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ORIGINAL PAPER

The gendered relationship between illicit substance use and self-harm in university students

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Abstract

Purpose To estimate associations between multiple forms of substance use with self-harming thoughts and behaviours, and to test whether gender is an effect modifier of these associations, both independently and along with perceived risk of cannabis use.

Methods Data were drawn from the 2018 Norwegian *Students' Health and Wellbeing Study* (SHoT 2018). A national sample of $n = 50{,}054$ full-time Norwegian students (18–35 years) pursuing higher education completed a cross-sectional student health survey, including questions on past-year self-harm: non-suicidal thoughts of self-harm, non-suicidal self-harm, suicidal thoughts, and suicide attempt. Students reported their frequency of past-year alcohol use (range: never to ≥ 4 times/ week), illicit substance consumption, and perceived risk of cannabis use. The AUDIT and CAST screening tools measured problematic alcohol and cannabis consumption, respectively. We used logistic regression modelling adjusted for age, symptoms of depression and anxiety, and financial hardship (analytic sample range: $n = 48{,}263$ to $n = 48{,}866$).

Results The most frequent alcohol consumption category (≥ 4 times/ week) was nearly always associated with more than a two-fold increased likelihood of self-harm. Less frequent alcohol consumption was associated with reduced odds of suicidal thoughts [monthly or less: OR = 0.87 (95% CI: 0.75–1.00), 2–4 times/month: OR = 0.79 (95% CI: 0.69–0.91), and 2–3 times/ week: OR = 0.83 (95% CI: 0.71–0.98)]. Problematic alcohol consumption was associated with most outcomes: odds ranging from 1.09 (95% CI: 1.01–1.18) for suicidal thoughts to 1.33 (95% CI: 1.00–1.77) for suicide attempt. There was evidence of multiple illicit substance by gender interactions: consumption of all but one illicit substance category (other drug use) was associated with all four forms of self-harm for women, but findings among men were less clear. Among men, only one illicit substance category (stimulant) was associated with most forms of self-harm. Women, but not men, who perceived cannabis use as a health risk were more likely to experience non-suicidal thoughts as cannabis consumption increased, and with harmful consumption patterns.

Conclusion Frequent alcohol consumption is associated with increased risk of self-harm and suicidality for young women and men. Associations between illicit substance use and self-harm and suicidality appear stronger in women compared to men.

Keywords Self-harm · Suicidality · Students · Alcohol · Illicit drugs · Epidemiology

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Introduction

A key developmental and transitional period of elevated risk for exposure to and engagement in substance use and self-harm is college and university. Students pursuing higher education have high rates of problematic and hazardous alcohol use [1], and are increasingly using illicit substances [2]. Between 2014 to 2018, the proportion of full-time Norwegian students aged 18–35 reporting past-year illicit drug use rose to 36.7% among men and 24.0% among women [2]. For many, this is not carryover of behavioural patterns from high school, but instead represents a unique period of vulnerability or exposure risk [3]. In high-risk environments for engagement in problematic or harmful substance use, young men and women are more similar in their alcohol than illicit substance consumption [4]. This is consistent with prevalence studies of students pursuing higher education. When compared to women, men are more likely to consume all forms of illicit substances, including cannabis [2], but genders are converging in their levels of problematic alcohol consumption patterns across time [5]. Like the global distribution of drug use patterns [6], cannabis is the most commonly used drug by Norwegian college and university students [2], and an important health concern given its longitudinal relationship with onset of depression and suicidality [7]. Perceived risk of regular cannabis use is considered a marker of drug use and in the last two decades, has been declining while perception of cannabis as posing little to no harm has risen [8]. Approximately one quarter of Norwegian students pursuing higher education are in favour of cannabis legalization (23.4%), while more than a quarter aren't sure (27.0%) [9]. However, there is limited evidence on the relationships between substance use, including cannabis, gender, and non-suicidal self-harming behaviours in adults aged 18 and over [10].

