

HEAVY EPISODIC DRINKING AND ALCOHOL-RELATED INJURIES: AN OPEN
COHORT STUDY AMONG COLLEGE STUDENTS.

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1 **Heavy episodic drinking and alcohol-related injuries: An open cohort study**
2 **among college students.**

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21 **Abstract**

22 **Aim:** The objective of this study is to assess the effects of Heavy Episodic Drinking (HED)
23 on the incidence of alcohol-related injuries among university students in Spain, taking sex
24 into consideration.

25 **Methods:** We carried out an open cohort study among college students in Spain (992 women
26 and 371 men). HED and alcohol-related injuries were measured by question 3th and 9th of
27 Alcohol Use Disorders Identification Test to every participant at the ages of 18, 20, 22, 24
28 and 27. For data analysis we used a Multilevel Logistic Regression for repeated measures
29 adjusting for alcohol and cannabis use.

30 **Results:** The incidence rate of alcohol-related injuries was 0.028 year^{-1} for females and 0.036
31 year^{-1} for males. The multivariate analysis showed that among females a high frequency of
32 HED and use of cannabis are risk factors for alcohol-related injuries (Odds Ratio [OR]=2.64
33 and OR=3.68), while being more than 23 is a protective factor (OR=0.34). For males,
34 bivariate analysis also showed HED like risk factor (OR=4.69 and OR=2.51). Finally, the
35 population attributable fraction for HED among females was 37.12%.

36 **Conclusions:** HED leads to an increase of alcohol-related injuries in both sexes and being
37 over 23 years old acts as a protective factor among women. Our results suggest that about one
38 third of alcohol-related injuries among women could be avoided by removing HED.

39 **Key words:** youth, alcohol, cohort study, injury, heavy episodic drinking.

40 **1. Introduction**

41 Risk behavior, including substance use, is common among youth.[Pickett et al., 2002]
42 Specifically, rates of heavy episodic drinking (HED) behavior are increasing among young
43 people around the world.[Jernigan, 2001] This alcohol consumption pattern is characterized
44 by the intake of large amounts of alcohol in a short period of time, reaching blood alcohol
45 concentrations of 0.8g/l or greater.[National Institute on Alcohol Abuse and Alcoholism,
46 2016] Reich's research found that about 58% of youth between 22 and 23 years old practice
47 HED. This proportion decreased after 5 years, among the same participants, to 42%. [Reich et
48 al., 2015] Spain is no exception, with high rates of HED. The prevalence of HED in Spain
49 among youth from 14 to 18 years old is 41.8%. [Delegación del Gobierno para el Plan
50 Nacional sobre Drogas, 2013]

51 During the college years people acquire behavior patterns and life styles that they maintain
52 through adulthood.[Schulenberg et al., 1996] Excessive alcohol consumption during youth is
53 also associated with an increased risk of dependence and alcohol-related problems in
54 adulthood.[Grant et al., 2006] Importantly, cerebral maturity, specifically in frontal and
55 temporal regions, continue to develop during adolescence and youth. These regions are also
56 particularly susceptible to the effects of alcohol.[Guerra and Pascual, 2010] Other
57 consequences that have been associated with HED are lower academic achievement,[Mota et
58 al., 2010; Powell et al., 2004] unsafe sex [Cooper, 2002; Moure-Rodríguez et al., 2016] and car
59 accidents.[Valencia-Martín JL et al., 2008; Wechsler et al., 2003]

60 Previous studies have also shown a higher risk of alcohol-related injuries among individuals
61 that present with HED, compared to those who do not show this pattern of consumption.
62 [Rehm et al., 2002; Watt et al., 2003]. Mundt, et al. found a 43% occurrence of alcohol-related
63 injuries among Heavy Episodic Drinkers compared with 10% among non-HED, and McLeod
64 has found three times the risk of these injuries among subjects who practice HED.[McLeod et

65 al., 1999; Mundt et al., 2009]. Finally, previous studies have also shown the prevalence of
66 HED is different among both female and male college students,[Moure-Rodríguez et al., 2016;
67 Wicki et al., 2010] and HED is also significantly different from the ages of 18 to 27 years
68 old.[Moure-Rodríguez et al., 2016] Not to mention, HED's consequences could be different as
69 well.[Caamano-Isorna et al., 2017; Kypri et al., 2009; Wiersma et al., 2002].

