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Binge drinking is associated with reduced quality of life in young students: A pan-European study



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ABSTRACT

Background: Binge drinking (BD) is frequently observed in youth, with psychological and cognitive consequences, but its link with quality of life has been scarcely explored.

Methods: Sociodemographic and alcohol consumption characteristics were collected in a cross-sectional survey including 15,020 European students. Health-related quality of life was assessed using the Alcohol Quality of Life Scale (AQoLS) measuring the self-reported negative impact of alcohol consumption. A flexible link function, using Bayesian P-splines, was used to study the relationship between alcohol-related quality of life and alcohol consumption.

Results: A non-linear relationship between BD and AQoLS scores was identified, showing that: (1) For students presenting moderate BD pattern, alcohol consumption is related to a robust reduction in quality of life, this link remaining stable for students with more intense BD patterns; (2) BD are not strongly associated with social, personal, and work activities, but are linked to an increase in perceived loss of control over consumption; (3) Harmful or hazardous consumption is also related with a massive decrease in quality of life; (4) The strongest relationship between BD and impacted quality of life is found among males and Eastern European students.

Conclusions: These results demonstrate the importance of measuring the perceived relation between alcohol and quality of life, beyond the classically assessed consequences, as this relation is strong among young students. Prevention programs should take this into account, notably regarding the perceived loss of control over alcohol consumption, which constitutes a key factor for the emergence of severe alcohol-use disorders.

1. Introduction

Binge drinking (BD), an excessive but episodic alcohol consumption pattern, is characterized by intense alcohol intoxication over a short period of time (Naimi et al., 2003). This harmful consumption pattern has recently become highly prevalent among college students (Hingson et al., 2009; Miller et al., 2004) and constitutes a major public health concern (Kuntsche et al., 2004; Naimi et al., 2003). Indeed, BD is related to mental and physical health problems, including risky behaviors, but also long-term cognitive and brain consequences (Hermens et al., 2013; Kuntsche et al., 2017).

Despite these largely documented negative outcomes, BD

prevalence remains high among students, notably because they underestimate its real consequences (Mallett et al., 2006). It seems therefore important to better define the impact of this consumption pattern, especially on quality of life. Indeed, several studies have shown that both frequency and intensity of BD are associated with poor general health-related quality of life (Mohamed and Ajmal, 2015; Okoro et al., 2004; Wen et al., 2012). However, these studies have used either generic self-rated health scales not specifically exploring alcohol-related variables or very simple self-reported measures (i.e., number of physically or mentally unhealthy days), which only offer a vague picture of well-being and are unable to specifically reflect the impact of alcohol consumption on quality of life (Luquiens et al., 2012). Only one

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study has directly explored the influence of BD using the Alcohol Quality of Life Scale (AQoLS; [Luquiens et al., 2014, 2015](#)), which assessed the subjective negative impact of alcohol consumption on quality of life. This study centrally showed that, compared with non-binge drinkers, French students with at least one BD episode during the past month reported an increased negative impact of alcohol on their quality of life ([Luquiens et al., 2016](#)). In particular, BD frequency (but not intensity) was independently associated with quality of life impairments. Moreover, the main reported impacts of BD were reduced sleep quality, impoverished living conditions, increased negative emotions, and reduced socio-cultural activities.

While these results offered crucial first insights by suggesting a strong relationship between BD and negative subjective impact on quality of life, they presented several limits. First, only French students were included in the sample, hampering generalization towards other student populations. Indeed, alcohol consumption culture and BD prevalence strongly vary across European countries, BD being more prominent in Northern/Eastern than Southern Europe ([ESPAD, 2015](#); [Kuntsche et al., 2004](#); [Mikolajczyk et al., 2016](#)). Moreover, gender differences in BD habits (usually more intense among men) have been recently found to be reduced in some countries ([Jang et al., 2017](#)), but nothing is currently known regarding this evolution in Europe. Second, the definition and measure of BD habits were quite imprecise, quantitatively and temporally. The period considered to differentiate BD and non-BD groups (e.g., monthly, in the previous 2-weeks, in the previous 6-months) strongly influences the reported BD prevalence and impacts the homogeneity of selected groups ([Kuntsche et al., 2017](#); [Tavolacci et al., 2016](#)). Specifically, when exploring BD influence on quality of life, it appears crucial to consider a sufficiently large period of time to assess these mid- and long-term anchored behaviors and their consequences. Third and finally, the relation between BD and quality of life was explored using simple linear models (e.g., linear correlation), totally ignoring potential non-linear relations. To better characterize the link between these factors, more flexible models containing a linear fit as a particular case, such as the P-splines model, could estimate the link between two measures without specific parametric assumption ([Bremhorst et al., 2017](#); [Eilers and Marx, 1996](#); [Jullion et al., 2009](#)).

To overcome these limits and deepen the understanding of the relationships between alcohol consumption and quality of life, a large-scale study was conducted among young European students. Importantly, we went beyond classical statistical linear analyses by using a flexible link function using Bayesian P-splines to study non-linear relations between quality of life and alcohol consumption ([Jullion and Lambert, 2007](#); [Lang and Brezger, 2004](#)). More specifically, we explored: (1) the differential negative link between global alcohol consumption (as measured by the Alcohol Use Disorders Identification Test; AUDIT; [Babor et al., 2001](#)) and specific BD pattern (as measured by BD score computation; [Townshend and Duka, 2002, 2005](#)), evaluated on a mid-term period, and a wide range of quality of life factors; (2) the variability of alcohol consumption and its relation with quality of life across European regions; and (3) the gender effect on alcohol-related quality of life, as gender differences have been reported regarding BD prevalence ([Kuntsche and Gmel, 2013](#); [Mäkelä et al., 2006](#)). Based on the results reported in a French students' population ([Luquiens et al., 2016](#)), we hypothesized that students with a larger alcohol consumption (in particular with high BD and AUDIT scores) would have a higher level of subjective impact of alcohol on quality of life.

