Hazardous Alcohol Use and Insomnia in women and men: Insights from the population-based Tromsø Study 2015-2016.

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Abstract

Background and aims Hazardous alcohol use is known to be comorbid with insomnia. The aim of this study was to estimate the prevalence of co-occurring hazardous alcohol use and insomnia symptoms, and the odds of insomnia among women and men with a hazardous alcohol use, using logistic regression and covariate-adjusted moderation analysis.

Design setting Cross-sectional data from the seventh survey of the Norwegian population-based Tromsø Study 2015-2016 (participation 65%).

Participants The sample included 17 381 women and men 40-96 years.

Measurements Hazardous alcohol was measured by the Alcohol Use Disorder Identification Test and insomnia by the Bergen Insomnia Scale. Covariates included socio-demographics, shift work, somatic conditions disease and mental distress (defined by Hopkins Symptom Check List).

Findings Insomnia was more prevalent among participants with hazardous alcohol use (21.2%) than those without (17.9%). Hazardous alcohol users had higher odds of insomnia (odds ratio=1.69, 95% confidence interval 1.38, 2.06), but the effect was non-significant after adjustment for mental distress. In moderation analyses the higher odds of insomnia among hazardous alcohol users was present only at low and mean levels of mental distress, and not among participants reporting high levels of mental distress.

Conclusion Insomnia was prevalent among women and men reporting hazardous alcohol use. Mental distress may play an important role in the association between hazardous alcohol use and insomnia.

Background

Insomnia is the most common sleep disorder in the adult general population (1), and is highly comorbid with hazardous alcohol use and alcohol use disorders (2-4) with comorbid prevalence ranging between 7-52% in epidemiologically-based samples (5, 6). There are some well-known gender differences in the prevalence for both insomnia and hazardous alcohol use; women having more insomnia (7, 8) while men use alcohol more hazardously (9, 10). Several factors correlate with both hazardous alcohol use and insomnia, such as somatic and mental health conditions (11-14), older age, low socioeconomic status, or shift working (7, 14-16). There are large variations in the reported prevalence estimates of both co-occurring hazardous alcohol use and insomnia in the general population (5, 6, 17-22). These variations may be due to methodological differences between the studies may be a contributor, e.g., large variations in gender distributions, which often are dominated by men (6, 17, 18), use of unrepresentative samples that increases heterogeneity, such as military veterans (17) and industrial workers (6), or variation in sample sizes including many small sample-sized studies (17, 19). Measurement factors may also play a role as the operationalization of hazardous alcohol use (5, 17, 23) and insomnia (17, 18, 21) vary between studies. In addition, studies vary in whether they adjusted the prevalence estimates for comorbid mental health conditions (5, 17, 21). We suggest that methodological improvements can be achieved by using epidemiological design; including a large representative sample from the general population, and applying standardized, widely used and acceptable instruments for the measure of insomnia, alcohol misuse and mental health. The Tromsø study offers this opportunity by including up to 21,000 individuals from the general population, as well as utilizing standardized and well-validated measures of the constructs in question. The present study contributes in filling gaps of knowledge by providing gender-specific prevalence estimates of insomnia and hazardous alcohol use, as well as odds-ratios of insomnia adjusted for comorbidity and socioeconomic factors.

Methods
Participants

The Tromsø Study (24) is a population-based study with seven repeated surveys between 1974 and 2016 (Tromsø 1-7), inviting total birth cohorts and random samples of registered inhabitants in the municipality of Tromsø, Norway. All registered inhabitants aged ≥40 years (N=32 951) were invited to participate in Tromsø 7 (2015-2016). In total, 21 083 (65%) women and men participated, of which 17 381 were included in this study. All variables included in the present analysis were collected by self-reported questionnaires. Along with the invitation, participants received a questionnaire (Q1) and user name and password for a digital platform in which an additional questionnaire (Q2) could be found.

