# Driving under the influence of alcohol and alcohol use disorder: the relevance of early identification from an Italian retrospective outpatient study

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**Abstract**

***Introduction.*** Worldwide, almost 1.2 million people drive under the influence of alcohol. However, early identification of alcohol use disorder (AUD) in subjects driving under the influence (DUI) of alcohol is seldom achieved.

***Aim.*** The aim of our retrospective study is to investigate the presence of AUD in a population of DUI subjects who had their driving license suspended, and if they were following a specific rehabilitation program.

***Methods and results.*** 750 subjects were retrospectively enrolled from 2018 to 2021. DSM-V to assess AUD was used. Forty-eight (6.4%) subjects presented a diagnosis of AUD, after one month they showed a statistically significant reduction of carbohydrate-deficient transferrin (CDT) (p<0.0001); however, none were following a program for the treatment of AUD.

***Conclusions.*** This outpatient setting may be considered a place of primary and secondary prevention where DUI subjects with a diagnosis of AUD may be entrusted to a Centre in order to follow rehabilitation treatment.

**Key words**
- drinking
- driving
- alcohol use disorder
- early diagnosis
- outpatient's setting

## INTRODUCTION

Alcohol consumption is a major public health risk, and accounts for 5.9% of all deaths (7.6% of deaths in men and 4% of deaths in women) and 5.1% of all global diseases; it is responsible for over 200 diseases and 14 different types of cancer involving every medical discipline [1]. Worldwide, the diagnosis of alcohol use disorder (AUD) ranges between 3% and 15% [1-3]. However, only 30% of patients affected by AUD attending a medical setting are clearly diagnosed [1, 2] and less than 10% of subjects with AUD are treated in specific Centers for Alcohol Addiction [1, 2]. One

reason for this underestimation is the fact that subjects with AUD tend to be in denial, often not considering their drinking habit a problem that needs to be resolved, and rarely asking practitioners or specialists for help.

In addition to the purely medical consequences, alcohol also has very serious consequences at the social level with episodes of violence, domestic and otherwise, and reckless conduct in the workplace or while driving. Road accidents due to drunk driving are one of the areas of greatest concern, given the often-fatal consequences. In Europe in 2018 alcohol consumption

was responsible for 25% of deaths due to traffic accidents [1], and in 2019 almost 1.2 million people drove under the influence of alcohol, with 10% of all traffic deaths related to alcohol use [4]. Moreover, in Italy in 2022, almost 10% of crashes were related to alcohol consumption [5]. Therefore, despite the serious consequences driving under the influence (DUI) of alcohol is a widespread phenomenon. As a consequence, driving licenses are often suspended in DUI subjects and every country has specific protocols for the termination of this suspension for subjects failing breathalyzer or involved in road accidents.

Several studies [6-10] have investigated the use of alcohol in social contexts outside medical settings (i.e., workplaces or drivers involved in traffic accidents). However, early identification of AUD in drivers who have had their driving license suspended after exceeding the legal limit of alcohol use is seldom achieved [11-13]. In particular, previously we investigated the presence of harmful drinking in a population of subjects who had their driving license suspended due to DUI [11]. Therefore, the aim of our retrospective study is to investigate the presence of AUD in a population of DUI subjects, and if they were following a specific rehabilitation program.

## MATERIALS AND METHODS

750 subjects were retrospectively enrolled from 2018 to 2021 at the University Center for the Study and Treatment of Alcohol-Related Diseases located in the Department of Internal Medicine in the SS. Annunziata Hospital of Cento (Ferrara, Italy). All subjects had been stopped at a checkpoint by the Traffic Police while driving, and their driving license withdrawn after breathalyzer showing they were over the legal limit for alcohol of 0.5 mg/dl. Following withdrawal of the driving license, subjects reported the Local Medical Commission for Driving Licenses (LMCDL) to see if they could once again be allowed [11]. When the LMCDL found some critical issues – evidence of alcohol-related diseases, alteration of the laboratory tests of alcohol misuse, high breath ethylometer level >1.5 g/l (under Italian law this is the limit above which the driver's vehicle is impounded), recidivism, DUI causing an accident, newly licensed individuals – it required further investigation to be carried out [11]. All 750 subjects in our study were checked into our Centre for a medical examination by an expert in alcohol-related problems.