2. Methods

2.1. Settings and participants

A large cross-sectional online survey explored global alcohol consumption and BD habits among young adults from European universities. The survey was disseminated through international students

associations' mailing lists and social networks between August and November 2016. 21,980 participants completed the whole survey (8,457 others only partly completed it). Teetotalers ($n = 1629$, 7.4% of the sample) were excluded, and a subsample of 15,020 participants was selected (selection rate of 68%) to focus on participants between 18 and 35-years of age who were currently students in a European country. All participants gave online consent before starting the survey, and their anonymity was guaranteed. The study protocol was approved by the ethical committee of the Université catholique de Louvain and conducted in accordance with the Declaration of Helsinki.

2.2. Procedure and measures

The survey, implemented in Qualtrics software (Qualtrics, LLC, Provo, OR, USA) and available in four languages (English, French, Spanish, and Italian), assessed sociodemographic variables (age, gender, and country), alcohol-consumption habits and health-related quality of life. Alcohol consumption was assessed by the AUDIT, a 10-item questionnaire measuring the general intensity of alcohol consumption during the last twelve months (score range: 0–40; [Babor et al., 2001](#)). Three complementary items evaluated consumption speed (number of alcohol units consumed per hour), frequency of drunkenness episodes, and percentage of drunkenness episodes compared to the total number of drinking episodes in the last six months, leading to a score specifically measuring binge-drinking consumption, following the formula ([Townshend and Duka, 2002](#)): $[(4 \times \text{consumption speed}) + (\text{drunkenness frequency} \times 0.2 \times \text{drunkenness percentage})]$. This BD score has been widely used in the literature. Finally, health-related quality of life was assessed using the AQoLS ([Luquiens et al., 2014](#)), exploring the specific impact of alcohol on quality of life during the last month. The AQoLS comprises 34 items, measuring seven dimensions: Activities (e.g., I have felt I miss out on everyday activities with family and friends), Relationships (e.g., Alcohol has interfered with my relationships with friends), Living conditions (e.g., Alcohol has had a negative effect on my housing situation), Negative emotions (e.g., I have worried about alcohol causing problems in my life), Self-esteem (e.g., I have neglected my general health), Control (e.g., I have planned my days around alcohol) and Sleep (e.g., I have not been getting enough sleep). For each item, participants indicated their level of agreement on a 4-point Likert scale (0 = Not at all, 1 = A little, 2 = Quite a lot, 3 = Very much). AQoLS total score and dimensions sub-scores were computed. Cronbach's alpha for the AQoLS total score was excellent (0.92).

2.3. Statistical analyses

First, descriptive analyses of the demographic, alcohol consumption, and AQoLS variables were reported ([Table 1](#)). Direct gender and regions comparisons were made, respectively using independent *t*-tests and one-way ANOVAs. Post-hoc *t*-tests were corrected for multiple comparisons (Bonferroni correction). Second, the link between alcohol consumption and quality of life was explored through a classical linear approach (Bonferroni-corrected Pearson linear correlations) and non-parametric Bayesian approach (flexible link function using Bayesian P-splines; [Eilers and Marx, 1996, 2010](#); [Jullion and Lambert, 2007](#); [Lang and Brezger, 2004](#); see Appendix A in Supplementary Material). Analyses were conducted between October 2017 and March 2018.

3. Results

3.1. Demographic, alcohol consumption, and AQoLS measures

The final sample ($N = 15,020$) comprised 10,825 females (72.1%) with a mean age of 21.9 ± 2.30 years old. Students, from 38 countries, were grouped in four geographical regions (according to EuroVoc classification; see [Table B.1](#) in Appendix B in Supplementary Material):

Table 1

Sample's characteristics on demographic, alcohol consumption and quality of life measures. Significantly larger values related to Gender and European regions comparisons are indicated in bold text.

Measures	Total sample (N = 15020)	Gender		European Regions			
		Male (n = 4195)	Female (n = 10825)	Eastern (n = 4163)	Northern (n = 1080)	Southern (n = 7064)	Western (n = 2713)
Demographic measures							
Age [mean (SD)]	21.9 (2.3)	22.4 (2.5)	21.7 (2.2)	22.0 (2.2)	22.7 (2.6)	21.7 (2.2)	22.1 (2.4)
Gender ratio (female/male, in %)	72/28	/	/	71/29	72/28	71/29	76/24
Alcohol consumption measures [mean (SD)]							
Alcohol Use Disorder Identification Test score	7.64 (4.9)	9.12 (5.4)	7.07 (4.6)	7.59 (4.9)	8.09 (5.0)	7.16 (4.7)	8.78 (5.2)
Binge Drinking score	14.25 (13.4)	17.28 (15.1)	13.08 (12.5)	13.78 (12.8)	13.46 (13.1)	15.99 (14.1)	16.37 (14.5)
Frequency (Number of occasions per week)	1.41 (1.1)	1.72 (1.2)	1.29 (0.9)	1.29 (1.0)	1.23 (0.9)	1.46 (1.1)	1.54 (1.1)
Quantity (Number of alcohol units per occasion)	3.84 (5.5)	5.55 (7.7)	3.18 (4.3)	3.57 (5.7)	3.59 (5.1)	3.63 (5.3)	4.89 (6.1)
AQoLS dimensions [mean (SD)]							
Activities	1.75 (2.7)	2.27 (3.3)	1.55 (2.5)	1.97 (2.9)	1.88 (2.8)	1.63 (2.7)	1.68 (2.6)
Relationships	0.93 (1.6)	1.20 (1.9)	0.82 (1.5)	1.05 (1.8)	1.00 (1.7)	0.86 (1.6)	0.88 (1.5)
Living conditions	0.61 (1.1)	0.84 (1.5)	0.52 (1.1)	0.77 (1.4)	0.71 (1.3)	0.52 (1.1)	0.55 (1.0)
Negative emotions	0.58 (1.0)	0.73 (1.2)	0.52 (0.9)	0.61 (1.1)	0.68 (1.1)	0.58 (1.1)	0.49 (0.9)
Self-esteem	0.78 (1.5)	0.97 (1.8)	0.70 (1.4)	0.91 (1.7)	0.97 (1.7)	0.71 (1.5)	0.69 (1.4)
Control	0.37 (1.1)	0.56 (1.5)	0.30 (0.9)	0.45 (1.3)	0.42 (1.1)	0.35 (1.1)	0.32 (0.9)
Sleep	0.75 (1.2)	0.83 (1.3)	0.71 (1.2)	0.70 (1.2)	0.83 (1.2)	0.74 (1.2)	0.81 (1.2)
AQoLS Total [mean (SD)]	5.77 (8.3)	7.40 (10.3)	5.14 (7.3)	6.45 (9.1)	6.49 (8.7)	5.39 (8.1)	5.42 (7.4)

