

Alcohol Hangover and Risk of Drinking Problems and Alcohol Use Disorder: A Systematic Review

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Abstract

Introduction: Despite its high frequency, hangovers have received little systematic attention in the field of alcohol research, even though alcohol hangover contributes to a large number of socioeconomic consequences as well as health risks. Alcohol-induced hangover is a complex syndrome defined by a spectrum of symptoms. Not all drinkers experience hangovers, indicating individual alcohol tolerance. It is unknown whether frequently experiencing hangovers predicts the risk of problem drinking and alcohol use disorder.

Methods: PubMed, EMBASE, PsycINFO, CINAHL, Web of Science, The Cochrane Library, Forskningsdatabasen.dk, Christin.no and Google were searched from January 1970 through August 2016 using combinations of search terms i.e., alcohol, alcohol dependence and hangover, and several other specific terms. All studies were conducted on human subjects, without restriction on participant demographics. Studies that investigated the association between experiencing hangover and alcohol use disorder were included. Two authors independently screened all papers, extracted study characteristics and assessed the quality by applying the Newcastle-Ottawa Scale.

Results: Of 743 identified studies, only 4 met inclusion criteria. Studies were heterogeneous in multiple ways and the quality varied; two high-quality studies were identified. Results from three out of four studies indicated higher risk of problem drinking among individuals who experienced hangover compared to individuals who did not, adjusted for drinking habits.

Conclusions: High-quality studies indicated an association of developing alcohol use disorder when frequently experiencing hangovers, adjusted for alcohol intake. This systematic review shows that the existing research is very sparse; hence further alcohol research in this area is much needed to increase our knowledge on alcohol hangover and its consequences.

Keywords: Alcohol drinking; Alcohol-induced disorders; Alcoholism; Public health; Review

Introduction

A night's heavy alcohol intake often results in an unpleasant morning after hangover. No consensus definition of hangover exists, but a common set of symptoms include headache, thirst, nausea and fatigue [1]. In addition, hangovers are associated with impaired cognitive functions such as memory deficits and mood depression [2-4]. The syndrome is not well understood and studies have often yielded inconclusive results. Multiple mechanisms have been proposed: one hypothesis argues that a hangover is the first phase of acute alcohol withdrawal [1,5], another suggests that a hangover is caused by an imbalance in the immune system [6], a third explanation concerns dehydration [5,7], a fourth hypothesis argues that hangover is directly promoted through its effects on blood sugar concentrations (hypoglycemia) [5] and finally, the metabolism of congeners, especially methanol, has been suggested to cause the discomfort [8,9]. Hangovers are generally not considered harmful and have received little scientific attention despite being the most frequently occurring alcohol-related

morbidity and to induce a number a socioeconomic consequences such as impaired job performance and reduced productivity [5,9-11].

Studies have found that approximately 25% of drinkers are resistant to hangovers altogether [12-14], indicating that such individuals tolerate alcohol well, at least in the short run. Data concerning the proportion of individuals who are especially susceptible to hangovers are lacking. Most likely a spectrum exists, ranging from individuals who never experience hangovers to individuals who always have severe and disabling hangovers, following a night's heavy drinking. It is unknown whether such individual alcohol tolerance is associated with problem drinking and the risk of developing alcohol use disorders.

Sons of alcoholics have reported worse hangover symptoms than others [15-17]. This led to the hair of the dog theory, arguing that alcohol is consumed the morning following heavy drinking with the purpose of alleviating hangover symptoms, resulting in increased alcohol intake and ultimately alcohol dependency [18-20]. A polar hypothesis is that hangovers are perceived as punishment for heavy drinking, thus preventing further use [1,19]. Neither of these theories is strongly supported by evidence [1].

The objective of the present study was to conduct a systematic review to investigate whether the frequency of experiencing alcohol

hangovers predicts alcohol drinking problems and the development of alcohol use disorder.