70 Furthermore, it has been observed the consequences of alcohol use vary considerably in
71 different countries.[Graham et al., 2011] Despite our previous results of this cohort,[Moure-
72 Rodríguez et al., 2014] we are not aware of any similar longitudinal studies in European
73 countries with traditional alcohol use.

74 The objective of this study is to assess the effects of HED on the incidence of alcohol-related
75 injuries among university students in Spain, taking sex into consideration.

76

77 **2. Methods**

78 **2.1 Design, population and sample**

79 An open cohort analysis was conducted within the framework of a cohort study designed to
80 assess neurocognitive and social consequences of alcohol use. The study was carried out
81 between November 2005 and February 2015 college students from a large public university at
82 the north west of Spain. We performed a cluster sampling. From each one of the 33 university
83 schools, at least one of the freshman year classes was randomly selected (a total of 53
84 classes). The number of classes selected on each university school was proportional to its
85 number of students. All students present in the class on the day of the survey were invited to
86 participate in the study (n=1,382). Abstinent subjects and subjects who were not born in 1987
87 were excluded from the study. The study follows the principles of the Declaration of Helsinki
88 and was approved by the university ethics committee (October 2004).

89 **2.2 Data collection procedures**

90 Participants were evaluated via a self-administered questionnaire in the classroom in
91 November 2005 and again in November 2007. Students that provided their phone number were
92 further evaluated by phone at 4.5- 6.5-, and 9.0- year follow-up. On all five occasions, alcohol
93 consumption and alcohol-related injuries were measured using the Galician validated version
94 of the Alcohol Use Disorder Identification Test (AUDIT).[Saunders et al., 1993; Varela et al.,
95 2005] At baseline and at the 2-year follow-up, participants responded to additional questions
96 about age of onset of alcohol consumption and about cannabis consumption.

97 **2.3 Definition of variables**

98 In order to characterize the samples, several variables were considered: sex, place of residence
99 (parental home/away from the parental home), university entrance grade (5 - <7 points; 7 - <9
100 points; and 9 - 10 points); and maternal educational level (primary school/high

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101 school/university). The subjects were also asked about the age of onset of use of alcohol using
102 the following question: “At what age did you start drinking alcohol?” Four categories were
103 defined for age of onset of use (after 16 years old, at 16, at 15, before the age of 15).

104 *Independent variables*

105 *Heavy episodic drinking (HED) at 18, 20, 22, and 24 years old.* Question 3 of the AUDIT:
106 “How often do you have 6 or more alcoholic drinks on a single occasion? Never; less than once
107 a month; at least once a month; at least once a week; daily or almost daily”. The categories at
108 least once a month; at least once a week; and daily or almost daily were recategorized to More
109 frequently. In Spain, a standard drink corresponds to 10 grams of alcohol, therefore the
110 consumption of 6 alcoholic beverages in 2 hours results in blood alcohol concentration levels
111 of 0.8g/l.

112 *Frequency of alcohol consumption at 18, 20, 22 and 24 years old.* Question 1 of the AUDIT:
113 “How often do you have a drink containing alcohol? Never; monthly or less; two to four times
114 a month; two to three times a week; four or more times a week”.

115 *Number of alcoholic drinks on a typical day at 18, 20, 22 and 24 years old.* Question 2 of the
116 AUDIT: “How many alcoholic drinks do you have on a typical day when you are drinking? 1
117 or 2; 3 or 4; 5 or 6; 7 to 9; 10 or more”.

118 *Cannabis consumption at 18, and 20 years old.* This variable was measured with the question
119 “Do you consume cannabis when you go out? Never; sometimes; most of the times; always”.
120 The categories “most of the times” and “always” were recategorized to Usually.

121 *Dependent variable*

122 *Alcohol-related injuries at 20, 22, 24 and 27 years old.* Question 9 of the AUDIT: “Have you
123 or someone else been injured as a result of your drinking? No; yes, but not during the last year;
124 yes, during the last year”.