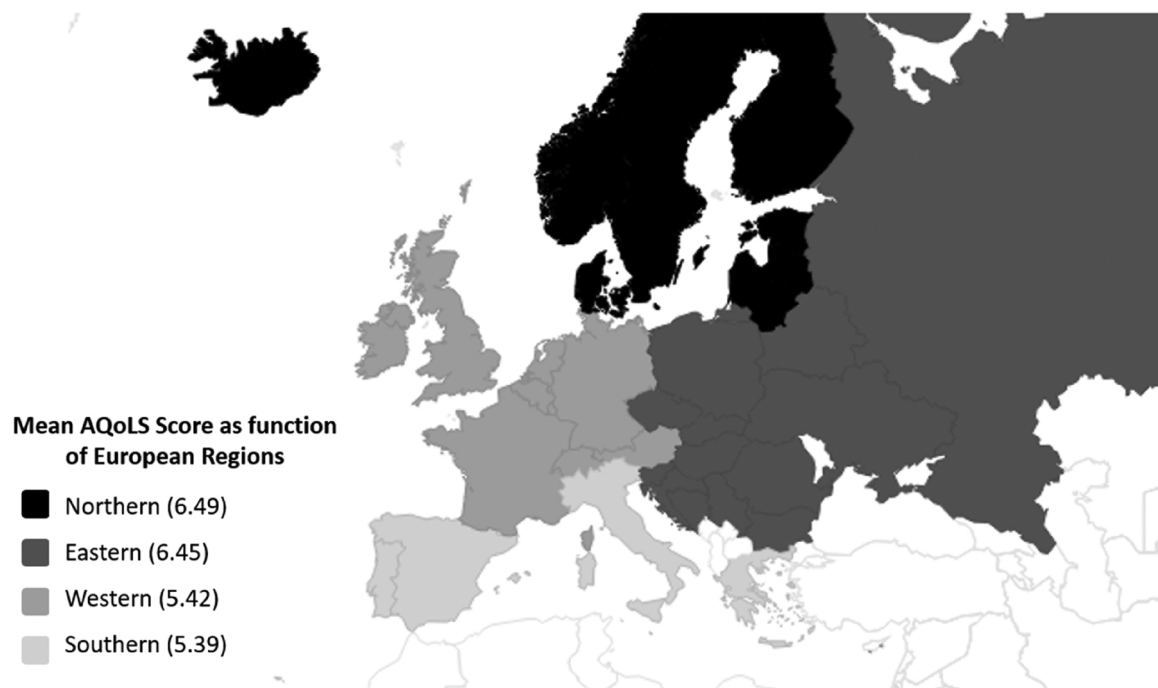


Fig. 1. Distribution of the mean AQoLS Total score as a function of European regions (Eastern, Northern, Southern, and Western).

Eastern (n = 4163), Northern (n = 1080), Southern (n = 7064), and Western (n = 2713; Fig. 1). Tobacco consumption during the last six months was found in 20.1% of the sample (6.86 ± 5.5 cigarettes per day), cannabis in 30.9%, and other drugs in 8%. Alcohol-related data are provided in Table 1. Mean age and geographical distribution of our sample were highly similar to those of the global European students' population (Eurostat report, 2015). It should, however, be underlined that, although a majority of women was globally reported among European students (i.e., 54.1% of women; Eurostat report, 2015), the over-representation of females was stronger in the present sample.

A main effect of region was observed for BD ($F(3,15019) = 38.723$, $p < .001$) and AUDIT ($F(3,15019) = 73.630$, $p < .001$) scores. Post-hoc comparisons showed that: (1) BD score was larger in Western/Southern regions than Eastern/Northern ones (all p -values $< .001$), (2)

the largest AUDIT score was observed in the Western region, the Southern presenting the smallest one. Significant differences were observed for the total AQoLS score ($F(3,15019) = 18.574$, $p < .001$): Eastern/Northern regions had larger scores than Southern/Western ones (Fig. 1). Gender comparison revealed larger BD ($t(15018) = 17.360$, $p < .001$), AUDIT ($t(15018) = 23.215$, $p < .001$), and AQoLS ($t(15018) = 15.049$, $p < .001$) scores for males.