Method

Data sources and searches

We conducted a systematic search following the MOOSE reporting guidelines [21]. The following databases were searched to identify all relevant studies: PubMed, EMBASE, PsycINFO, CINAHL, Web of Science, The Cochrane Library, Forskningsdatabasen.dk and Christin.no. The literature search was performed by combining the terms presented in Table 1. The search was conducted on March 23, 2015 and updated in August 2016. Bibliographies of retrieved papers were reviewed to identify studies that could have been overlooked in the initial search. Relevant grey literature was identified by searching the first 10 pages of Google.com and Google Scholar using the same search terms. In addition, experts in the field were contacted regarding missed, unpublished and ongoing studies.

Search word	Specific terms
Alcohol	Ethanol, binge drink*, alcohol intoxication, alcohol intake, heavy drinking, alcohol* drink*, drinking pattern, alcoholic beverages, drinking behavior, ethanol drink*, drink*, liquor* and ethanol intake
Alcohol dependence	Alcohol abuse, alcoholism, alcohol use disorders, AUD, alcohol misuse, alcohol addiction, drinking abuse, excessive alcohol use and alcohol withdrawal
Hangover	Veisalgi, alcohol-induced hangover* and alcohol hangover*

Table 1: Search terms used to identify relevant studies.

Study selection

Studies were found eligible and were included if they fulfilled the following inclusion criteria:

Type of study: All studies conducted on human subjects published from 1970 to August 2016. In addition, relevant grey literature and unpublished studies from the same time period were included. No restriction was imposed on language.

Type of participants: No limitations in regard to subject demographics such as age, sex or racial/ethnic background of the participants were used.

Type of exposure measure: All measures of alcohol hangover were included.

Type of outcome measures: We included studies that described all varieties of problem drinking and alcohol use disorder.

Data extraction and quality assessment

Studies were independently screened by two authors (ALS and MLM) to make sure that assessment was carried out systematically and uniformly. Relevant data were extracted, including information about participants, study design, setting, exposure, outcome, results, and reference group and confounder adjustment. In addition, key indicators of study quality, including risk of bias, were obtained. Results were compared and in case of discrepancies, these were addressed by consulting a third reviewer (JST).

Data synthesis and analysis

Four studies investigated hangovers and the risk of problem drinking and alcohol use disorder. The evidence was evaluated overall, with emphasis on whether a consistent tendency of outcome prediction was seen in the findings, such as a relation between adjustment and risk estimate. The quality assessment was based on the Newcastle-Ottawa Scale for nonrandomized studies, which is a rating system with 9 stars indicating the highest quality (Table 2) [22]. We defined high-quality studies as studies that fulfilled three criteria: 1. prospective design, 2. adjustments at least for age and total alcohol intake, and 3. a rating of 6 or more stars in the Newcastle-Ottawa Scale quality assessment (Table 3).

Results

Literature search

The literature search identified 743 studies from databases and 6 studies from reference lists. Three articles from grey literature were identified, but they did not fulfil the inclusion criteria. Of these, 705 were excluded by screening the title and abstract. This left 44 full-text articles to be assessed for eligibility. In the full-text screening, 40 studies were excluded for various reasons: 13 of the 40 studies were excluded because they did not use hangover as exposure. Additionally, 15 articles were excluded because they did not have alcohol dependency as outcome. Many of these studies investigated predictors of hangover and thus did not examine the association between hangover and the outcome relevant for this study. Finally, 12 studies were excluded due to an irrelevant study design, such as economic evaluations, reviews and studies validating hangover scales. In total, 4 studies were eligible for qualitative synthesis. The inclusion process is illustrated by a PRISMA flow diagram (Figure 1) [23].

Summary of studies

The evidence of a potential association between hangovers and the development of alcohol drinking problems included one cross-sectional study [20] and three cohort studies (Table 4) [24-26]. One of the included cohort studies was Finnish [24] and the other three studies were American and conducted among college students [20,25,26]. All studies used self-reported measures for hangovers and measured drinking problems by applying either diagnosis codes from hospital admissions [24], screening tests [20,25] or by the standard instrument for hangover the Acute Hangover Scale [26]. Three of the four studies found that hangovers predicted later drinking problems, after adjusting for alcohol consumption [20,24,25]. Two studies investigating alcohol use disorder fulfilled the three star high-quality criteria: Paljärvi et al. [24] and Rohsenow et al. [26].