Measures
Hazardous alcohol use

Hazardous alcohol use is defined as a pattern of alcohol consumption that increases the risk of harmful consequences for the user or others (9). Alcohol consumption and hazardous drinking were measured with The Alcohol Use Disorder Identification Test (AUDIT) (25), an extensively validated and commonly used international screening instrument to identify hazardous drinking (26). AUDIT consists of 10 items (score range 0-4) measuring alcohol consumption (frequency of drinking, amounts consumed when drinking, and frequency of binge drinking), behavior patterns (e.g. not being able to stop, need a drink in the morning) and consequences (e.g. failed expectations, feeling of guilt or remorse). AUDIT has a sum score range of $0 - 40$, and in accordance with established practice, we used values ≥ 8 as a cut-off indicative of hazardous alcohol use (27). Dichotomizing the summative scale at this cutoff has shown high sensitivity (92%) and specificity (94%) in detecting problematic drinking/hazardous alcohol use (27). The term hazardous alcohol use will be used from here on, although it also may include individuals scoring above cut-off with more serious alcohol problems, such as alcohol dependency.

Insomnia

Insomnia was measured by the Bergen Insomnia Scale (BIS) which has shown to have good psychometric properties. (22). BIS consists of six items, including nocturnal symptoms (sleep onset latency, sleep maintenance, early morning awakening) and non-restorative sleep, daytime impairment and dissatisfaction with sleep. Response categories ranged from 0=no days per week to 7=7 days per week. An additional item on the duration of sleep problems was included, with response options ranging from "do not have a sleeping problem" to "more than 10 years". Insomnia was categorized as following: ≥3 days on at least one of the nocturnal symptoms, and ≥3 days per week on daytime impairment or dissatisfaction with sleep, and ≥3 months duration of sleep problems (28, 29), in accordance with DSM-5 and ICSD-3 criteria of insomnia (30, 31).

Comorbidity

Somatic disease was defined as having at least one of the following (0-no, 1-yes): myocardial infarction, stroke, heart failure, atrial fibrillation, angina pectoris, hypertension, diabetes, cancer (past or present), kidney disease, chronic obstructive pulmonary disease, asthma, rheumatoid arthritis, arthrosis or migraine.

Mental distress is a frequently used term referring to high levels of symptoms of anxiety or depression. Mental distress was measured by the Hopkins Symptoms checklist-10 (HSCL-10) (32) which includes symptoms of anxiety (4 items) and depression (6 items) during the past week. The HSCL-10 is a widely used, well validated instrument (33). Response categories ranged from 1=no complaint to 4=very much, and scores were averaged across all items. The 10 item version of HSCL is a short form of the HSCL-25, and performs almost equally well as the full version when measuring mental health (33). HSCL-10 has high internal consistency (Cronbach's α=.87), and a mean cut-off score > 1.85 has been found indicative of an affective mental disorder fulfilling diagnostic criteria (33).

Sociodemographic and socioeconomic factors

　　Age, educational level (primary school, upper secondary education, tertiary education <4 years, tertiary education >4 years), living with spouse (yes/no), and shift work (yes/no) were included to adjust for sociodemographic and socioeconomic factors

Statistical analyses

　　To estimate the prevalence of insomnia among women and men, we used a two-way test of proportions with confidence intervals (CIs). In addition, we specified a logistic binomial regression model with insomnia (0-no, 1-yes) as the outcome variable, and hazardous alcohol use (0-no, 1-yes) as the predictor. Gender differences was modeled by adding the interaction term, alcohol×gender. Effect sizes for the model parameters are given as odds ratios (OR), including 95% confidence intervals, In order to compare models, we specified a series of four nested logistic regression models: 1) model 1 specifying hazardous alcohol use and gender, in addition to the alcohol×gender interaction term in order to examine if the OR of hazardous alcohol use was different for women and men, 2) model 2 added the variables age, education, living with spouse, and shift working, 3) model 3 added somatic disease as a variable, and 4) model 4 added mental distress (HSCL) both as a covariate and an interaction (alcohol×HSCL). These analyses were performed in STATA 16 (STATA Corp LP Texas, USA). The alcohol x mental distress interaction was run in SPSS using Process Macro, log odds were manually transformed into OR. Since mental distress was a continuous variable, it was centered before being multiplied with the alcohol variable. Given a statistical significant interaction effect, we further probed the interaction effect by examining the association between insomnia and hazardous alcohol use depending on four predefined values of the HSCL variable, i.e., zero mental distress (HSCL = 1.0), average (HSCL = 1.3), at the cutoff score indicating a probable diagnosis (HSCL = 1.85) and among those with a substantial level of affective symptoms (+1 SD above the cutoff, HSCL = 2.25).