During the examination, to identify problems related to the use of alcohol, a detailed medical history was taken together with blood chemistry analyses in relation to laboratory parameters of alcohol misuse: gamma-glutamyl-transpeptidase (GGT; normal value: 5-55 UI/L); aspartate aminotransferase (AST) (normal value: 5-50 UI/L), alanine aminotransferase (ALT) (normal value: 5-59 UI/L), and mean cellular volume (MCV) (normal value: 88-99 fL), carbohydrate-deficient transferrin (CDT) [2]. Scores for the administration of the alcohol use disorder identification test (AUDIT) [14] were also recorded, and DSM-V [15] was used to assess a diagnosis of AUD. Moreover, the amount of alcohol intake in

the 4 weeks before suspension of the driving license was recorded, expressed in units of alcohol (1 unit=10-12 g of pure alcohol which corresponds to 125 ml of wine, 330 ml of beer, or 40 ml of spirits) [1] per day or per occasion. All subjects attended a brief intervention consisting of counseling for 5-10 minutes aimed at educating the subjects about problematic drinking, increasing motivation to change behavior, and reinforcing skills to address problematic drinking [16, 17]. Specifically this included: a) do not drink before driving or during work; b) if you decide to drink, do it moderately (not more than 2 units of alcohol per day, and not more than 4 units per occasion for men; no more than 1 unit a day, and no more than 3 units per occasion for women) [18]; c) do not drink alcohol on an empty stomach, do not use alcohol during pregnancy, and do not use alcohol if you are in chronic pharmacological therapy. From the 750 subjects investigated, we then selected those with a diagnosis of AUD, planning a further examination one month later.

The following study is approved by the Ethics Committee (number: 704/2020/Oss/AUSLFe).

### Statistical analysis

Results are expressed as mean ± standard deviation. The analysis included continuous variables (age, average number of cigarettes per day, average daily and occasional alcohol consumption, average AUDIT score, blood alcohol level, average values of laboratory data), category variables (occupation, smoking, road accidents, recidivism, diagnosis of AUD, and in care in centre for addiction treatment) between males and females and the difference in the laboratory parameters of alcohol misuse between the first and the second examination in AUD patients with student's T and chi-square tests. A p<0.05 was considered significant. Data analyses were conducted using STATA 15.1 statistical software.

## RESULTS

The total sample consists of 750 subjects, 61 (8.1%) females and 689 (91.9%) males: the characteristics of DUI subjects are shown in *Table 1*. The mean age of the entire group was 39.2±10.8 years. Stratification of subjects according to the various age groups shows that the most were between 30 and 49 years old. Regarding employment, a statistically significant difference emerges between males and females (88.4% *vs* 72.1%: p<0.0001). In addition, 73.9% were smokers and a statistically significant difference in mean daily use of cigarettes between males and females was found (17.2±9 *vs* 14.3±7: p<0.03). Mean and occasional use of alcohol consumption and AUDIT score did not differ between males and females. Furthermore, even though not statistically significant between males and females, almost 50% of subjects showing a breath ethylometer level of >1.5 g/l. One hundred seventeen (15.6%) subjects were involved in road crashes, and 174 (23.2%) had already had their license suspended for DUI (recidivism).

Subsequently, out of the whole sample we identified 702 (93.6%) subjects without a diagnosis of AUD;