The cross-sectional study by Earleywine included 172 college students (48.3% male) who self-reported the frequency of five hangover symptoms experienced during the past year (headache, vomiting, regretting behaviour, black out and waking up too late the morning after drinking), measured as a percentage of the times they drank alcohol [20]. Experiencing these hangover symptoms significantly predicted alcohol problems using the Short Michigan Alcoholism Screening Test (SMAST), compared to those reporting having experienced hangover symptoms 0% of the times they drank alcohol. The result was adjusted for the average quantity of alcohol consumed per occasion.

Newcastle-Ottawa quality assessment scale: Case-control studies					
Selection					
Is the case definition adequate?	Yes, with independent validation*	Yes, e.g., record linkage or based on self-report	No description		
Representativeness of the case	Consecutive or obviously representative series of cases*	Potential for selection biases or not stated			
Selection of Controls	Community controls*	Hospital controls	No description		
Definition of controls	No history of disease (endpoint)*	No description of source			
Comparability					
Comparability of cases and controls on the basis of the design or analysis	Study controls for total alcohol intake*	Study controls for any additional factor, e.g., drinking frequency, age, sex, smoking, socioeconomic status*			
Exposure					
Ascertainment of exposure	Secure record*	Structured interview where blind to case/control status	interview not blinded to case/control status	Written self-report or medical record only	No description
Same method of ascertainment for cases and controls	Yes*		No		
Non-response rate	Same rate for both groups*	Non respondent described	Rate different and no designation		
Total number of stars					

Table 2: Quality assessment sheet based on the NOS for case-control studies. Categorizes marked by ☒ account as one point.

	Total number of stars	Selection	Comparability	Outcome
Earleywine	3	2	1	0
Paljärvi et al.	7	3	2	2
Piasecki et al.	5	2	1	2
Rohsenow et al.	6	3	2	1

Table 3: Quality assessment with the Newcastle-Ottawa scale star system. Number of NOS stars for the included cohort and cross-sectional studies.

The first cohort study by Piasecki et al. followed 489 freshmen college students (47% male) aged 18-19 years for a mean period of 11.4 years [25]. Piasecki et al. found an Odds Ratio (OR) of 1.75 (95% CI: 1.18; 2.60) when being diagnosed with an alcohol use disorder using DSM-III. This was among those experiencing at least a yearly headache due to hangovers, compared to those reporting never to have experienced or not to have experienced in the past year a headache due to hangovers. The results were adjusted for family history of alcoholism, sex, alcohol use disorder and heavy drinking at baseline.

The second cohort study by Paljärvi et al., which is part of the Health and Social Support Study (HeSSup), followed 21,204 men and women aged 20-54 years for a mean follow-up period of 3.0 years for

alcohol specific causes [24]. Paljärvi et al. investigated different frequencies of hangovers per year and found a statistically significant P-trend (<0.001). The specific result for the 2,224 participants (48 cases) who reported experiencing hangovers once a month was a hazard ratio (HR) of 3.54 (95% CI: 2.17; 5.75) for alcohol-related hospitalization or mortality (94% of the cases were related to either symptoms of alcohol dependence or diseases of the stomach, liver or pancreas using ICD-10), compared to currently drinking men and women who never experienced hangovers. This result was adjusted for several potential confounders: age, sex, education, cohabiting, employment status, smoking, family history of drinking problems, age when started drinking, binge drinking, drinking frequency and total alcohol intake. Owing to the composite outcome, it was not possible to disentangle the separate effect of hangovers on alcohol use disorder. The study was considered a high-quality study, receiving 7 out of 9 possible stars on the Newcastle-Ottawa Scale.

The third and last cohort study by Rohsenow et al. followed 131 college seniors (51% male) aged 21-24 years for a mean period of 2.3 years [26]. A special feature of this study was that hangover symptoms were measured using the Acute Hangover Scale [27] at baseline after the participants had been administered alcohol to a mean of 0.12 g% breath alcohol concentration. At follow-up, 50.4% of the participants scored 8 or more on the Alcohol Use Disorders Identification Test (AUDIT). In contrast to the above results, Rohsenow et al. found a decreased OR of 0.68 (95% CI: 0.44; 1.06) of developing alcohol problems, measured by AUDIT, for those having severe hangovers compared to not having any hangover symptoms. The results were adjusted for age and employment status at follow-up, sex and average

daily drinking volume at exposure. This study was also considered a high-quality study, receiving 6 stars on the Newcastle-Ottawa Scale.