The differences in the proportion estimates between those having and not having a hazardous alcohol use was tested for significance at each of these defined HSCL levels. All covariates from the preceding models were retained when conducting these significance tests.

Treatment of missing values

In order to reduce the risk of bias, missing values on the individual items of hazardous alcohol use, mental distress and insomnia were imputed using the Missing Values Analysis (MVA), Expectation Maximization (EM) method in SPSS version 25. For a missing value to be imputed, the record needed at least 50% valid data on the items of the instrument being imputed. Thus, missing cases were reduced from 15.8% to 7.0% for hazardous alcohol use, from 6.0% to 3.3% for mental distress, and from 10.2% to 7.0% for insomnia.

Research ethics

This study was approved by the Regional Committee for Medical and Health Research Ethics North (REC North, ref. 2019/839) and evaluated by the Data protection services at the Norwegian Centre for research data (ref. 663733). Data collection was performed according to the ethical standards set by the Helsinki Declaration. Participants gave written informed consent.

Results

Study sample characteristics are presented in Table 1. In total, 50.4% were women. Mean age was 55.6 years in women and 56.7 years in men. Prevalence of hazardous alcohol use was 5.6 % in women and 18.4% in men. Insomnia prevalence was 23.2% in women and 14.3% in men. The proportions of participants with insomnia according to hazardous alcohol use and non-hazardous alcohol use are presented in Table 2. In total, 23.1% of the participants with hazardous alcohol use also reported insomnia, relative to 18.1% of the non-hazardous alcohol users ($p <.001$). A significantly higher proportion of women with hazardous alcohol use, reported concurrent insomnia compared to women without hazardous use (32.4% versus 22.5%, $p <.001$), the same was observed among men with and without hazardous alcohol use (20.2% versus 12.9%, $p <.001$).

The logistic regression analysis showed a significant relationship between hazardous alcohol use and insomnia. The interaction term (alcohol×gender) did not significantly modify this relationship, neither did adjustment for sociodemographic and socioeconomic factors, or somatic disease. However, in the fully adjusted model that included mental distress (HSCL), the insomnia-alcohol association turned non-significant (see Table 3) owing to the fact that mental distress had a strong relationship with insomnia (OR=11.8, p<.001) and partly with hazardous alcohol usage (Spearman's rho = .12, p < .001). Being female, having lower education, working shifts, not living with a spouse and having somatic health problems were also independently associated with a higher odds of having insomnia. A significant age effect appeared when adjusting for comorbidity and mental distress

In the moderation analysis including the term mental distress×alcohol, the main effects of hazardous alcohol use (log odds = .21, S.E. =.08, (i.e. OR= 1.23 p < .01) and mental distress (log odds = 2.59, S.E. =.07, (i.e. OR= 13.33) p < .001), as well as the moderation effect (log odds = -.65, (i.e. OR=.52) S.E. =.14, p < .001) were significant. Hazardous alcohol use was positively associated with insomnia, but this effect was entirely moderated by levels of mental distress, as illustrated in Figure 1. Among subjects reporting no (HSCL = 1.0) or minor mental distress (HSCL = 1.3), the proportion of subjects reporting insomnia was higher among those reporting hazardous alcohol use as compared to non-hazardous users (HSCL=1.0: 12.5% vs 8.7%, p < .001; HSCL=1.3: 20.3% vs 17.1%, p < .01). At higher levels of mental distress this relationship turned increasingly opposite as those with a probable treatment need (HSCL=1.85; 42.8% vs 46.5%, p = .084) and substantial levels of clinical affective symptoms (HSCL=2.25; 62.0% vs 71.0%, p = .003) had less problems with insomnia if drinking hazardously as compared to non-hazardous drinkers.

Discussion

In this population-based study, the main finding was the higher prevalence of insomnia among participants with a hazardous alcohol use. However, moderating effects of mental distress indicated that this may play a larger contributing role towards insomnia.