125

126 **2.4 Statistical analysis**

127 The follow-up was structured in 4 periods: 11/2005- 11/2007 (2 years); 11/2007 – 05/2010
128 (2.5 years); 05/2010 – 05/2012 (2 years); and 05/2012 - 02/2015 (2.5 years). Because of the
129 open cohort design of the study, the conditions of subjects may have changed during follow-
130 up. While the 9th AUDIT question refers to alcohol related injuries suffered in the past, the
131 independent variables about alcohol consumption and cannabis consumption were referred
132 about the present. Therefore, the variable “alcohol-related injuries” measured in 11/2007,
133 05/2010, 05/2012 and 02/2015 was considered as the effect of both the number of alcoholic
134 drinks on a typical day (Question 2 of the AUDIT) and the HED (Question 3 of the AUDIT)
135 having occurred in 11/2005, 11/2007, 05/2010, and 05/2012 respectively. Since we have only
136 two measures of cannabis use (11/2005 and 11/2007), we considered the alcohol-related
137 injuries in 11/2007 as the effect of the cannabis use in 11/2005, and alcohol related injuries
138 for the rest of the periods as the effect of cannabis use at 11/2007. At each stage of the study
139 the subjects than answered “Never” to the first question of the AUDIT were excluded.

140 We used multilevel logistic regression for repeated measures to obtain adjusted Odds Ratios
141 for Alcohol-related injuries. Cannabis consumption and number of alcoholic drinks on a typical
142 day (Question 2 of the AUDIT) were also considered as independent variables, because it is
143 known that both variables can result in a lower risk perception and decreased attention, which
144 may consequently lead to injury. Adjusting by both variables, we can therefore identify the
145 specific effect associated to HED. Frequency of alcohol consumption (Question 1 of the
146 AUDIT) was also considered in order to remove the abstinent subjects. The university school
147 and the class were considered as randomized variables. The follow-up time was included as an
148 offset term. Data were analyzed using Generalized Linear Mixed Models from the SPSS 20.0.

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149 Finally, in order to calculate the population impact measures, we considered the following
150 formulas.[Llorca et al., 2001] (1) To calculate the proportion of alcohol related injuries in
151 exposed subjects attributable to HED $1-(1/OR)$; and (2) To calculate the population attributable
152 fraction $pc-(pc/OR)$, being pc the prevalence of exposition in ill subjects. For both formulas,
153 OR was calculated dichotomizing the HED variable (yes/no).
154

155 **3. Results**

156 The response rate at the beginning of the study was 99.6%. Characteristics of female and male
 157 initial and follow-up samples are shown in tables 1 and 2.

158

159 Table 1. Characteristics of females in the initial and follow-up samples. Santiago de Compostela, Spain. 2005-
 160 2015.