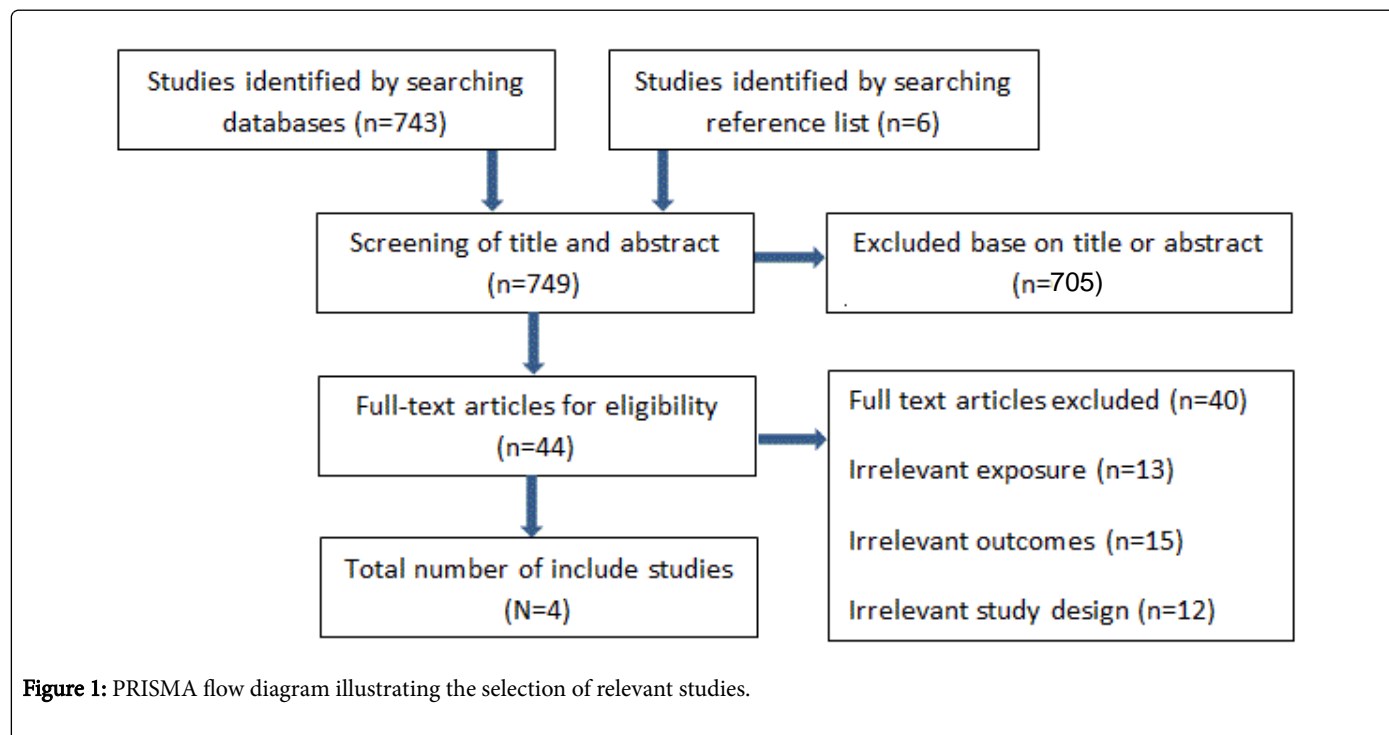


Figure 1: PRISMA flow diagram illustrating the selection of relevant studies.