Non-suicidal self-harm is highly prevalent among Norwegian students [11] and can be defined as intentional self-harm that is not expected to cause death (it lacks suicidal intent) [12]. Non-suicidal self-harm is a strong correlate of suicide attempt, more so than depression and anxiety [13], and predicts the transition from suicidal thoughts to attempt [14]. It is less understood than suicidality (suicidal ideation and attempt) and requires further study before inclusion as a separate diagnostic category in the diagnostic and statistical manual for mental disorders [15]. The literature on gender differences in suicidality is more robust [16] than that for non-suicidal self-harm [17]. As a result, there is greater knowledge on the shared and gender-specific risk factors for suicidality, one of which is drug and alcohol abuse [16]. In their systematic review and meta-analysis, Miranda-Mendizabal and colleagues [16] identified substance abuse disorder as a gender nonspecific risk factor for suicide attempt. In the same study [16], drug and alcohol use, as opposed to disordered behaviours, were not associated with suicide attempt for either gender. However, different illicit substances were not considered and most importantly, few studies addressed drug and alcohol use ($n = 3$ and $n = 3$, respectively) [16]. In the previously noted population-based birth cohort, Mars et al. [14] observed that cannabis and other illicit substance use, but not heavy alcohol use, predicted incident suicide attempt among adolescents with suicidal thoughts or non-suicidal self-harm at baseline. As is common practice, other illicit substances were grouped together though their pharmacological effects may differ. In comparison to suicidality, even less is known about the relationship between substance use and non-suicidal self-harm, and how this may differ according to gender.

In their systematic review, Cipriano et al. [17] note the potential comorbidity of non-suicidal self-harm and substance use disorder, and a greater likelihood of substance abuse among adolescents experiencing non-suicidal self-harm. Otherwise, the possible extent of the relationship between alcohol and drug use with non-suicidal self-harm, and whether substance use is a stronger predictor for one gender versus another remains unclear based on the literature summarized to date [17]. In a clinical sample of adolescent and adult participants, Victor et al. [18] found that more males than females had a substance use disorder and used substances before engaging in non-suicidal self-injury; however, these between-group differences were not statistically different. In a Canadian university sample that examined thoughts of, and engagement in, non-specific self-harm (with and without suicidal intent), having ever consumed alcohol was not related to self-harming thoughts and behaviours (lifetime) [19]. At the same time, some illicit drug use was associated with self-harm behaviours but not thoughts, except for (ever) cannabis use and (ever) inappropriate use of prescription drugs, which were tied to both [19]. Unfortunately, we do not have a strong understanding of the etiology of non-suicidal self-harm, and men are less represented in this area [17]. Currently, there are knowledge gaps in our understanding of the relationships between substance use and non-suicidal self-harm [10].

A better understanding of the potentially nuanced relationship between substance use (frequency, problematic use, differing substances) and self-harm, and how gender may interact, could aid our understanding of the risk for self-harm. Such insight may have implications for mental health care, especially in student populations where substance use and stress are typical. Of particular relevance is the study of cannabis, given shifting societal attitudes towards its use and legalization in an increasing number of countries. Even in Norway, where cannabis remains illegal, changes in societal

trends are evident by the increasing rates of drivers impaired with cannabis or multiple drugs [20]. To improve our understanding of the substance use and self-harm relationships, we used an epidemiological study of Norwegian full-time students ($n = 50{,}054$) pursuing higher education to:

1. Examine the relationships between multiple forms of substance use with self-harming thoughts and behaviours, with emphasis on a broad range of illicit drugs;
2. Test whether the relationship between substance use and self-harm depends on gender (potential effect modifier) by introducing a substance use × gender (two-way) interaction term;
3. Test whether the relationship between cannabis use and self-harm depends on gender and risk perception of cannabis use (potential effect modifiers) by introducing a three-way interaction term (cannabis use × gender × risk perception).

Methods

Design and participants

We used data from the 2018 Norwegian *Students' Health and Wellbeing Study* (SHoT2018), a large epidemiological health survey of full-time students with Norwegian citizenship attending higher education either within Norway or abroad [21]. In Norway, students can attend university ($n = 17$, including specialized universities [$n = 7$]), university college ($n = 24$), and private university colleges ($n =$ unavailable) [21]. Universities and university colleges differ in the type of primary subjects offered [22]. There is no cost for public higher education [21]. The percentage of the Norwegian population with a tertiary level education is greater than the OECD average, and 48.7% of Norwegians aged 25–34 year are tertiary educated (data for < 25 years not available) [23]. SHoT2018 is a collaboration of all Norwegian student welfare associations and the Norwegian Institute of Public Health. The three largest student welfare associations (SiO, Sammen, and SiT) were part of the original SHoT study development [21]. In Norway, every student is affiliated with a student welfare association which helps provide services including housing [21].