| | Percentage or mean (95% CI) | | | | | |
|--|--|---|---|---|---|---------|
| | Initial (18-19 years old) n =992 | 2-year follow-up (20-21 years old) n =669 | 4-year follow-up (22-23 years old) n =461 | 6-year follow-up (24-25 years old) n =266 | 9-year follow-up (27-28 years old) n =325 | p-value |
| Maternal educational level | | | | | | |
| Primary school | 41.8 (38.4, 45.3) | 44.2 (40.1, 48.4) | 43.1 (38.3, 48.3) | 47.3 (41.3, 54.1) | 45.7 (40.1, 51.8) | |
| High school | 33.6 (30.2, 37.1) | 30.5 (26.4, 34.7) | 30.6 (25.8, 35.8) | 26.5 (20.4, 33.3) | 28.1 (22.5, 34.2) | |
| University | 24.6 (21.2, 28.1) | 25.3 (21.3, 29.6) | 26.3 (21.4, 31.4) | 26.1 (20.1, 32.9) | 26.2 (20.7, 32.4) | 0.642 |
| Residence | | | | | | |
| In parental home | 24.7 (22.1, 27.5) | 22.9 (19.7, 26.1) | 22.2 (18.5, 26.0) | 22.1 (18.1, 26.1) | 20.9 (16.5, 25.1) | |
| Away from the parental home | 75.3 (72.6, 78.0) | 77.1 (74.0, 80.3) | 77.8 (74.1, 81.6) | 77.9 (73.9, 81.9) | 79.1 (74.9, 83.5) | 0.720 |
| University entrance grade^a | | | | | | |
| 9 - 10 points | 45.6 (42.3, 49.1) | 43.2 (39.3, 47.5) | 43.2 (38.4, 48.3) | 43.3 (38.3, 48.8) | 47.1 (41.3, 52.9) | |
| 7 - <9 points | 48.8 (45.5, 52.3) | 50.3 (46.4, 54.6) | 50.6 (45.8, 55.6) | 50.1 (45.1, 55.6) | 47.1 (41.3, 52.9) | |
| 5 -<7 points | 5.6 (2.2, 9.0) | 6.5 (2.5, 10.7) | 6.2 (1.4, 11.2) | 6.6 (1.6, 12.1) | 5.8 (0, 11.6) | 0.977 |
| Age of onset of use of alcohol | | | | | | |
| After 16 years old | 19.0 (16.5, 21.8) | 17.9 (14.9, 21.3) | 16.5 (13.0, 20.5) | 16.7 (12.1, 22.5) | 14.5 (10.5, 19.2) | |
| At 16 years old | 38.9 (35.6, 42.2) | 38.1 (34.1, 42.2) | 36.8 (32.0, 41.7) | 40.1(33.6, 46.8) | 36.6 (30.9, 42.6) | |
| At 15 years old | 25.6 (22.7, 28.7) | 25.9 (22.3, 29.6) | 26.5 (22.2, 31.1) | 26.4 (20.8, 32.7) | 28.3 (23.0, 34.0) | |
| Before age of 15 years | 16.5 (14.0,19.7) | 18.1 (15.0, 21.5) | 20.3 (16.4, 24.5) | 16.7 (12.1, 22.5) | 20.7 (16.0, 25.9) | 0.438 |

161 a Variable with a scale of 1 to 10

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165 Table 2. Characteristics of males in the initial and follow-up samples. Santiago de Compostela, Spain. 2005-
166 2015.

| Percentage or mean (95% confidence interval) | | | | | | |
|--|--|---|---|--|--|-------------|
| | Initial (18-19 years old) n =371 | 2-year follow-up (20-21 years old) n =206 | 4-year follow-up (22-23 years old) n =139 | 6-year follow-up (24-25 years old) n =81 | 9-year follow-up (27-28 years old) n =90 | p- value |
| Maternal educational level | | | | | | |
| Primary school | 32.0 (26.5, 37.8) | 35.8 (28.4, 43.3) | 41.6 (32.8, 50.8) | 43.0 (31.6, 54.8) | 41.6 (31.5, 53.5) | |
| High school | 27.6 (22.1, 33.3) | 27.4 (19.9, 34.9) | 25.5 (16.8, 34.7) | 24.1 (12.7, 35.8) | 27.0 (16.8, 38.9) | |
| University | 40.3 (34.8, 46.0) | 36.8 (29.3, 44.3) | 32.8 (24.1, 42.0) | 32.9 (21.5, 44.7) | 31.5 (21.3, 43.4) | 0.449 |
| Residence | | | | | | |
| In parental home | 29.7(25.1, 34.5) | 27.8 (21.9, 34.1) | 28.8 (21.6, 36.4) | 31.6 (23.9, 40.6) | 28.9 (20.0, 38.3) | |
| Away from the parental home | 70.3 (65.7, 75.1) | 72.2 (66.3, 78.5) | 71.2 (64.0, 78.9) | 68.4 (60.7, 77.4) | 71.7 (62.2, 80.5) | 0.949 |
| University entrance grade^a | | | | | | |
| 9 - 10 points | 50.7 (45.3, 56.2) | 47.5 (40.6, 55.0) | 50.0 (42.0, 59.2) | 50.0 (41.4, 60.1) | 51.7 (41.6, 62.7) | |
| 7 - <9 points | 42.7 (37.3, 48.2) | 43.6 (36.6, 51.0) | 43.5 (35.5, 52.7) | 42.2 (33.6, 52.3) | 42.7 (32.6, 53.7) | |
| 5 - <7 points | 6.6 (1.1, 12.1) | 8.9 (2.0, 16.4) | 6.5 (0, 15.7) | 7.8 (0, 17.8) | 5.6 (0, 16.6) | 0.996 |
| Age of onset of use of alcohol | | | | | | |
| After 16 years old | 18.1 (12.5, 24.1) | 16.8 (9.2, 24.7) | 15.5 (6.9, 25.5) | 16.4 (6.0, 29.7) | 18.2 (7.8, 30.3) | |
| At 16 years old | 36.9 (31.2, 42.8) | 41.0 (33.5, 49.0) | 44.0 (35.3, 54.0) | 50.7 (40.3, 64.0) | 48.1 (37.7, 60.1) | |
| At 15 years old | 21.6 (15.9, 27.5) | 20.2 (12.7, 28.2) | 21.6 (12.9, 31.6) | 23.9 (13.4, 37.2) | 20.8 (10.4, 32.8) | |
| Before age of 15 years | 23.4 (17.8, 29.4) | 22.0 (14.4, 30.0) | 19.0 (10.3, 29.0) | 9.0 (0.0, 22.3) | 13.0 (2.6, 25.1) | 0.381 |