**Table 1**
Characteristics of the whole sample, and gender differences

| | | Whole sample | Females | Males | p |
|---|---|---|---|---|---|
| **Subjects** | N subjects (%) | 750 (100) | 61 (8.1) | 689 (91.9) | |
| **Age** | Mean age (mean±SD) | 39.2±10.8 | 37.7±10.5 | 39.3±10.9 | 0.249 |
| | <30 years | 158 (21.1) | 17 (27.9) | 141 (20.5) | 0.498 |
| | 30/39 | 251 (33.5) | 17 (27.9) | 234 (34.0) | |
| | 40/49 | 207 (27.6) | 18 (29.5) | 189 (27.4) | |
| | 50/59 | 100 (13.3) | 7 (11.5) | 93 (13.5) | |
| | >=60 | 31 (4.1) | 1 (1.6) | 30 (4.4) | |
| **Employment** | Yes | 653 (87.1) | 44 (72.1) | 609 (88.4) | <0.0001 |
| | No | 93 (12.4) | 17 (27.9) | 76 (11.0) | |
| **Smoking** | Yes | 554 (73.9) | 48 (78.7) | 506 (73.4) | 0.371 |
| | No | 196 (26.1) | 13 (21.3) | 183 (26.6) | |
| **N of cigarettes** | Mean daily use (mean±SD) | 16.9±8.9 | 14.3±7 | 17.2±9 | 0.033 |
| **≥10 cigarettes per day** | N subjects | 476 (63.5) | 38 (62.3) | 438 (63.6) | 0.843 |
| **Units of alcohol (grams)** | N of subjects and mean daily use (mean±SD) | 212 (28.3) 2.3±1.1 | 13 (21.3) 1.8±0.7 | 199 (28.9) 2.4±1.1 | 0.660 0.105 |
| | N of subjects and mean occasional use (mean±SD) | 489 (65.2) 2.2±0.7 | 43 (70.5) 2±0.5 | 446 (64.7) 2.2±0.7 | 0.365 0.119 |
| **Binge drinkers** | N of subjects (%) | 4 (0.5) | 0 (0) | 4 (0.6) | - |
| **AUDIT score** | N of subjects (%) | | | | |
| | <8 points | 657 (87.6) | 57 (93.4) | 600 (87.1) | 0.174 |
| | 8-13 points | 50 (6.7) | 1 (1.6) | 49 (7.1) | |
| | >13 points | 8 (1.1) | 0 (0) | 8 (1.2) | |
| **Breath ethylometer value** | Mean age (mean±SD) | 1.69±0.61 | 1.73±0.56 | 1.69±0.62 | 0.686 |
| | N subjects (%) | 519 (69.2) | 45 (73.8) | 474 (68.8) | |
| | <1.5 g/l | 164 (21.9) | 13 (21.3) | 151 (21.9) | 0.682 |
| | ≥1.5 g/l | 355 (47.3) | 32 (52.5) | 323 (46.9) | |
| **Traffic crashes** | Yes | 117 (15.6) | 14 (23.0) | 103 (14.9) | 0.099 |
| | No | 633 (84.4) | 47 (77.0) | 586 (85.1) | |
| **Recidivism** | Yes | 174 (23.2) | 9 (14.8) | 165 (23.9) | 0.103 |
| | No | 576 (76.8) | 52 (85.2) | 524 (76.1) | |

N: number; SD: standard deviation; AUDIT: alcohol use disorder identification test.

with our certification they returned to the LMCDL for the final decision on their license. Forty-eight (6.4%) subjects were diagnosed with AUD (*Table 2*) and were asked to undergo a second medical examination one month later, with the results of the new laboratory parameters for alcohol misuse. After one month a trend in the reduction of laboratory parameters, for AUDIT and alcohol consumption was observed, and a statistically significant reduction of CDT parameters was found (2.02±0.98 *vs* 1.41±0.51: p<0.0001) (*Table 3*). Moreover, some interesting results emerged (*Table 2*): the 48 subjects with AUD were middle-aged men, 12.5% were recidivist, heavy smokers, and 33.3% had a breath ethylometer level of >1.5 g/dl. None were following a treatment program, so that the final certification for the LMCDL recommended a treatment in a Centre for detoxification and a rehabilitation program for the treatment of AUD. No comparison was made between the AUD group and the remaining subjects or between males and females in the AUD group due to the low number of patients and women.

