol consumption during menses when low estrogen levels are present; this is most likely due to hormonal-related mood disruptions<sup>23-25</sup>. However, among young females, fluctuating hormonal levels are present and may not accurately reflect the pathophysiology behind female alcohol consumption<sup>22</sup>. However, other factors such as stress, social support, and poverty may play a role in age distribution of alcoholic intoxicated women<sup>16</sup>. Although there is a controversy, alcohol may have greater effects on females in terms of biomedical damage and impaired performance compared to men which make them more susceptible for traumatic injury<sup>26</sup>. Focused research to gender related factors associated with alcohol intoxication and development of the effective preventive strategies are needed.

We found a significantly higher rate of self-inflicted trauma in alcoholic intoxicated women. From among the 2.5% of the study population that had reported self-inflicted trauma, women comprised this percentage more than men even though a greater percentage of men suffered from chronic alcohol abuse. This may be due to the increased likelihood of partaking in risk-taking behaviors that may lead to self-infliction after engaging in alcohol use<sup>27</sup>. Other factors such as stress, mental health, social support, and poverty may related to the significant higher rate of self-inflicted trauma in alcoholic intoxicated women<sup>16</sup>. The specific relationship between female alcohol consumption and self-inflicted trauma requires further investigation.

We found a gradual increase in rate of chronic alcoholic abuse with an increase in age. Alcohol involved traffic crashes have been reported as an important cause of trauma and death in all age groups<sup>28,29</sup>. Also, alcohol consumption increases risk of trauma for all mechanisms of trauma by cognitive impairment and psychomotor dysfunctions like as eye-brain-hand-foot dyscoordination<sup>30,31</sup>. Elderly more tends to be more seriously injured than younger drivers in crashes<sup>29</sup>. Also, an elderly driver with alcoholism is more impaired than an elderly driver without alcoholism after consuming an equivalent dose of alcohol and age may interact with alcoholism to increase driving risk<sup>28</sup>. Elderly are in higher risk of severe injury in case of motor vehicle crash<sup>28,29</sup>. Also, other injuries like hip fractures and head injuries increases with alcohol consumption in elderly<sup>32,33</sup>. Data from the National Longitudinal Alcohol Epidemiologic Survey

demonstrate that, elderly with alcoholism have three times more risk of major depressive disorder<sup>34</sup>. Grabbe et al. reported 16 times more risk of die of suicide in alcoholic elderly<sup>35</sup>. The gradual increase in the rate of chronic alcoholics in elderly is an important health care issue that requires more research in order to help develop injury prevention strategies.

This study found a higher mortality risk for intoxicated elderly, especially men. Increased severity of injury in all mechanisms of trauma for intoxicated patients was reported in literature<sup>28-30</sup>. A study of more than one million drivers involved in motor vehicle crashes revealed a drinking driver is more likely to contribute to increased morbidity and mortality rates compared to that of a nondrinking driver; this may also be related to injury-related variables such as safety belt use, vehicle deformation, vehicle speed, driver age, and vehicle weight<sup>36</sup>. Elderly intoxicated patients have additional morbidity and mortality risks considering the general conditions and comorbidities<sup>28,29,33</sup>. More strict population-level alcohol consumption policies in situation like driving and population level injury preventive policies (like fall) may result in the reduction of alcohol-related injury<sup>31,37</sup>. We found elderly intoxicated men as the group with highest mortality risk after trauma. There is limited data on this topic. More research is needed to investigate and develop preventive strategies for this high-risk group of patients.

## Study Limitations

This study has several limitations. The retrospective nature of the study prevents any causal conclusion from being made. Missing data was presented for some variables which was less than 5% of cases. Data for this study was extracted from a large national database that involved data from medical records allowing for coding errors to be present. We did not factor potentially important details, such as those regarding the type and extent of trauma injuries, which could affect the results. Although TQP is a nationwide database, the data is not reflecting nationwide data and the rates may be flawed since hospitals enter and exit the TQP database annually and the report of national prevalence for a condition (like alcoholic intoxication) using the database is not possible. Despite these limitations, this study is one of the first that has reported trends of alcoholic intoxication in trauma patients. Also, using a nationwide database that includes information of patients in a broad national geographic representation from across all regions of the country, makes the study suitable to evaluate trauma patients on a national level.