167 a Variable with a scale of 1 to 10

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169 The mean follow-up period was 5.3 years and the median follow-up period 4.6 years. The

170 number of alcoholic drinks on a typical day is greater for male students, except in the last

171 period. This number also decreased significantly over the study period for both sexes.

172 Regarding the HED practice, we can see that women have the highest prevalence at 18 while

173 men reach their peak at age 22 (Table 3).

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Table 3. Main Characteristics of the College Students throughout the follow-up study. Santiago de Compostela, Spain. 2005-2015.

| | Initial (18 years old) n=1369 | | 2-year follow-up (20 years old) n=877 | | 4-year follow-up (22 years old) n=601 | | 6-year follow-up (24 years old) n=347 | | 9-year follow-up (27 years old) n=415 | |
|---|-------------------------------------|-------------------|---|-------------------|---|-------------------|---|-------------------|---|-------------------|
| | Male (n=371) | Female (n=992) | Male (n=206) | Female (n=669) | Male (n=139) | Female (n=461) | Male (n=81) | Female (n=266) | Male (n=90) | Female (n=325) |
| Abstainers^a(%) | 11.6 | 13.9 | 7.8 | 11.8 | 7.9 | 9.8 | 7.4 | 8.6 | 12.2 | 12.3 |
| Number of drinks on a typical day^b(%) | | | | | | | | | | |
| 1 or 2 | 11.6 | 13.9 | 9.7 | 10.2 | 32.4 | 45.1 | 38.3 | 45.9 | 57.8 | 68.2 |
| 3 or 4 | 31.5 | 41.8 | 30.6 | 37.5 | 33.8 | 42.7 | 51.9 | 50.0 | 38.4 | 30.6 |
| 5 or 6 | 26.1 | 29.5 | 29.1 | 35.7 | 29.2 | 10.2 | 7.4 | 4.1 | 6.7 | 0.9 |
| 7 or 9 | 18.6 | 11.9 | 22.3 | 13.2 | 6.5 | 1.7 | 1.2 | 0.0 | 1.1 | 0.3 |
| 10 or more | 9.2 | 2.5 ^d | 6.8 | 3.1 ^d | 2.2 | 0.2 ^d | 1.2 | 0.0 | 0.0 | 0.0 |
| Heavy episodic drinking^c(%) | | | | | | | | | | |
| Never | 39.1 | 61.2 | 34.5 | 56.4 | 29.5 | 56.8 | 50.6 | 75.6 | 45.6 | 60.0 |
| Less than once a month | 25.3 | 20.9 | 26.7 | 26.9 | 27.3 | 27.5 | 32.1 | 20.3 | 21.1 | 22.5 |
| More frequently | 35.6 | 17.9 ^d | 38.8 | 16.7 ^d | 43.2 | 15.6 ^d | 17.3 | 4.1 ^d | 33.4 | 17.5 ^d |
| Cannabis consumption(%) | 27.0 | 18.6 | 19.9 | 16.1 | | | | | | |

^aNever at the Question 1 of the AUDIT: Frequency of drinking.

^bQuestion 2 of the AUDIT: Typical quantity.

^cQuestion 3 of the AUDIT: Frequency of heavy episodic drinking.

^dChi-square $p < 0.05$.