3.2. Link between alcohol consumption and quality of life

3.2.1. Classical linear approach

All correlations between alcohol consumption variables and AQoLS were significant (all p -values $< .001$), but the linear assumption was not supported by the data (even after logarithmic transformation), as

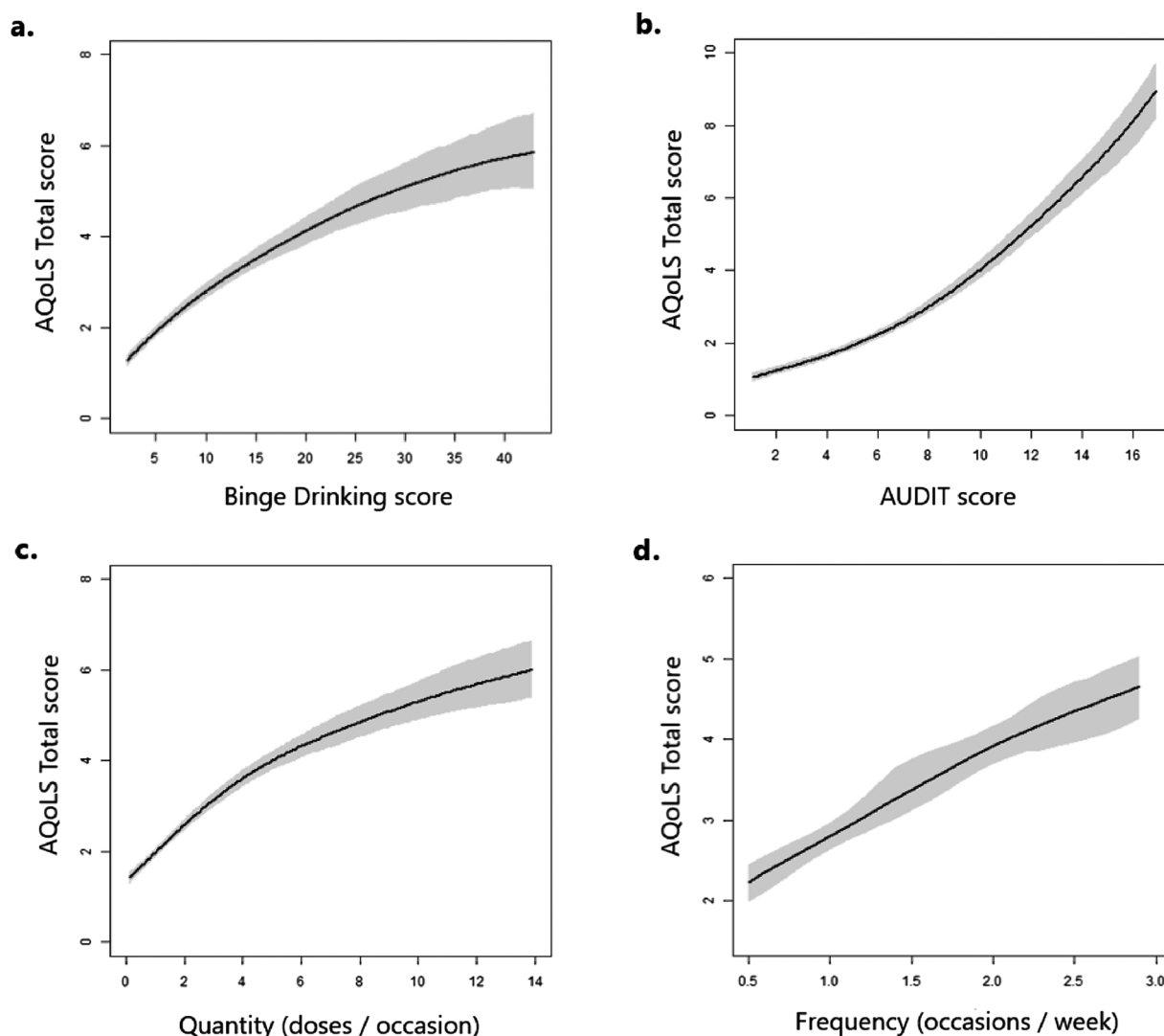


Fig. 2. Estimate [with the 95% simultaneous credible interval in (dark grey)] of the link between AQuLS Total score and BD score (a), AUDIT score (b), Quantity (c), and Frequency (d) using the Bayesian P-splines model. A stronger positive relation between BD and AQuLS score was observed for BD scores between 2 and 25 (a), while AQuLS scores remained quite constant with further increase in BD scores (25–43). Similar relationship was found between AQuLS score and the Quantity of alcohol consumed (c). The link between AQuLS score and Frequency of alcohol consumption was linear (d). Finally, a non-linear relationship was observed between AQuLS and AUDIT scores, this relation being particularly strong for AUDIT scores between 8 and 16.

illustrated in Fig. C.1 (see Appendix C in Supplementary Material) for the BD score - AQuLS score relation.

3.2.2. The P-splines model

Since no classical shape can be deduced from the above scatterplot, we used a flexible link function using (Bayesian) P-splines (Jullien and Lambert, 2007). The P-splines model was first fitted on the complete sample to estimate the AQuLS - BD scores link. The relation is not linear (Fig. 2a): the subjective impact of BD on AQuLS score presents a stronger increase for BD scores between 2 and 25, while AQuLS influence remained constant with higher scores (25–43). BD effect on quality of life thus seems especially strong when moving from a low (BD score < 5) to moderate binge drinking (10–25), whereas the transition towards intense (> 25) or very intense (> 35) BD scores is not characterized by an increase of quality of life consequences. The link function is only illustrated on the 90% BD score confidence interval [2,43] to avoid over-interpretation with increasing uncertainty.

In a second step, the relation between other alcohol consumption variables (AUDIT score, frequency, and quantity) and the total AQuLS score was assessed. The link between AQuLS Total score and Quantity (Fig. 2c) is highly similar to the one observed between AQuLS Total

score and BD score (Fig. 2a). Conversely, a linear relationship was observed between AQuLS Total score and Frequency of alcohol consumption (Fig. 2d): The higher the number of alcohol drinking occasions per week, the larger the negative subjective impact on quality of life. Finally, a non-linear relationship was observed between AUDIT and AQuLS scores (Fig. 2b): From a consumption considered as hazardous regarding AUDIT cut-off scores (AUDIT > 8), a significant impact on the quality of life is observed. This deleterious effect increases when approaching harmful consumption (AUDIT > 16; Babor et al., 2001).