## Conclusion

There is a gradual increase in the rate of alcoholic intoxication in women with trauma during 2007–2019. Intoxicated women have a significantly higher rate of self-inflicted trauma compared to intoxicated men. Approximately one third of intoxicated patients have chronic alcoholic abuse, which increases as age increases. Elderly patients with alcoholic intoxication have a higher mortality, especially those who are elderly men. Further studies are needed to investigate alcohol intoxication in women and the possible preventive strategies for them.

# Declarations

## Disclosure

Drs. Yeganeh Z, Kopatsis A, Rahimi M, Cuervo C, and Kopatsis AP have no conflicts of interest or financial ties to disclose.

## Author Contribution

**Yeganeh Z:** Conceived and designed the analysis; collected the data; contributed data or analysis tools, wrote the paper, approval of final version, accountable for all aspects of the work.

**Kopatsis A:** Conceived and designed the analysis, critical revision, co-wrote and edited paper, approval of final version, accountable for all aspects of the work.

**Kopatsis AP:** Conceived and designed the analysis, critical revision, co-wrote and edited paper, approval of final version, accountable for all aspects of the work.

**Cuervo C:** Conceived and designed the analysis; collected the data; contributed data or analysis tools, wrote the paper, approval of final version, accountable for all aspects of the work.

**Rahimi M:** Conceived and designed the analysis, critical revision, co-wrote and edited paper, approval of final version, accountable for all aspects of the work.