**DISCUSSION**

This study shows that 6.4% of DUI subjects were affected by AUD, and none were undergoing treatment for alcohol-related problems. Most were males, with

**Table 2**
Characteristic of patients with alcohol use disorder (AUD)

| Subjects | N subjects (%) | 48 (6.4) |
|---|---|---|
| | Males | 40 (83.3) |
| **Age** | Mean age (mean±SD) | 46.2±11.5 |
| | <30 years | 2 (4.2) |
| | 30/39 | 12 (25.0) |
| | 40/49 | 13 (27.1) |
| | 50/59 | 16 (33.3) |
| | >=60 | 5 (10.4) |
| **Employment** | Yes | 41 (85.4) |
| | No | 7 (14.6) |
| **Traffic crashes** | Yes | 9 (18.8) |
| | No | 39 (81.3) |
| **Recidivism** | Yes | 6 (12.5) |
| | No | 42 (87.5) |
| **Following a rehabilitation treatment for AUD** | Yes | 0 (0) |
| | No | 48 (100) |
| **Smoking** | Yes | 36 (75.0) |
| | No | 12 (25.0) |
| **N of cigarettes** | Mean daily use (mean±SD) | 23.8±10.1 |
| **≥10 cigarettes per day** | N subjects | 35 (72.9) |
| **Units of alcohol (grams)** | N of subjects and mean daily use | 21 (43.8) |
| | (mean±SD) | 2.8±1.1 |
| | N of subjects and mean occasional use | 23 (47.9) |
| | (mean±SD) | 2.7±1.4 |
| **Binge drinkers** | N of subjects (%) | 2 (4.2) |
| **Bretah ethylometer value** | Mean (mean±SD) | 1.8±0.8 |
| | N subjects (%) | 24 (50.0) |
| | <1.5 g/l | 8 (16.7) |
| | ≥1.5 g/l | 16 (33.3) |
| **AUDIT score** | N of subjects (%) | 46 (95.8) |
| | <8 points | 29 (60.4) |
| | 8-13 points | 14 (29.2) |
| | >13 points | 3 (6.3) |

N: number; SD: standard deviation; AUDIT: alcohol use disorder identification test.

**Table 3**
Difference between medical check 0 and medical check 1 (after one month) in the AUDIT score, laboratory markers of alcohol intake, and mean daily drinking of subjects diagnosed with alcohol use disorder (AUD)

| | Medical check 0 | Medical check 1 | |
|---|---|---|---|
| | Mean±SD | Mean±SD | p |
| **AUDIT score** | 7.04±6.69 | 5.18±3.53 | 0.067 |
| **AST (UI/L)** | 34.21±21.88 | 33.52±47.38 | 0.464 |
| **GGT (UI/L)** | 86.29±104.20 | 71.47±72.67 | 0.212 |
| **MCV (fl)** | 87.63±13.14 | 88.84±8.04 | 0.704 |
| **CDT (%)** | 2.02±0.98 | 1.41±0.51 | 0.000 |
| **Units of alcohol (units/day)** | 2.81±1.10 | 2.28±0.93 | 0.057 |

SD: standard deviation; AUDIT: alcohol use disorder identification test; AST: aspartate aminotransferase;
GGT: gamma-glutamyl-transpeptidase; MCV: mean cellular volume; CDT: carbohydrate-deficient transferrin.

the largest percentage in the 50-59-year-old range, employed, heavy smokers and with high occasional and daily use of alcohol. Many subjects had breath ethylometer level of >1.5 g/l.

The data for the diagnosis of AUD in DUI subjects are higher than in our previous study where 1.7% of DUI subjects were diagnosed with AUD [11]. However, in our previous paper DSM-V was not used and, it is likely that 4.1% of subjects considered harmful drinkers may have had a mild or moderate DSM-V diagnosis; if so, the number of DUI subjects with AUD was similar in the two studies. DSM-V is suitable in this context since it has been shown to be the most accurate tool for the diagnosis of AUD in DUI subjects [19].

Generally males drink more than women as shown in the literature, although recently there has been an increase in the numbers of females [5]. The correlation between the use of alcohol and smoking is well-known and, in this regard, as is the synergism of the two factors in determining a state of disease [20, 21]. Close to 50% of subjects declare that they use alcohol daily and the other half occasionally. Regarding daily use, risky consumption exceeds [1]: 2 units per day for men and 1 unit per day for women.