Then, to determine the differential influence of BD on AQuLS subscales, the links between BD score and each AQuLS dimension were measured through two-by-two Bonferroni corrected comparisons (See Table D.1 in Appendix D in Supplementary Material), showing that: (1) BD score has a significantly larger negative impact on *Control* (i.e., feeling of losing control over one's alcohol consumption) than on all other subscales; (2) the *Activities* dimension (i.e., restrictions encountered regarding engagement in family, social, and work activities due to alcohol consumption) was the least affected subscale when BD score increased. For a graphical representation of significant differences, see Appendix D (Fig. D.1 & D.2 in Supplementary Material). Moreover, these two-by-two comparisons were also performed for each

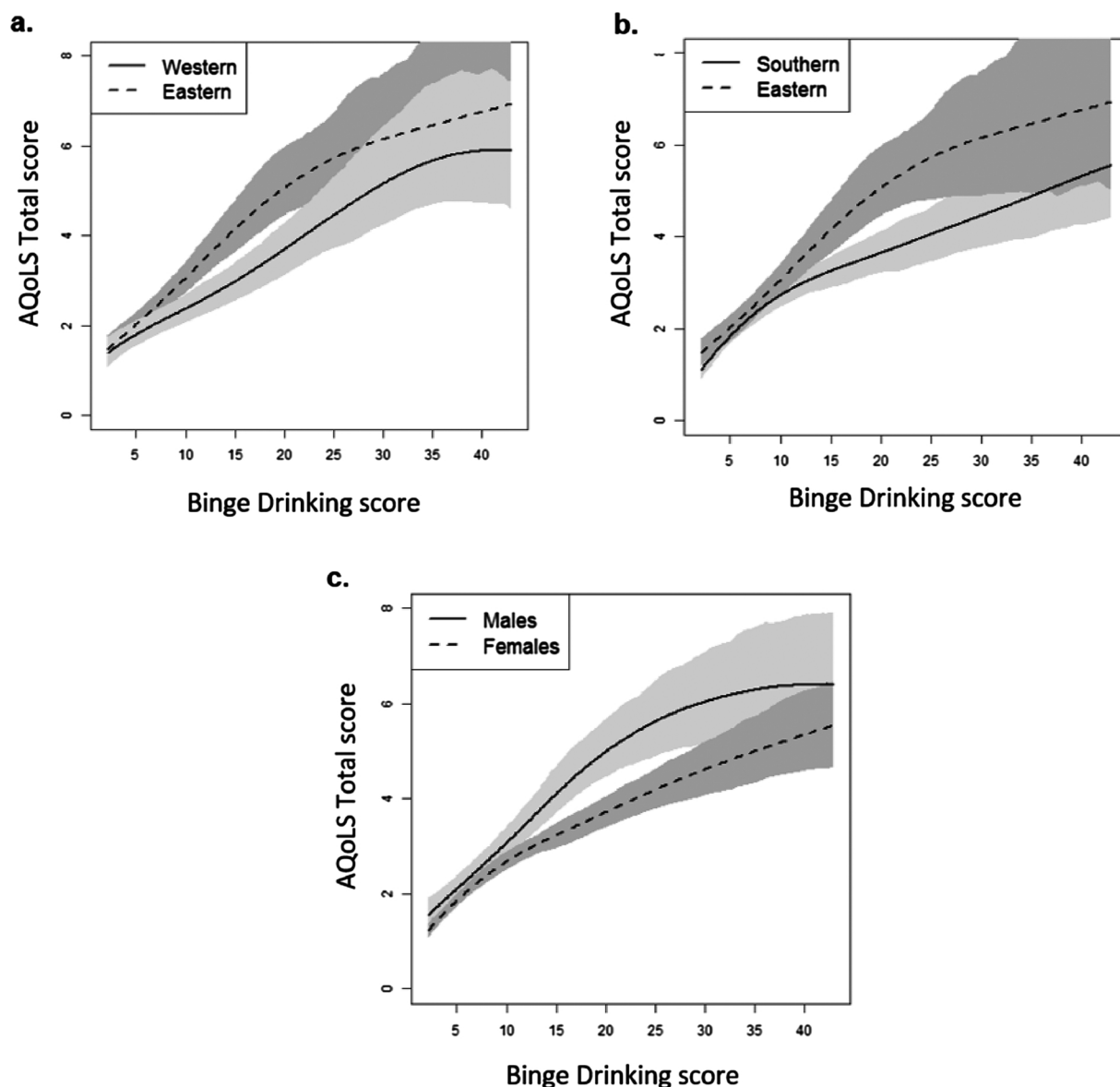


Fig. 3. Estimates [with the 95% simultaneous credible interval in (dark) grey] of the link between AQuLS Total score and BD score for (a) Western (solid line) and Eastern (dashed line) regions, for (b) Southern (solid line) and Eastern (dashed line) regions, and for (c) males (solid line) and females (dashed line) using the Bayesian P-splines model. A stronger relation between BD score and AQuLS was observed in Eastern compared to Western (a) and Southern (b) regions. The relation between BD score and AQuLS was larger for males than females only for BD scores between 12 and 29.

gender separately, and similar results were observed. The differential relation between BD and AQuLS scores across European regions was also explored, showing larger subjective impact in Eastern compared to Western (Fig. 3a) and Southern (Fig. 3b) regions, no difference being observed across other regions.

Finally, as significant alcohol consumption differences were observed between males and females, and to take into account the gender imbalance of our sample, similar analyses were performed independently for males and females. A significant difference was found between the fitted curves for BD scores between 12 and 29, where the subjective impact on AQuLS Total score was larger for men (Fig. 3c). Such comparisons were also computed for each AQuLS dimension (see Appendix E in Supplementary Material for graphical representations; Fig. E1), revealing a larger impact of the BD score on the *Activities*, *Living conditions*, *Negative emotions*, *Control*, and *Relationship* dimensions among males, while no significant differences were shown for *Self-esteem* and *Sleep*.