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## Figures

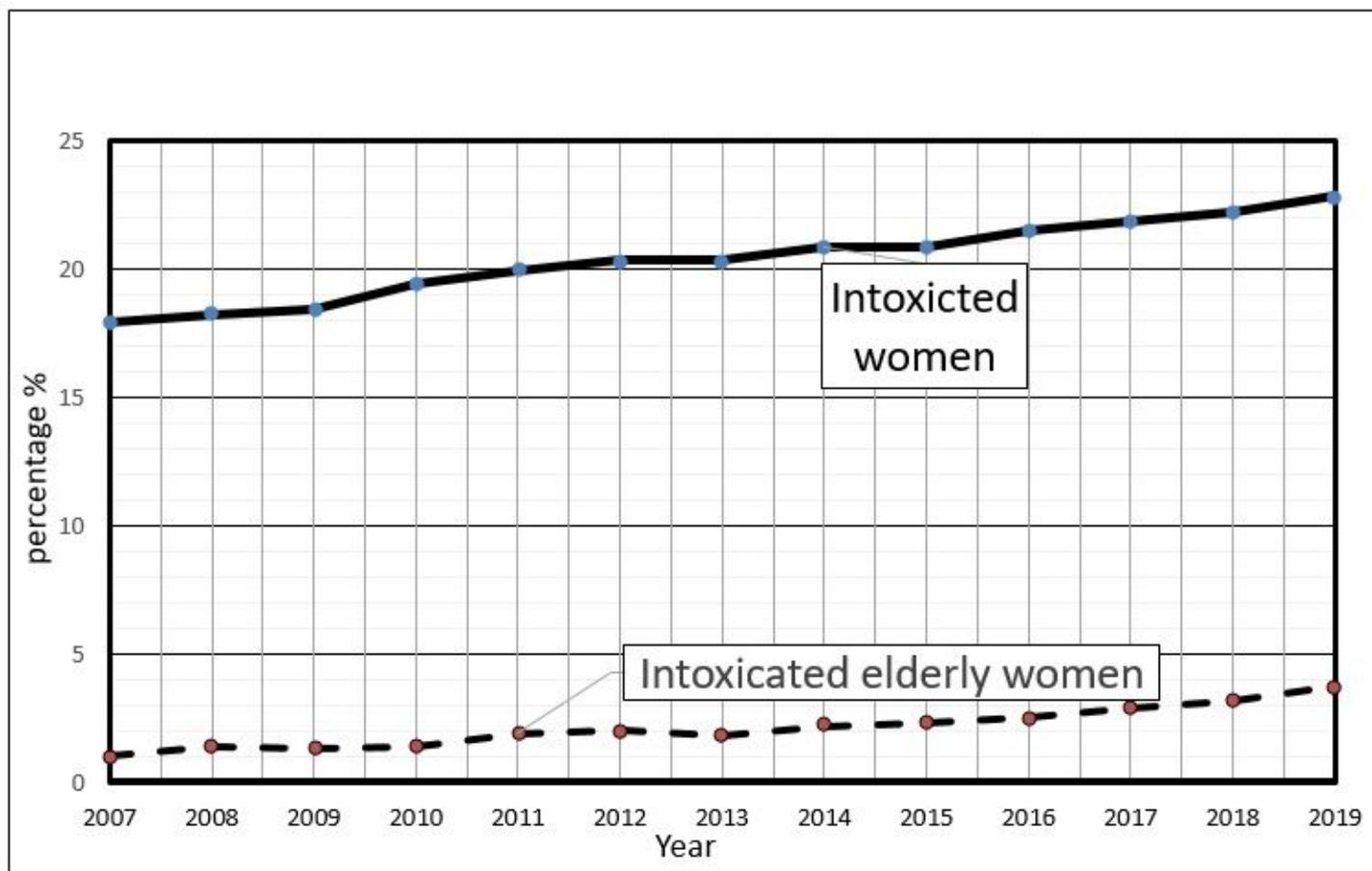


Figure 1

Trends in rate of intoxicated female trauma patients during 2007-2019 TSQ database