The higher prevalence of insomnia among participants with hazardous alcohol use are in line with findings from previous studies (5, 18, 23). Our findings are in the lower end of the range compared to previous US epidemiological studies (22, 23), however these have studied more severe alcohol problems. Our findings are similar to one study from Sweden (18), however they only included men. Thus, it is difficult to compare our results with other epidemiological studies, due to methodological differences, such as more severe operationalization of hazardous alcohol use (e.g. alcohol abuse, dependence), and different measures of alcohol (e.g. consumption and single item questions).

As previous studies have looked at different kind of severities of alcohol problems from our study, it suggests that serious alcohol problems may be related to an even higher probability of insomnia (23) . However, as alcohol problems occur along a spectrum of severity, it is equally important to estimate the probability at lower ends of the spectrum that in turn may develop in to more serious alcohol problems over time (9)

A potential explanation for the relationship between hazardous alcohol use and insomnia, is the neurochemical effect of alcohol on sleep , disrupting REM sleep in the second half of the night (34), a period associated with the greatest physiological recovery (34). However, as this is a cross-sectional study, it is not possible to establish any causality or direction of effects between alcohol use and insomnia.

Although men in this study had higher rates of hazardous alcohol use, women with hazardous alcohol use reported higher levels of insomnia compared to men. Although gender differences are relatively understudied, the gender differences in our study are consistent with some previous findings (5, 23), and a meta-analysis concluded that women have a higher

predisposition for insomnia compared to men (7). It is, however, unclear whether this is due to affective disorders known to appear highly comorbid with insomnia, or potential gender differences in sleep physiology (7).

We found hazardous alcohol use to be associated with increased insomnia. However, the inclusion of mental distress rendered the relationship between hazardous alcohol use and insomnia non-significant. This finding contradicts two prospective studies from the US general population (23, 35) where alcohol dependence remained a risk factor also after adjustment for a history of mental health conditions (affective, anxiety, psychotic and drug use disorders).

Moreover, some previous studies have not adjusted for mental distress (5, 17, 36), which may lead to spurious relationship to emerge between alcohol use and insomnia. Anxiety and depression are the most common comorbidities (37) and can be causally related to both alcohol use (38) and insomnia (39). However, a comorbid factor explaining a substantial part of the variance in the outcome, may also affect how the exposure affects the outcome. This association was evident only among hazardous alcohol users with low to moderate levels of mental distress, indicating that mental distress play an important role.

In contrast, participants with high scores of mental distress and hazardous alcohol use, had less difficulties with insomnia. A tentative explanation is the effect of alcohol and the self-medicative hypothesis (40), as proposed in several previous studies (41-43). The sedative effect of alcohol (34) may num the mental distress, and thereby decrease sleeplessness and insomnia. Supporting the hypothesis, a qualitative study found the main reasons for using alcohol or other substances to self-medicate, was to lower symptoms of anxiety, depression and sleeplessness (44).

Although a causal relationship cannot be inferred from these cross-sectional associations, the validity of our findings draw support from studies highlighting the high comorbidity of

hazardous alcohol use, insomnia and mental health problems, in particular anxiety and depression (45). In addition, a common part of treatment for depression is the use of psychopharmacological interventions, which may also disturb the sleep physiology and even aggravate the insomnia (46). However, we were not able to control for any such effects, as our data set did not include information about potential medical treatment.

The present findings underline the importance of screening for hazardous alcohol use and mental distress among patients presenting with insomnia, in primary care (47), as these are common comorbid conditions, and alcohol and mental distress may be contributing factors to insomnia. This may potentially result in severe health consequences.

Strengths and limitation

A strength of this study is the large sample with equal distribution of women and men from a general population with a reasonably high attendance. Selection bias however, cannot be excluded. The use of validated instruments for hazardous alcohol use, insomnia, and mental distress provide more precise estimates than using only single question items. All measures were self-reported, therefore deliberate or undeliberate inaccuracy of reporting cannot be ruled out. Our estimates were also adjusted for several potential confounders, allowing for higher precision. A possible limitation is the use of the same cut-off score for AUDIT in women and men, rather than a lower score for women, which have been suggested by the WHO collaborative team who created the AUDIT (47). However, our prevalence of hazardous alcohol use yielded the same trend in prevalence of hazardous alcohol use as results from the Oslo study (48), we found a 12 month prevalence of 5.6% in women, and the Oslo study found 6.0% respectively, suggesting that a cut-off of 8 for women is sufficient.