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179 Among females, 91 cases of alcohol-related injuries were detected in a follow-up period of
 180 3,257.00 years. The incidence rate of alcohol-related injuries during the follow-up was 0.028
 181 year⁻¹ [95%CI: 0.022, 0.034]. After adjusting for number of alcoholic drinks on a typical day,
 182 multivariate model revealed that a high frequency of HED and cannabis consumption were risk
 183 factors for alcohol-related injuries (OR=2.64 and OR=3.68, respectively), while being more
 184 than 23 is a protective factor (OR=0.34). The number of alcoholic drinks on a typical day was
 185 not a significant variable, but it stayed as a part of the definitive model because it was a
 186 confounding variable (Table 4).

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Table 4. Factors associated with the incidence of alcohol-related injuries during the nine year follow-up period among female participants. Santiago de Compostela, Spain. 2005-2015.

| | Bivariate Analysis | | | | Multivariate Analysis ^a | |
|--|--------------------|--------------------|---------------|----------------------------|------------------------------------|----------------------------|
| | Cases | Follow-up Years | Odds ratio | 95% confidence interval | Odds ratio | 95% confidence interval |
| Age of onset of alcohol use | | | | | | |
| After 16 years old | 7 | 476.3 | 1 | | 1 | |
| At 16 | 38 | 1,193.2 | 2.21 | 0.88, 5.56 | 2.16 | 0.93, 5.00 |
| At 15 | 25 | 833.8 | 2.16 | 0.82, 5.65 | 1.74 | 0.72, 4.23 |
| Before 15 years old | 19 | 570.8 | 2.35 | 0.86, 6.44 | 1.64 | 0.65, 4.14 |
| Heavy episodic drinking^b | | | | | | |
| Never | 28 | 1,848.9 | 1 | | 1 | |
| Less than once a month | 32 | 925.7 | 2.42 | 1.44, 4.09 | 1.64 | 0.94, 2.86 |
| More frequently | 31 | 539.1 | 4.43 | 2.60, 7.57 | 2.64 | 1.46, 4.77 |
| Cannabis consumption | | | | | | |
| Never | 58 | 2,669.5 | 1 | | 1 | |
| Sometimes | 23 | 532.1 | 2.20 | 1.31, 3.68 | 1.49 | 0.85, 2.59 |
| Usually | 10 | 112.1 | 5.51 | 2.56, 11.87 | 3.68 | 1.61, 8.38 |
| Subjects' age | | | | | | |
| 18 - 20 years | 28 | 1,158.0 | 1 | | 1 | |
| 20 - 22 years | 39 | 1,015.0 | 1.32 | 0.78, 2.23 | 1.41 | 0.83, 2.38 |
| 22- 24 years | 19 | 625.0 | 1.25 | 0.67, 2.34 | 1.45 | 0.78, 2.69 |
| 24- 27 years | 5 | 432.0 | 0.29 | 0.11, 0.80 | 0.34 | 0.11, 0.99 |
| All subjects | 91 | 3,257.00 | | | | |

^aAdjusted for all the variables included in the column and for the question 2 of the AUDIT: "How many alcoholic drinks do you have on a typical day when you are drinking?"

^bQuestion 3 of the AUDIT: "How often do you have six or more drinks on one occasion?"

190 Among males, 36 cases of alcohol-related injuries were detected in 1,011.50 years. The
 191 incidence rate was 0.036 year⁻¹ [95%CI: 0.025, 0.049]. Bivariate model revealed that a high
 192 frequency of HED and cannabis consumption were risk factors for alcohol-related injuries
 193 (OR=4.69 and OR=2.51, respectively). No changes are observed with the age (Table 5). Figure
 194 1 shows the trend of incidence rate of alcohol-related injuries for males and females.