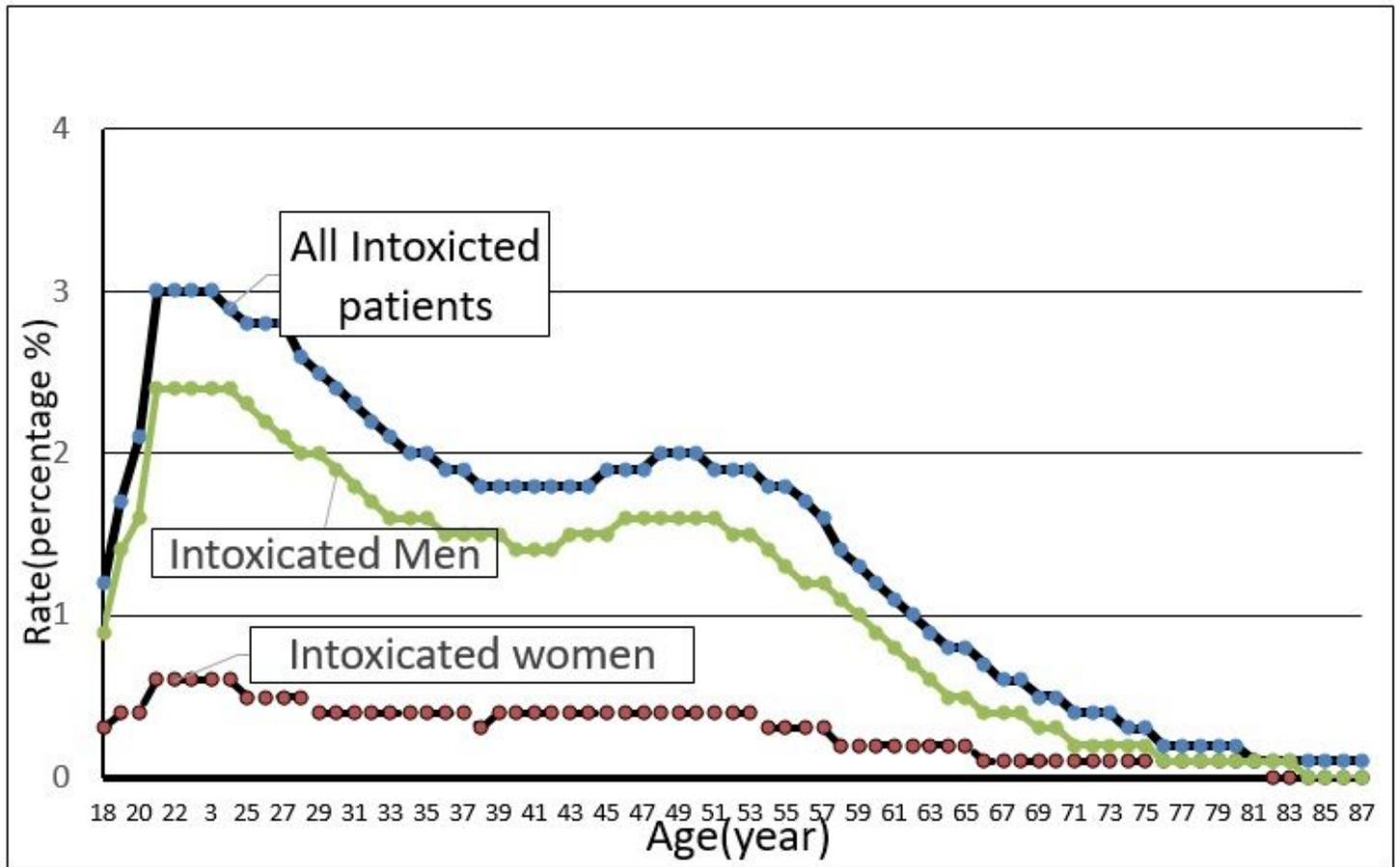


Figure 2

Trends in rate of intoxicated trauma patients by age TSQ database

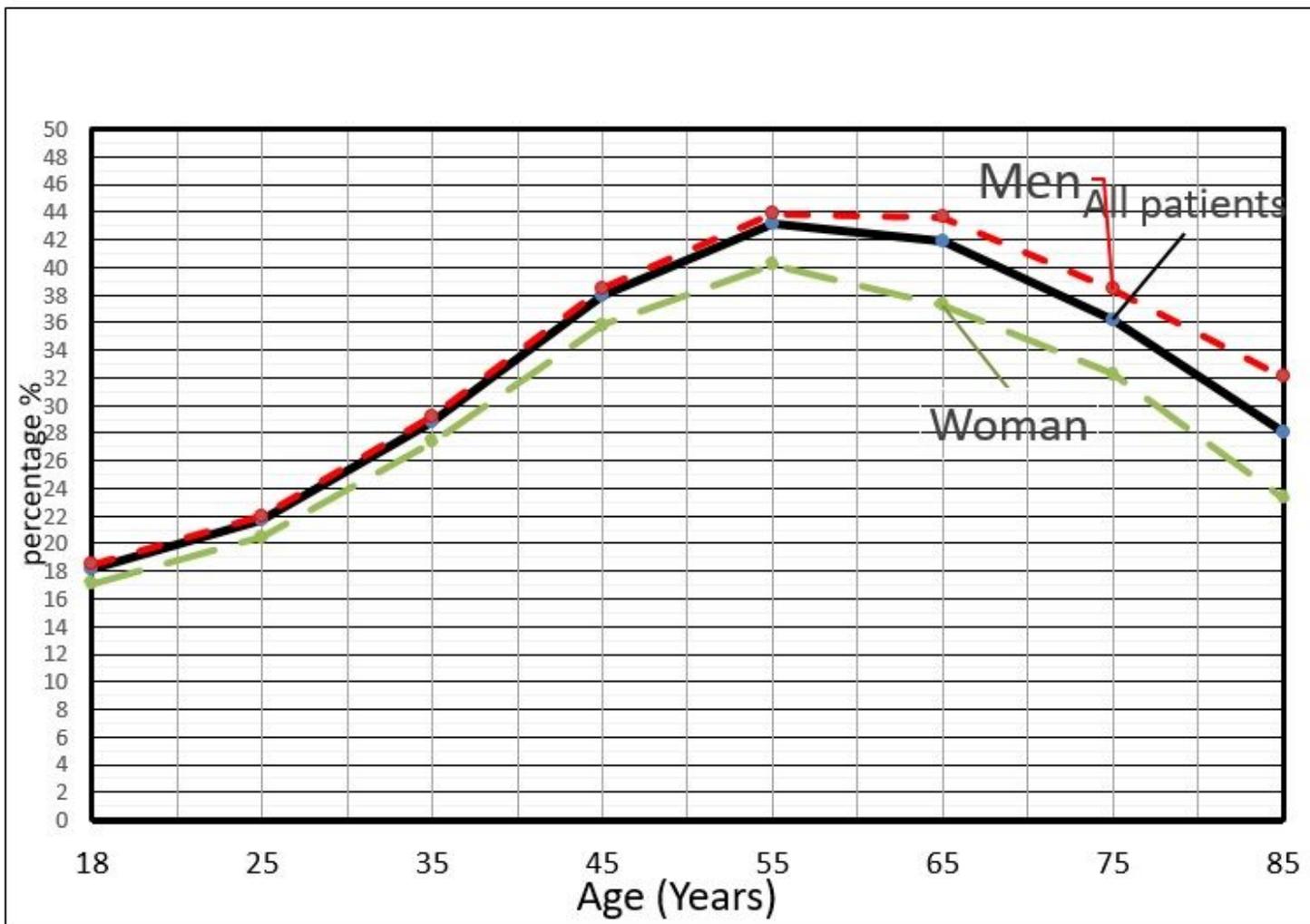


Figure 3

Trends in rate of chronic alcohol abuse for intoxicated trauma patients by age and sex TSQ database