Furthermore, a worrying percentage of subject (12%) with DUI and AUD experience episodes of recidivism demonstrating that more has to be done since the risk of consuming alcohol before driving continued to be underestimated. In addition, 33% of subjects showed a level of breath ethylometer of >1.5 g/l. This is a lower percentage than in another Italian study carried out some years ago, where 50% of positive samples showed BAC concentrations above 1.5 g/L [12]. This confirms the efficacy of prevention strategies are although a lot of work remains to be done.

Regarding the AUDIT for patients with AUD, 60% had a normal score (<8 points). This may seem strange, since laboratory markers exceed normal values, but reflects the fact that subjects completing the questionnaire tried to mask their drinking habits. Indeed, it is worth noting that AUDIT is a self-administered questionnaire and the participant can deny or minimize habitual alcohol consumption, consequently we were cautious about the scores. The AUDIT questionnaire alone should not be considered an adequate tool for detection of AUD and needs to be combined with a clinical evaluation, DSM-V, and the results of blood markers for alcohol misuse. On the other hand, during the second examination a trend in the reduction of the AUDIT scores and for laboratory markers of alcohol use, particularly for CDT, was recorded. This indicates a change in the subject's previous consumption habits. It is not surprising to note that considering the very short half-life of CDT (10-12 days) compared all the other parameters (2-3 weeks for GGT and AST, and 2-3 months for MCV) [2, 22, 23], the values of CDT were significantly lower indicating complete alcohol abstinence or a substantial decrease in consumption. This result is likely related to the effect of counselling, but the lack of a control group may limit the scientific validity of this assertion. These results are in line with our previous study [11] since in subjects with harm-ful drinking an improvement of alcohol habits in the short-term period was found, as demonstrated by the significant reduction in the laboratory markers of alcohol misuse.

From the overall analysis of the entire sample, the majority of patients are male, mostly aged between 30 and 39, in employment with a higher percentage for men, and heavy smokers. This is in line with our previous experience [11] where harmful drinkers were heavy smokers. Breath ethylometer level has a worrying average value (1.69±0.61), with 47.9% at the level of ≥1.5 g/l; women recorded the highest values. This is worth focusing on; the same amount of alcohol produces more harmful effects for women who have a less efficient enzymatic set for metabolizing alcohol [24]. Another relevant finding concerns recidivism, present in 23% of the sample.

Our study has some limitations. First, subjects had their driving licenses withdrawn, a measure that is indispensable to maintain their autonomy. This involves a bias due to the strong motivation to change drinking habits in order to return to driving; this may explain the reduction of laboratory markers and AUDIT in AUD patients. Second, our study lacks a control group to compare with AUD patients and this may have shown the efficacy of our counselling intervention during the first examination. Third, our study cannot be compared with worldwide studies since the legal consumption limit in the US and other European countries is different from Italy.

## CONCLUSIONS

To sum up, the number of DUI subjects with AUD in this context was high and not specialist Centre for the treatment of alcohol addiction was involved. This is in line with the literature since only <10% of patients in Italy are treated for AUD [5]. Thus, this outpatient setting may be considered a place of primary and secondary prevention where a brief intervention may be undergone by all DUI subjects with or without a diagnosis of AUD. Those diagnosed with AUD may be entrusted to a centre and follow a rehabilitation program. As already demonstrated both in the European Union [6, 25] and in Anglo-Saxon countries [9, 10, 26-28], prevention policies have been efficient in reducing the risk of traffic accidents and deaths associated with alcohol use.

This approach needs to be continued in order to fill the gap in the treatment of the serious problem of AUD. In particular, a monitoring program involving a network of professionals (policy makers, lawyers, police, experts in forensic medicine, and experts in the diagnosis and treatment of AUD) for the detection, and treatment of subjects with AUD could be set up [29]. Controlled studies to investigate AUD and the efficacy of brief intervention with a population of DUI subjects with AUD are warranted.

### Authors' contributions

The Authors confirm their contribution to the paper as follows: study conception and design: FC, GP; papers collection: FC, GP, LL, AC, GC, RDG, GT, ES;

analysis and interpretation of results: RMP, SS, FC, GP, LL. All Authors reviewed the results and approved the final version of the manuscript. All Authors approved the final manuscript.

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