Conclusion

The findings from this population based sample showed that having a hazardous alcohol use yielded a higher prevalence of insomnia. However, the presence of mental distress was more crucial for increased probability of insomnia. Future research could benefit from a

longitudinal design to further investigate the role of mental distress on alcohol and insomnia

over time.

Table 1. Sample characteristics. The Tromsø Study (2015-2016).

	Women (N=8762)	Men (N=8619)
Age, years (SD)	55.9 (10.6)	56.6 (10.8)
Education, %		
Primary school	20.6 (1806)	20.3 (1752)
Secondary school	25.4 (2222)	30.7 (2643)
University/college <4 years	18.5 (1623)	21.9 (1893)
University/college >4 years	35.5 (3111)	27.1 (2331)
Live with spouse, %	74.0 (6482)	82.4 (7103)
Work shifts, %	9.2 (808)	11.5 (994)
Hazardous alcohol use[a], %	5.6 (490)	18.4 (1589)
Insomnia symptoms (DSM-5)[b], %	23.2 (2017)	14.3 (1231)
Somatic disease[c], %	62.2 (5447)	56.8 (4897)
Mental distress[d], mean (SD)	1.34 (0.40)	1.23 (0.34)

Numbers are means for continues variables (standard deviation) and proportion (number) for categorical variables.

[a] Hazardous alcohol use was defined by an AUDIT score of >8.

[b] Insomnia was defined as scoring >3 days on sleep onset latency, sleep maintenance or EMA, and >3 days on either daytime impairment or dissatisfaction, a duration criteria of >3 months was set in accordance with the DSM-5 criteria for insomnia.

[c] Somatic disease was defined as a positive response to one of the following diseases: hypertension, myocardial infarction, heart failure, arterial fibrillation, angina pectoris, stroke, diabetes, kidney disease, chronic pulmonary disease, asthma, cancer, arthritis, arthrosis and migraine, past or present.

[d] Mental distress was defined by a mean score on the HSCL-10.

Table 2. Proportion of insomnia among participants with and without hazardous alcohol use. The Tromsø study (2015-2016).

	No hazardous alcohol use[a]			Hazardous alcohol use[b]			
	% (N)	95% CI	SE	% (N)	95% CI	SE	*p*
Women	22.5 (8 272)	21.6, 23.4	.00	32.4 (490)	28.5, 36.7	.021	<.001*
Men	12.9 (7 030)	12.2, 13.7	.004	20.2 (1589)	18.3. 22.2	.010	<.001*
Total	18.1 (15 302)	17.5, 18.7	.003	23.1 (2079)	21.3, 24.9	.009	<.001*

[a] Insomnia was defined as scoring >3 days on sleep onset latency, sleep maintenance or EMA, and >3 days on either daytime impairment or dissatisfaction, a duration criteria of >3 months was set in accordance with the DSM-5 criteria for insomnia.
[b] Hazardous alcohol use was defined by an AUDIT score of >8.

Table 3. Predictors of insomnia by logistic regression analysis. The Tromsø Study (2015-2016).