4. Discussion

Through a large cross-sectional European survey, this study explored the links between alcohol consumption behaviors, particularly BD habits, and quality of life among students. By using a recently developed and validated scale specifically exploring alcohol-related quality of life (Luquiens et al., 2014, 2015), a direct self-reported assessment of alcohol's negative impact was performed, encompassing highly relevant dimensions for students (e.g., loss of control, self-esteem), which are not considered in generic health-related quality of life questionnaires (Luquiens et al., 2012). Moreover, the use of non-parametric statistical analyses (Lang and Brezger, 2004) allowed to go beyond classical linear analyses, offering new insights into the links between alcohol consumption and quality of life.

As a whole, binge drinking among young European students was associated with decreased quality of life, as previously observed in French (Luquiens et al., 2016), Irish (Mohamed and Ajmal, 2015), and

US (Okoro et al., 2004) adults. However, non-parametric statistical models allowed to overstep the limits of classical linear approaches, and non-linear relations were better characterized. Indeed, beyond significant linear correlations, as previously reported (Luquiens et al., 2016), a deeper exploration of the distribution of BD and AQuLS scores revealed a more complex relationship: the effect of alcohol consumption on quality of life is particularly strong for moderate BD pattern (i.e., BD score: 2–25), while the further increase of BD score (25–43) leads to a more constant influence on AQuLS score. The negative influence of alcohol consumption on quality of life is thus centrally determined by the presence of BD habits rather than by their intensity. This finding is confirmed by the results observed when the quantity and frequency of drinking are respectively considered: a similar relationship between the mean number of alcohol doses consumed per occasion (i.e., the central characteristic of BD) and the AQuLS score was indeed observed, while the link between this quality of life score and the frequency of alcohol consumption (i.e., mean number of drinking occasions per week) is rather linear. This linear relationship extends previous results in French and US binge drinkers by suggesting that drinking frequency is a critical issue which should be better taken into account by prevention programs (Luquiens et al., 2016; Okoro et al., 2004). Until now, reducing drinking intensity (i.e., the quantity of alcohol consumed per occasion) constitutes the main goal of brief interventions among binge drinkers (Luquiens et al., 2016). In view of the linear relation between consumption frequency and quality of life, developing alternative prevention campaigns targeting consumption frequency rather than intensity might have a more significant impact to limit the subjective negative effects of alcohol consumption on quality of life.

The link between AUDIT (globally assessing the intensity and dangerousness of alcohol consumption) and AQuLS scores present a different profile. While light drinkers (AUDIT score: 1–8) did not report a significant subjective impact of alcohol on their quality of life, a negative influence was observed for AUDIT scores higher than 8, corresponding to a hazardous alcohol consumption (Babor et al., 2001). Moreover, when alcohol consumption pattern becomes harmful (AUDIT score: 16–19) or indicates the potential presence of severe alcohol-use disorder (AUDIT score: 20–40), a strong increase in the negative effect of alcohol on quality of life was observed in a linear way. The differential influence of AUDIT and BD scores observed on quality of life suggests that these two scores measure different consumption behaviors and confirms that, despite the AUDIT is the most widespread screening tool to identify high-risk alcohol consumption in youth (Hagman, 2016; Patton et al., 2014), it is not adapted to measure BD habits and their consequences on quality of life (Blank et al., 2015; Cortés-Tomás et al., 2017; Letourneau et al., 2017).

Complementary analyses related to each AQuLS subscale revealed a larger subjective impact on *Control*, particularly for low BD scores (i.e., 5–15), suggesting that even low BD habits are related to the emergence of feelings of losing control over alcohol consumption. This finding is in line with the executive deficits frequently reported in BD, like reduced planning (Hartley et al., 2004), decision making (Goudriaan et al., 2007) or inhibition (Field et al., 2008; Lannoy et al., 2017) abilities. Importantly, these impairments underline the lack of control over drinking and may reinforce the development of excessive drinking habits. The *Activities* subscale was less affected by light BD scores than other subscales, indicating that students practicing moderate binge drinking do not feel that their excessive consumption negatively influences their family, social or work involvement. This difference between high *Control* and low *Activities* subscales scores in binge drinkers might also be influenced by the fact that the loss of control is an immediate and directly experienced BD consequence, while BD's relation with *Activities* most probably appears after a longer consumption period, BD even potentially facilitating social interactions at early stages.

The comparison of BD habits among European students as a

function of the region showed that the BD score was globally higher in Western/Southern regions, confirming that cultural and socio-economic differences can influence alcohol consumption (ESPAD, 2015; Kuntsche et al., 2017). Interestingly, reduced quality of life among Eastern European students was significantly more associated with BD behaviors compared to students from Western/Southern regions, suggesting that BD and AQuLS scores were not linearly related. Moreover, consistent with previous studies (Ljubotina et al., 2004; Mikolajczyk et al., 2016), alcohol consumption and excessive drinking were more frequent among males, as reflected by both larger AUDIT and BD scores. However, alcohol consumption led to significantly larger negative influence on the quality of life of males, especially for moderate to intense binge drinkers (BD score: 12–29). These results suggest that, for a similar consumption, practicing binge drinking would have a significantly stronger subjective impact on males' quality of life, particularly for *Activities*, *Living conditions*, *Negative emotions*, *Control*, and *Relationship* subscales. It is, however, worth noting that our sample was unbalanced (72% of females in our sample, which is higher than the 54.1% reported in the global European population in 2015; Eurostat report), leading to potential biases.