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Table 5. Factors associated with the incidence of alcohol-related injuries during the 9-year follow-up period among male participants. Santiago de Compostela, Spain. 2005-2015.

| | Bivariate Analysis | | | |
|--|--------------------|--------------------|---------------|----------------------------|
| | Cases | Follow-up Years | Odds Ratio | 95% confidence interval |
| Age of onset of alcohol use | | | | |
| After 16 years old | 2 | 155.5 | 1 | |
| At 16 | 14 | 413.1 | 2.92 | 0.64, 13.35 |
| At 15 | 7 | 198.2 | 2.91 | 0.58, 14.57 |
| Before 15 years old | 11 | 157.1 | 6.8 | 1.42, 32.50 |
| Heavy episodic drinking^a | | | | |
| Never | 6 | 347.5 | 1 | |
| Less than once a month | 5 | 275.7 | 1.13 | 0.33, 3.84 |
| More frequently | 25 | 391.0 | 4.69 | 1.83, 12.0 |
| Cannabis consumption | | | | |
| Never | 25 | 783.6 | 1 | |
| Sometimes | 7 | 170.4 | 1.45 | 0.58, 3.62 |
| Usually | 4 | 60.2 | 2.51 | 0.77, 8.19 |
| Subjects' age | | | | |
| 18 - 20 years | 11 | 364.0 | 1 | |
| 20 - 22 years | 12 | 322.5 | 0.94 | 0.40, 2.22 |
| 22 - 24 years | 8 | 190.0 | 1.40 | 0.54, 3.62 |
| 24 - 27 years | 5 | 135.0 | 0.86 | 0.28, 2.61 |
| All subjects | 36 | 1,011.5 | | |

^aQuestion 3 of the AUDIT: "How often do you have six or more drinks on one occasion?"

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201 Fig 1. Incidence rate of alcohol-related injuries at the different ages for males and females.

202

203 Finally, in relation to population impact measures, our study found that the population
 204 attributable fraction for HED among females was 37.12%. This proportion was not calculated
 205 for males given that multivariate analysis cannot be generated.

206

207 **4 Discussion**

208 Our results show a strong association between HED and the incidence of alcohol-related
209 injuries in men and women in the bivariate analysis. This association has only been confirmed
210 for women with multivariate analysis. The relationship persisted after adjusting for
211 confounding variables such as the number of alcoholic drinks consumed on a typical day, and
212 cannabis consumption.

213 Regarding the evolution of the practice of HED we found a bell-shaped trend, which coincides
214 with the trends observed in other countries.[Bewick et al., 2008; Kandeld and Logan, 1984]
215 The fact that women reach their peak HED consumption earlier than men has been observed in
216 other studies and a possible explanation could be an earlier maturity in women.[Andersson et
217 al., 2007; Bates and Labouvie, 1997] Further studies are needed to confirm these results, as
218 these differences in consumption prevalence with respect to sex may have important
219 implications in establishing effective preventative measures.

220 Several papers have previously found an association between alcohol use and injury.[Rehm et
221 al., 2002] Of particular interest is the association of alcohol-related injuries to the volume of
222 alcohol consumed before injury, which seems to be more important than the quantity of alcohol
223 usually consumed or how often alcohol is consumed.[McLeod et al., 1999] However, most of
224 studies on this topic have been conducted at the emergency departments of hospitals or health
225 centers; thus, they take into account only injuries that require subsequent medical attention.
226 Our study considered all injuries reported by the participants, not only those that need medical
227 attention. Our study therefore analyzed participants' relationships to the characteristic
228 consumption pattern of this vital stage.

229 As mentioned previously, alcohol consumption is influenced by gender. In Mediterranean
230 countries, alcohol use it is traditionally practiced by male, but among young people gendered

231 differences are decreasing.[Cortés et al., 2011] We have taken gender into account in our
232 analysis to assess whether these differences are maintained among college students. Our study
233 found a significant association between alcohol-related injuries and HED in men, although the
234 sample size did not permit multivariate analysis. Other studies have showed more negative
235 consequences to alcohol use in men.[Graham et al., 2011]

236 Regarding age, we can see that age greater than 23 years old acts as a protective factor for
237 alcohol-related injuries. High doses of alcohol decrease the activity of some brain regions
238 involved in error processing, prevention of compulsive actions, behavior regulation, cognition,
239 and coordination of motor activities.[Anderson et al., 2011] This could increase the risk of
240 injury. The fact that risk of injury is lower after 23 years of age can be explained by tolerance
241 developed by students, over time. Another possible reason could be that individuals at this age
242 are more mature, so they practice Binge Drinking in safer contexts and assume fewer risks, and
243 therefore injuries are less frequent.[O`Malley, 2004]

244 The fact that cannabis use was found to be risk factor for alcohol-related injuries allows us to
245 suggest that multiple drug use may be an interesting point of evaluation in future studies
246 among this population.