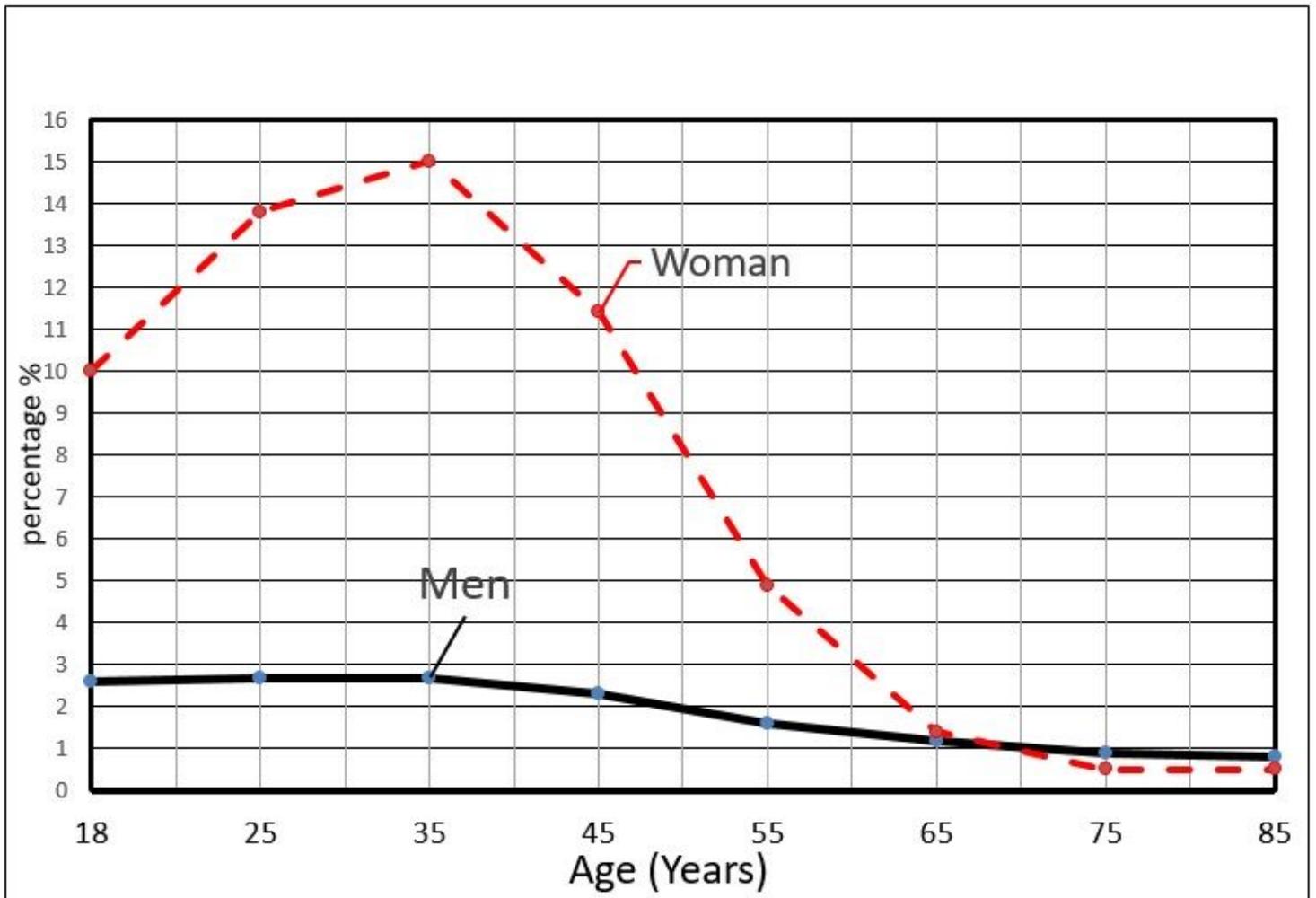


Figure 4

Trends in rate of self-inflicted trauma in alcohol intoxicated patients by age and sex TSQ database