Source	Study design	Setting	Participants	Exposure	Outcome	Results	Reference group	Adjustment	Quality (NOS)
Earleywine	Cross-sectional	USA (University of Southern California), 1993	172 college students aged 17–27 years	Self-reported frequency of five hangover symptoms experienced during the past year as a percentage of the times they drank alcohol	Drinking problems, assessed using the SMAST	OR=1.26 (95% CI: 1.06; 1.50)	Those reporting experiencing hangover symptoms 0% of the times they drank alcohol in the past year	Average quantity of alcohol consumed per occasion	3
Paljärvi et al.	Cohort (mean follow-up: 3.0 years). Part of the HeSSup study	Finland, 1998	21,204 Finnish men and women aged 20–54 years	Different frequencies of self-reported hangovers during the past year (ranging from none to 52+ times)	Hospitalization or death related to alcohol, based on ICD-10 (the majority were related to alcohol dependence) N= 310 (1.5%)	P for trend <0.001 2,224 participants reported monthly hangovers (48 cases) HR=3.54 (95% CI: 2.17; 5.75)	Currently drinking men and women never experiencing hangovers	Age, sex, binge drinking, education, cohabiting, employment status, smoking, family history of alcohol problems, age when started drinking, drinking frequency and total alcohol intake	7
Piasecki et al.	Cohort (mean follow-up: 11.4 years)	USA (University of Missouri, Columbia), 1987–1988	403 freshmen students aged 18–19 years with paternal alcoholism	Self-reported frequency of headaches due to hangovers during the past year (a question from the YAAPST)	Alcohol use disorder diagnoses from DSM-III diagnosis N= 40 (9.9%)	OR=1.75 (95% CI: 1.18; 2.60)	Those reporting never or not to have experienced hangovers during the past year*	Family history of alcoholism, sex, alcohol use disorder and heavy drinking at baseline	5

Rohsenow et al.	Cohort (mean follow-up: 2.3 years)	USA (Boston Medical Center), 2004–2008	131 college seniors aged 21–24 years	Self-reported intensity of hangovers, assessed using the AHS	Alcohol problems, assessed using the AUDIT N=66 (50.4%)	OR=0.68 (95% CI: 0.44; 1.06)	Those not feeling any hangover symptoms after being administered alcohol	Age and employment status at follow-up, sex and average daily drinking volume at exposure	6
HeSSup: Health and Social Support Study; YAAPST: Young Adult Alcohol Problem Screening Test; AHS: Acute Hangover Scale; SMAST: Short Michigan Alcoholism Screening Test; AUDIT: Alcohol Use Disorder Identification Test; OR: Odds ratio; HR: Hazard ratio; NOS: Newcastle-Ottawa Scale quality rating system for nonrandomized studies, ranging from 0-9 stars with 9 stars indicating the highest possible quality									
*A proportion of participants in the reference group were potentially non-drinkers									

Table 4: Characteristics of four studies investigating hangovers and the risk of alcohol use disorder.

Discussion

Key findings

Results from this systematic review showed that individuals who experienced hangovers more often have problem drinking and higher risk of developing alcohol use disorder compared to individuals who did not experienced alcohol-induced hangovers, adjusted for drinking habits. However, only 4 studies fulfilled the eligibility criteria, reflecting that research on alcohol-induced hangover has received too little scientific attention, even though it has both medical, socio-economic and public health significance.

Strengths and limitations

The included studies were heterogeneous in several ways, e.g. in respect to study design, follow-up period, extent of confounder control, endpoint and the assessment of hangover frequencies. No studies took drinking pattern into account. One study only [26] used severity of hangovers as a diagnostic measure of exposure, while the remaining studies applied frequency of hangovers. In addition, the quality of studies varied. When applying the Newcastle-Ottawa Scale quality assessment system, 2 high-quality studies were identified (Table 3) [24,26]. The wide range of experienced hangover frequency measures used in these two studies makes a valid comparison between them extremely difficult. It can be discussed if it were appropriate (or necessary) to assess the quality by this system for studies on alcohol-related hangover. Even though it is indicating, more studies using common diagnostic measures of hangovers are needed.

The literature search identified studies dating back to 1970. In addition, we searched several databases, grey literature, and contacted relevant authors in order to avoid publication bias and to make sure all the pertinent material was included. We performed the search and data extraction systematically and evaluated study quality on the basis of the Newcastle-Ottawa Scale [22].