As a national student survey, the SHoT2018 eligible student population 18–35 years was $n = 162{,}512$ [21]. Invited participants were emailed a detailed survey introduction and those who provided informed consent (electronically) accessed the web-based survey. The response rate was 31% ($n = 50{,}054$) [21]. Data was collected over a two-month period (February 6-April 5, 2018). More women than men were eligible for SHoT2018 and participated; the age distribution between eligible students and participants was the same [21]. The Regional Committee for Medical and Health Research Ethics in Western Norway approved SHoT2018 (no. 2017/1176). Details regarding data access are available from the Norwegian Institute of Public Health (https://www.fhi.no/en/more/access-to-data/).

Measures

Substance use

As part of the SHoT2018 study, students were asked to report the frequency they typically consumed alcohol and past year illicit substance use. Specifically, respondents were asked to report "How often do you have a drink containing alcohol?". Response options were "never" (referent), "monthly or less", "2–4 times a month", "2–3 times a week", and "4 or more times a week". Regarding illicit substances, students were presented with a comprehensive list [2] and asked to report how often in the last 12 months they had consumed each ("never" [referent], "1 time", "2–4 times", "5–50 times", "more than 50 times"). Drugs were classified according to their pharmacological effects and categorized to represent none versus any (1 time or more) drug use in the past year: *Depressants*: Benzodiazepines without prescription (e.g., Sobril, Valium), GHB (i.e., Gamma-hydroxybutyrate), and Heroin; *Stimulants*: Amphetamine/methamphetamine, Ecstasy/MDMA (i.e., 3,4-methylenedioxy-methamphetamine), Cocaine, and Ritalin (without prescription); *Hallucinogen*: LSD/Psilocybin; *New psychoactive substance*: synthetic cannabinoids (i.e., Spice); *Other drugs*. Relevin (a fictitious drug) was also included in the list of drug names for validity purposes. Following a common methodological practice, those respondents who positively endorsed consuming Relevin were removed from all analyses [24]. We classified drugs according to their pharmacological effects for two reasons: to increase the likelihood of adequate cell sizes and statistical power for our illicit drug-self-harm associations and interactions with gender, and because we expected illicit drugs with similar properties to be related to self-harm in the same manner. In a separate cannabis specific section of the SHoT2018 questionnaire, respondents were asked to report their past-year frequency of cannabis (hash/ marijuana) use: "never" (referent), "1 time", "2–4 times", "5–50 times", more than 50 times", and "daily".

Validated tools measured problematic alcohol and cannabis consumption patterns, behaviours which are highly prevalent within the SHoT2018 sample [1, 9]. The Alcohol Use Disorders Identification Test (AUDIT) [25] is a 10-item screening tool developed by the World Health Organization which covers three conceptual domains: hazardous alcohol use (e.g., "frequency of heaving drinking"), dependence symptoms (e.g., "morning drinking"),

and harmful alcohol use (e.g., "blackouts"). Total scores range from 0 to 40, and a cut-off score of ≥ 8 was used to identify problematic (i.e., "hazardous and harmful alcohol use") consumption patterns [25]. AUDIT scores < 8 were considered to reflect low-risk [26]. The Cannabis Abuse Screening Test (CAST) [27] is a short, 6-item screening tool used to identify problematic cannabis consumption and like the AUDIT, includes questions on frequency of use, dependence ("smoked cannabis before midday"), and resulting problems ("arguments, fights, anxiety attacks, poor results at school"). Response options range from "never" (0) to "very often" (4), for a maximum score of 24. A dichotomous variable was computed to represent severe problematic use (CAST score ≥ 7) and less risk (< 6) cannabis consumption patterns. A cut-off of ≥ 7 has good psychometric properties for identifying severe DSM-5 symptoms of cannabis use disorders [28], and has previously been applied to the SHoT2018 data to represent clinically elevated use [9].