Several limitations related to this study should be underlined. First, as students were invited to participate in the study, the sample was not randomized and corresponded therefore to a convenience sample. However, the main demographical characteristics of our sample did not significantly differ from those of other recent studies exploring alcohol consumption in European students' population (e.g., Luquiens et al., 2016; Tavalacci et al., 2016) and might be considered as representative of this population. Second, because the study was cross-sectional, the current findings do not allow to infer any causal link between alcohol consumption and quality of life, despite the fact that the AQuLS questionnaire was specifically designed to explore this subjective link (by asking participants to evaluate the direct effect of alcohol consumption on their quality of life). Third, as a global regions' classification was used, differences between countries within specific regions could have been masked (e.g., different drinking habits were previously observed between French and UK populations, both countries being here included in the Western region; Luquiens et al., 2017). Future studies should use more demographically representative European samples and go beyond cross-sectional approaches to explore causal relationships between quality of life and alcohol consumption. Finally, as this relationship might be moderated by comorbidities (co-occurring psychiatric disorders or other drugs consumption) and other personal and social variables (e.g., socio-economic status, drinking motivations, social support), these factors should also be measured and taken into account in future works.

5. Conclusions

Our study, conducted in a large sample of 21,980 European students, offers a precise and in-depth measure of consumption patterns among young students, and considers longer (6 months) and therefore more stable consumption periods than earlier ones, thus allowing to more accurately characterize the relationship between alcohol consumption and quality of life. Moreover, thanks to the Bayesian non-parametric analyses performed, the limitations of the classical linear methods have been overcome, and the true nature of these relations has been highlighted.

Contributors

V.D. and P.M. designed the study, performed the literature review, and managed data collection; V.D., V.B., and P.M. analyzed the data; all authors participated to the writing of the manuscript and approved the final version.

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Conflict of interest

No conflict declared

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Supplementary Material

Supplementary Material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.drugalcdep.2018.08.033>.