247 Our findings suggest that an important part of alcohol-related injuries among college students,
248 all through university period and also when this period is over, is due to HED consumption
249 pattern. Preventive measures, therefore, must be implemented in order to reduce heavy
250 episodic drinking practices among college students and so as to avoid an important part of the
251 negative consequences of alcohol consumption, such as alcohol-related injuries. It is
252 fundamental to act to reduce the accessibility of alcohol to college students through strictly
253 applied legislative measures.

254 Young people are particularly affected by alcohol prices because of their limited economic
255 resources. Therefore, administrative measures, such as raising taxes on alcoholic beverages,
256 would act to reduce their alcohol consumption.[Ivano Scandurra et al., 2011; Laixuthai and
257 Chaloupka, 1993] It would also be effective to ban promotional packaging that mixes alcohol
258 with sodas, thus promoting excessive alcohol consumption in youth. Increasing the minimum
259 legal age for alcohol consumption has been associated with fewer car accidents and suicide
260 among young people, even without tight compliance control.[Griffith, 1997]

261 Youth are especially vulnerable to alcohol promotion and publicity; binge drinkers in
262 particular seem to be the most susceptible.[Sassi, 2015] Strict policy for regulating and
263 limiting the advertisement of these products, therefore, is essential.

264 Other measures, such as brief motivational interventions or skill-based interventions, appear
265 effective among young people, specifically among college students when they are given
266 personalized feed-back.[Larimer and Cronce, 2007] College freshmen are particularly
267 disposed to these interventions and therefore a general intervention could be interesting in this
268 subpopulation.[Larimer and Cronce, 2007]

269 We must take into account that our social context may generate strong opposition to any
270 measures that try to decrease alcohol consumption. On one hand, Spanish society is quite
271 permissive with regards to alcohol use. However, Spain alcohol industry is also very
272 important -- Spain being one of the most important wine producers in the world with an
273 important tourism industry.[Calafat, 2002]

274 Our study largely confirms what is known from the literature: HED is related to alcohol-
275 related injuries. We do not know of, apart from our previous studies, another longitudinal
276 study in Mediterranean European Countries, which associates the HED with alcohol-related
277 injuries among college students. We must not forget that this cohort has been followed up

278 beyond the university period and the association does not disappear. This is an interesting
279 result as tends to be understood in Mediterranean countries as a pattern of consumption
280 limited to the vital period of adolescence and early youth. Our university students did not only
281 continue practicing HED after ending their university periods, they also continued suffering
282 some of its negative consequences. Our results highlight the importance of avoiding HED
283 among youth.

284 There are six main limitations to this study: 1) there is a possibility of selection bias, due to
285 loss of subjects at follow-up. However, the absence of significant differences between the
286 initial samples and the follow-up samples suggests the absence of a selection bias; 2) self-
287 reported data may be skewed due to inconsistent personal feelings or memories. However, the
288 AUDIT questionnaire has been internationally validated in adolescents and young adults; 3)
289 the most appropriate definition of HED in Spain implies differences between sexes: more than
290 five alcoholic beverages for women and more than six for men, on a single occasion. The
291 third question of the AUDIT therefore underestimates the prevalence of HED in women.
292 However, this limitation will mainly affect descriptive and not analytical statistics; 4) subjects
293 may have minimized the role of alcohol in the occurrence of injuries; 5) subjects were not
294 asked how many injuries they had suffered, only whether they had or had not suffered an
295 injury; 6) when subjects responded “Yes, but not in the last year” we only considered that this
296 was a new instance of injury if the subject had not reported a previous alcohol-related injury
297 in a previous AUDIT.

298 **5 Conclusions**

299 We can conclude that heavy episodic drinking leads to an increase of alcohol-related injuries
300 among both male and female college students. This shows a new dimension on the
301 consequences of this public concern already related with a variety of health and social

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302 problems. Furthermore, our results allow us to suggest that about one third of alcohol-related
303 injuries could be avoided by removing this consumption pattern.

304

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309

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