Although the literature search was carried out in detail, this systematic review does have some limitations. First, three out of the four studies were confined to American college students and therefore represents a selected sample of the general population; thus results may not be generalizable. In addition, the majority of the studies investigating alcohol use disorder had small sample sizes and short follow-up periods. Most studies had limited power as evaluated by the number of cases in each study, which added to the difficulty in determining a potential association.

Second, available research was based on a heterogeneous set of measurement strategies; only in Rohsenow et al. and Piasecki et al. validated instruments for hangover assessment were used (Acute Hangover Scale (AHS) and Young Adult Alcohol Problem Screening (YAAPST)) [25,26]. A standard instrument for hangover assessment is lacking [10]. The heterogeneous hangover measures challenge a valid comparison of the findings in this present review. All four studies [20,24–26] obtained information about hangovers through self-reporting, either using a questionnaire or a structured interview. Little is known regarding the symptomatic presentation and the individual differences hangover profiles.

Third, the lack of thorough adjustment for alcohol habits especially drinking pattern could lead to confounded results. The intake during a night is naturally associated with experiencing hangovers and is a known risk factor for developing alcohol use disorder [28]. However, the total alcohol intake for two persons could be the same, but while one person might drink small amounts every day, another may drink heavy once a week. The latter drinking pattern is obviously more associated with experiencing hangovers. Several studies have investigated the effect of various forms of drinking patterns on subsequent alcohol intake [19,26,29,30]. However, the studies were heterogeneous and the results were inconclusive.

Previous research

A review by Piasecki et al. focused on the risk of developing alcohol use disorder and found that the evidence, though limited, suggested a complex link between hangovers and alcohol use disorder. These findings are supported by the high-quality studies identified in this systematic review [31].

Implications for future research

Knowledge in the area of whether alcohol-induced hangovers predict long-term adverse health effects as alcohol use disorder is incomplete, and to draw firm conclusions more research is needed. As emphasized by the Alcohol Hangover Research Group, there is limited understanding of many basic issues related to hangover as e.g., why, despite excessive alcohol consumption, there are great individual differences in the presence and severity of alcohol hangovers [10].

This systematic review demonstrates that further research should seek to obtain valid information on hangover severity, as this may be a better indicator of the level of physiological stress than frequency of hangovers alone. Therefore, the severity of hangovers might be more precise measure than the frequency of hangovers. This was illustrated in a study by Howland et al. in which the incidences of all hangover

symptoms were significantly greater for those reporting greater hangover severity levels [13]. Ideally if possible the two measures; hangover frequency and hangover severity; should be combined to optimally capture all aspects of the hangover syndrome. In addition, special attention should be paid to collecting data about confounding effects, especially participants' total alcohol consumption and other drinking habits. Particular attention should be paid to patients with cardiovascular diseases and cardiac risk factors, such as obesity, hypertension, and high cholesterol, as they may be more sensitive to physiological stress, such as increased strain on the heart and the increased cardiac workload induced by alcohol hangovers [1,32,33]. Also, ethanol may provoke oxidative stress [34]. Additionally, it is shown in a systematic review and meta-analysis by Brien et al. that moderate intake of alcohol have favourable effects on levels of high density lipoprotein cholesterol, apolipoprotein A1, adiponectin, and fibrinogen which indicates a protective effect of alcohol consumption, particularly associated with a lower risk of coronary heart disease [35]. This was already reported in a meta-analysis by Rimm et al. in 1999 in which they concluded that trough changes in lipids and haemostatic factors alcohol is causally related to lower risk of coronary heart disease [36]. Finally, the effects of hangovers may vary for men and women owing to biological differences; thus, large studies including both genders are necessary [10,37,38].

Conclusion

In this systematic review two identified high-quality studies indicated increased risks of alcohol use disorder, when experiencing frequent hangovers, controlled for alcohol intake. Also it distinctly shows that the existing evidence on the area of alcohol-induced hangover is sparse and more research is needed to draw firm and convincing conclusions.

Main Findings

- Research on alcohol-induced hangover has received little scientific attention.
- Individuals who experience hangovers are more likely to developing alcohol use disorder compared with individuals with less hangover.

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