References

- Babor, T.F., Higgins-Biddle, J.C., Saunders, J.B., Monteiro, M.G., 2001. AUDIT: The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Care, 2nd ed. World Health Organization, Geneva, Switzerland. <http://www.who.int/iris/handle/10665/67205>.
- Blank, M.L., Connor, J., Gray, A., Tustin, K., 2015. Screening for hazardous alcohol use among university students using individual questions from the alcohol use disorders identification test-consumption. *Drug Alcohol Rev.* 34, 540–548.
- Bremhorst, V., Kreyenfeld, M., Lambert, P., 2017. Nonparametric double cure survival models: an application to the estimation of the nonlinear effect of age at first parenthood on fertility progression. *ISBA Discuss. Pape.* 13.
- Cortés-Tomás, M.T., Giménez-Costa, J.A., Motos-Sellés, P., Sancerni-Beitia, M.D., 2017. Revision of AUDIT consumption items to improve the screening of youth binge drinking. *Front. Psychol.* 8, 910.
- Eilers, P., Marx, B., 1996. Flexible smoothing with B-splines and penalties (with discussion). *Stat. Sci.* 11, 89–121.
- Eilers, P., Marx, B., 2010. Splines, knots, and penalties. *WIREs Comp. Stat.* 2, 637–653. <https://doi.org/10.1002/wics.125>.
- Eurostat, 2015. Education and Training in the EU – Facts and Figures. Annual Report. (Accessed August 15, 2018). http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Tertiary_education_statistics.
- Field, M., Schoenmakers, T., Wiers, R.W., 2008. Cognitive processes in alcohol binges: a review and research agenda. *Curr. Drug Abuse Rev.* 1, 263.
- Goudriaan, A.E., Grekin, E.R., Sher, K.J., 2007. Decision making and binge drinking: a longitudinal study. *Alcohol Clin. Exp. Res.* 31, 928–938. <https://doi.org/10.1111/j.1530-0277.2007.00378.x>.
- Hagman, B.T., 2016. Performance of the AUDIT in detecting DSM-5 alcohol use disorders in college students. *Subst. Use Misuse* 51, 1521–1528.
- Hartley, D.E., Elsabagh, S., File, S.E., 2004. Binge drinking and sex: effects on mood and cognitive function in healthy young volunteers. *Pharmacol. Biochem. Behav.* 8, 611–619. <https://doi.org/10.1016/j.pbb.2004.04.027>.
- Hermens, D.F., Lagopoulos, J., Tobias-Webb, J., De Regt, T., Dore, G., Juckes, L., Latt, N., Hickie, I.B., 2013. Pathways to alcohol-induced brain impairment in young people: a review. *Cortex* 49, 3–17. <https://doi.org/10.1016/j.cortex.2012.05.021>.
- Hingson, R.W., Zha, W., Weitzman, E.R., 2009. Magnitude of and trends in alcohol-related mortality and morbidity among US college students ages 18–24, 1998–2005. *J. Stud. Alcohol Drugs (Suppl. 16)*, 12–20.
- Jang, J.B., Patrick, M.E., Keyes, K.M., Hamilton, A.D., Schulenberg, J.E., 2017. Frequent binge drinking among US adolescents, 1991 to 2015. *Pediatrics* 139, e20164023.
- Jullion, A., Lambert, P., 2007. Robust specification of the roughness penalty prior distribution in spatially adaptive Bayesian P-splines models. *Comput. Stat. Data Anal.* 51, 2542–2558. <https://doi.org/10.1016/j.csda.2006.09.027>.
- Jullion, A., Lambert, P., Beck, B., Vandenhende, F., 2009. Pharmacokinetic parameters estimation using adaptive Bayesian P-splines models. *Pharm. Stat.* 8, 98–112.
- Kuntsche, E., Gmel, G., 2013. Alcohol consumption in late adolescence and early adulthood—where is the problem. *Swiss Med. Wkly.* 143, w13826.
- Kuntsche, E., Rehm, J., Gmel, G., 2004. Characteristics of binge drinkers in Europe. *Soc. Sci. Med.* 59, 113–127.
- Kuntsche, E., Kuntsche, S., Thrul, J., Gmel, G., 2017. Binge drinking: health impact, prevalence, correlates and interventions. *Psychol. Health* 32, 976–1017.
- Lang, S., Brezger, A., 2004. Bayesian P-splines. *J. Comput. Graph. Stat.* 13, 183–212. <https://doi.org/10.1198/1061860043010>.
- Lannoy, S., D'Hondt, F., Dormal, V., Billieux, J., Muraire, P., 2017. Electrophysiological correlates of performance monitoring in binge drinking: impaired error-related but preserved feedback processing. *Clin. Neurophysiol.* 128, 2110–2121. <https://doi.org/10.1016/j.clinph.2017.08.005>.
- Letourneau, B., Sobell, L.C., Sobell, M.B., Agrawal, S., Gioia, C.J., 2017. Two brief measures of alcohol use produce different results: AUDIT-C and quick drinking screen. *Alcohol Clin. Exp. Res.* 41, 1035–1043.
- Ljubotina, D., Galic, J., Jukic, V., 2004. Prevalence and risk factors of substance use among urban adolescents: questionnaire study. *Croat. Med. J.* 45, 88–98.
- Luquiens, A., Reynaud, M., Falissard, B., Aubin, H.J., 2012. Quality of life among alcohol-dependent patients: how satisfactory are the available instruments? A systematic review. *Drug Alcohol Depend.* 125, 192–202.
- Luquiens, A., Whalley, D., Crawford, S.R., Laramée, P., Doward, L., Price, M., Hawken, N., Dorey, J., Owens, L., Llorca, P.M., Falissard, B., Aubin, H.J., Falissard, B., 2014. Development of the alcohol quality of life scale (AQoLS): a new patient-reported outcome measure to assess health-related quality of life in alcohol use disorder. *Qual. Life Res.* 24, 1471–1481.
- Luquiens, A., Whalley, D., Laramée, P., Falissard, B., Kostogianni, N., Rehm, J., Manthey, J., Paille, F., Aubin, H.J., 2015. Validation of a new patient-reported outcome instrument of health-related quality of life specific to patients with alcohol use disorder: the alcohol quality of life scale (AQoLS). *Qual. Life Res.* 25, 1549–1560.
- Luquiens, A., Falissard, B., Aubin, H.J., 2016. Students worry about the impact of alcohol on quality of life: roles of frequency of binge drinking and drinker self-concept. *Drug Alcohol Depend.* 167, 42–48.
- Luquiens, A., Owens, L., Whalley, D., Rahhali, N., Laramée, P., Crawford, R., Llorca, P.M., Falissard, B., Aubin, H.J., 2017. Health-related quality of life in alcohol dependence: similar cross-cultural impact beyond specific drinking habits. *J. Ethn. Subst. Abuse* 14, 1–17. <https://doi.org/10.1080/15332640.2017>.
- Mäkelä, P., Gmel, G., Grittner, U., Kuendig, H., Kuntsche, S., Bloomfield, K., Room, R., 2006. Drinking patterns and their gender differences in Europe. *Alcohol Alcohol.* 41, i8–i18.
- Mallett, K.A., Lee, C.M., Neighbors, C., Larimer, M.E., Turrisi, R., 2006. Do we learn from our mistakes? An examination of the impact of negative alcohol-related consequences on college students' drinking patterns and perceptions. *J. Stud. Alcohol.* 67, 269–276.
- Mikolajczyk, R.T., Sebens, R., Warich, J., Naydenova, V., Dudziak, U., Orosova, O., 2016. Alcohol drinking in university students matters for their self-rated health status: a cross-sectional study in three European countries. *Front. Public Health* 4, 210.
- Miller, J.W., Gfroerer, J.C., Brewer, R.D., Naimi, T.S., Mokdad, A., Giles, W.H., 2004. Prevalence of adult binge drinking: a comparison of two national surveys. *Am. J. Prev. Med.* 27, 197–204.
- Mohamed, S., Ajmal, M., 2015. Multivariate analysis of binge drinking in young adult population: data analysis of the 2007 survey of lifestyle, attitude and nutrition in Ireland. *Psychiatry Clin. Neurosci.* 69, 483–488.
- Naimi, T.S., Brewer, R.D., Mokdad, A., Denny, C., Serdula, M.K., Marks, J.S., 2003. Binge drinking among US adults. *Jama* 289, 70–75.
- Okoro, C.A., Brewer, R.D., Naimi, T.S., Moriarty, D.G., Giles, W.H., Mokdad, A.H., 2004. Binge drinking and health-related quality of life: do popular perceptions match reality? *Am. J. Prev. Med.* 26, 230–233.
- Patton, R., Deluca, P., Kaner, E., Newbury-Birch, D., Phillips, T., Drummond, C., 2014. Alcohol screening and brief intervention for adolescents: the how, what and where of reducing alcohol consumption and related harm among young people. *Alcohol Alcohol.* 49, 207–212.
- Tavolacci, M.P., Boerg, E., Richard, L., Meyrignac, G., Dechelotte, P., Ladner, J., 2016. Prevalence of binge drinking and associated behaviors among 3286 college students in France. *BMC Public Health* 16, 178.
- The ESPAD Group., ESPAD Report, 2015. Results from the European School Survey Project on Alcohol and Other Drugs. EMCDDA, Lisbon. <http://www.espad.org/report/summary>.
- Townshend, J.M., Duka, T., 2002. Patterns of alcohol drinking in a population of young social drinkers: a comparison of questionnaire and diary measures. *Alcohol Alcohol.* 37, 187–192.
- Townshend, J.M., Duka, T., 2005. Binge drinking, cognitive performance and mood in a population of young social drinkers. *Alcohol Clin. Exp. Res.* 29, 317–325.
- Wen, X.J., Kanny, D., Thompson, W.W., Okoro, C.A., Town, M., Balluz, L.S., 2012. Binge drinking intensity and health-related quality of life among US adult binge drinkers. *Prev. Chronic. Dis.* 9, e86.