Self-harm thoughts and behaviours with and without suicidal intent

Past-year self-harm outcomes were four items drawn or adapted from two international surveys: a single-item adapted from the Child and Adolescent Self-harm in Europe Study [29] was used to assess thoughts of non-suicidal self-harm, whereas three questions pertaining to non-suicidal self-harm, suicidal thoughts, and suicide attempt were drawn from the Adult Psychiatric Morbidity Survey [30]. Non-suicidal thoughts of self-harm, non-suicidal self-harm, suicidal thoughts, and suicide attempt were each assessed with the following questions, respectively: "Have you ever seriously thought about trying to deliberately harm yourself but not with the intention of killing yourself, but not actually done so?", "Have you ever deliberately harmed yourself in any way but not with the intention of killing yourself? (i.e., self-harm)", "Have you ever seriously thought of taking your life, but not actually attempted to do so?", and "Have you ever made an attempt to take your life, by taking an overdose of tablets or in some other way?". For each form of self-harm, participants were asked to indicate whether it had occurred in the last year (yes/no). The prevalence of self-harm in the SHoT2018 sample is described in detail elsewhere [11]. Across all ages and for both genders, the past-year prevalence estimates for self-harm in SHoT2018: 8.8% (95% CI: 8.6–9.1%) for non-suicidal thoughts of self-harm, 4.1% (95% CI: 3.9–4.2%) for non-suicidal self-harm, 7.2% (95% CI: 6.9–7.4%) for suicidal thoughts, and 0.4% (95% CI: 0.4–0.5%) for suicide attempt [11].

Covariates

Covariates included age (continuous), financial hardship, and symptoms of depression and anxiety. Financial hardship was captured by a single item: "Has it happened during the past 12 months that you/your household have had difficulty coping with the running costs, for example for food, transport, and housing?" (never [referent]/rarely/occasionally/often). Active symptoms (past two weeks) of depression and anxiety were measured using the self-report Hopkins Symptom Checklist-25 (HSCL-25) [31]. The HSCL-25 is comprised of 10-items that measure anxiety (e.g., "feeling tense or keyed up") and 15-items that measure depression (e.g., "crying easily"). There are four response options for each item: 1 = "not at all", 2 = "a little", 3 = "quite a bit", and 4 = "extremely". A total score is computed by averaging responses, with higher scores indicating more symptoms of depression and anxiety. The total score has been recommended for use in epidemiological studies of student populations as a uni-dimensional construct [32].

Effect modifiers

Respondents were asked to report their gender identity: gender binary (woman/man), or "other" (e.g., transperson). Due to a small subsample size ($n = 113$), respondents who identified as "other" were removed for analytic purposes.

Perceived risk of cannabis use on health was assessed with one item, similar to that used in other population health work [33]. Respondents were asked "To what extent do you think you may be physically or mentally injured if you use cannabis once or twice a week?". Respondents who answered "no risk" or "small risk" were classified as low perceived risk for harm, whereas those who were unsure ("do not know") or indicated that cannabis use was associated with "moderate" or "high" health risks, were considered to perceive regular cannabis use as risky. Perception of risk is known to be an indicator of trends in actual usage [8].

Statistical analysis

Descriptive statistics (proportions [%], means and standard deviations [*M (SD)*]) of sample characteristics were computed for the total sample and by gender. We used logistic regression modelling to model the (past-year) presence (versus absence) of each form of self-harm by each (substance) exposure. Odds ratios (OR) and corresponding 95% confidence intervals (95% CI) were estimated. To explore effect modification, we tested three series of interaction models for each self-harm outcome: *Series 1* = two-way interactions for alcohol use [frequency of consumption, AUDIT score] x gender; *Series 2* = two-way interactions for illicit substance use [frequency of cannabis use, CAST score, stimulants,

depressants, LSD, Spice, and other illicit drug use] x gender; *Series 3* = three-way interactions for perceived risk of cannabis use [frequency of cannabis use, CAST score] × gender × perceived health risk of regular cannabis consumption. In each series of exposures, a separate model was conducted for the unique relationship between each exposure and outcome. For example, in series 1, when the frequency of alcohol use was the exposure, we did not control for AUDIT score, and a separate model was conducted for each form of self-harm (outcomes). In the event of a statistically significant interaction term, improvement in model fit was determined using a likelihood ratio (LR) test to compare fit indices (−2 log) between nested models. In the presence of effect modification (LR test $p < 0.05$) for multiple models within a series, stratified results are reported, otherwise gender was adjusted for.

All models controlled for potential confounders: depression and anxiety, financial hardship, and age. Respondents who reported having consumed the dummy drug Relevin ($n = 13$) were removed from all analyses. Missing data on the self-harm outcomes was minimal and well within standard acceptable limits ($n \leq 267$), so we employed listwise deletion, as has been done by others who have analyzed the SHoT2018 self-harm data [11]. After removal of those who consumed Relevin ($n = 13$), non-binary young persons ($n = 113$), and those for whom gender identity was missing ($n = 103$), there was a potential $n = 49{,}825$ gender binary young persons for analyses. The analytic sample size ranged from $n = 48{,}263$ to $n = 48{,}866$. Within SHoT2018, there have been documented differences in mental health by tier of education [34], and in problematic alcohol consumption by age [1]. In light of these findings, we conducted a sensitivity analysis with a subset of the sample restricted by age (18–25 years), in order to assess the tenability of our full sample (18–35 years) results. Alpha was set to 0.05, two-sided. Data were analyzed using Stata version 16.0 (StataCorp). The analysis was not pre-registered and as such, the results should be considered exploratory.