	Model 1[a] OR* 95% (CI)	p	Model 2[b] OR (95% CI)	p	Model 3[c] OR (95% CI)	p	Model 4[d] OR (95% CI)	p
Hazardous alcohol use	1.66 (1.36. 2.02)	<.001	1.67 (1.37, 2.04)	<.001	1.69 (1.38, 2.06)	<.001	1.02 (.80, 1.28)	.909
Sex	.51 (.47, .56)	<.001	.53 (.47, 56)	<.001	.53 (.49, .58)	<.001	.68 (.62, .75	<.001
Sex x hazardous alcohol use [e]	1.03 (.81, 1.31)	.831	1.00 (.78, 1.27)	.974	.98 (.77, 1.25)	.868	1.08 (.82, 1.43)	.567
Age			1.00 (1.00, .1.00)	.852	.99 (.99, .99)	.009	1.01 (1.01, 1.02)	.<001
Education			.92 (.88, .95)	<.001	.92 (.89, .96)	<.001	.96 (.92, 1.00)	.041
Live with spouse			.77 (.71, .84)	<.001	.78 (.71, .85)	<.001	.90 (.81, .99)	.035
Working shifts			1.23 (1.08, 1.39)	.001	1.23 (1.10, 1.40)	<.001	1.33 (1.16, 1.52)	.<001
Somatic disease					1.64 (1.51, 1.79)	<.001	1.38 (1.25, 1.51)	<.001
Mental distress							11.84 (10.56, 13.28)	<.001

*OR= Odds ra   CI= Confidence interval.
[a]Model 1 include hazardous alcohol use, sex, and the sex*hazardous alcohol use interaction term.
[b]Model 2; addition of education level, marital status and whether respondents worked shifts.
[c]Model 3; addition of somatic disease.
[d]Model 4; addition of mental distress.
[e]Interaction between sex and hazardous alcohol use

Figure 1. The Proportion of Subjects Suffering from Insomnia Depending on Hazardous Alcohol use and levels of Mental Distress. The Tromsø Study (2015-2016).
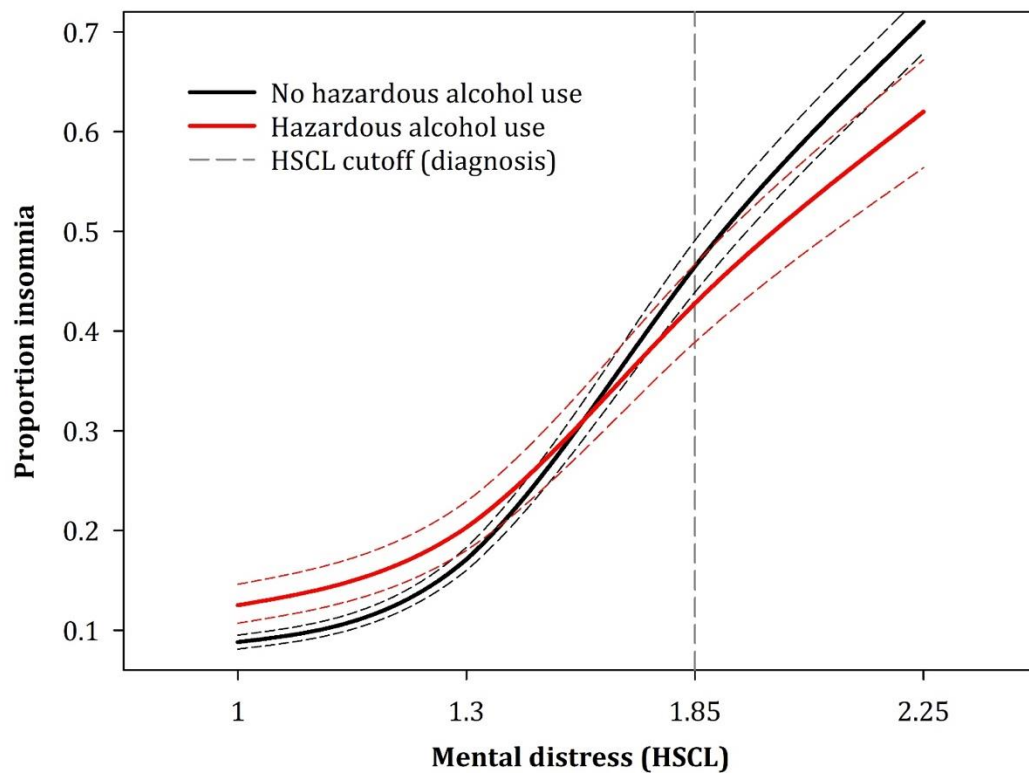

Figure legend: Solid and dashed lines represent estimates of insomnia prevalence and 95% confidence intervals, respectively. The vertical line represents the cutoff zone for participants having a probable affective depressive or anxiety disorder.

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