Results

Sample characteristics are presented in Table 1. The majority of respondents were women (69.1%, $n = 34{,}431$), among whom the most commonly reported form of self-harm was non-suicidal thoughts of self-harm (12.0%). Among men, suicidal thoughts were the most frequently reported (6.7%) outcome. Problematic alcohol use was observed in more than half of both women and men (56.4%). Overall, 27.6% ($n = 13{,}713$) of the sample reported having consumed any drug in the past year, with cannabis use being most common (15.2%, $n = 7{,}565$).

Alcohol use

Frequent (≥ 4 times per week) and problematic alcohol consumption were associated with nearly all self-harm outcomes (Table 2). For those who consumed alcohol less frequently (< 4 times per week), the associations between alcohol use and self-harm outcomes were inconsistent. For some outcomes, such as thoughts of non-suicidal self-harm, less frequent alcohol use was associated with increased risk, while for other outcomes, such as thoughts of suicide, less frequent alcohol use was associated with decreased risk.

Illicit substance use

There was evidence of multiple interactions between the different illicit substances and gender (Online Resource 1). Among women, consumption of all illicit substances were associated with nearly all self-harm outcomes (Table 3).

Cannabis

Associations between frequency of cannabis use, problematic cannabis consumption patterns, and self-harm were all stronger for women than men: odds of self-harm ranged from OR = 1.52 (95% CI: 1.26–1.84) to OR = 2.75 (95% CI: 1.82–4.16). In most cases, we did not observe associations between frequency of cannabis use and self-harm outcomes for men: odds of self-harm ranged from OR = 0.53 (95% CI: 0.13–2.24) to OR = 2.08 (95% CI: 0.95–4.56).

Other illicit substances

With regards to other illicit substances (Table 3) and among women, all substances were associated with self-harm, with some of the strongest associations observed for past year depressant use: benzodiazepines without prescription, GHB, and Heroin. For example, women who used depressants without prescription in the past year had 4.92 times increased odds (95% CI: 3.03–8.00) to attempt suicide.

Positive associations between substance use and outcomes among men were less strong or not observed (Table 3, columns 6–9): the odds of self-harm ranged from $OR_{other} = 1.04$, 95% CI: 0.82–1.31) to $OR_{spice} = 2.33$ (95% CI: 0.70–7.74). Use of illicit substances were not associated with suicide attempts for men.

Perceived health risk of regular cannabis use

There was evidence of three-way interactions (Online Resource 2) between cannabis use (frequency and problematic use), perceived health risk of regular cannabis consumption, and gender for non-suicidal thoughts of self-harm (Table 4). Women who perceived cannabis use as a

Table 1 Characteristics of respondents from the SHoT2018 study (n_{women} = 34,431) and men (n_{men} = 15,394)

Characteristics	Total	Women	Men
Age —M (SD)	23.25 (3.29)	23.12 (3.27)	23.54 (3.32)
Financial hardship—*n* (%)			
Never	23,736 (47.6)	15,305 (44.6)	8,350 (54.3)
Rarely	11,345 (22.7)	8,025 (23.4)	3,274 (21.3)
Occasionally	10,900 (21.8)	8,085 (23.5)	2,772 (18.0)
Often	3,929 (7.9)	2,935 (8.5)	971 (6.3)
Depression/anxiety—M (SD)	1.73 (0.55)	1.82 (0.56)	1.53 (0.48)
Outcomes—past 12-months *n* (%)			
NSSH thoughts	5,001 (10.0)	4,137 (12.0)	814 (5.3)
NSSH	2,055 (4.1)	1,706 (5.0)	323 (2.1)
Suicidal thoughts	3,590 (7.2)	2,522 (7.4)	1,031 (6.7)
Suicide attempt	229 (0.5)	164 (0.5)	62 (0.4)
Alcohol use—*n* (%)			
Frequency			
Never	3,966 (8.0)	2,775 (8.1)	1,158 (7.6)
Monthly or less	15,990 (32.1)	11,992 (34.9)	3,919 (25.6)
2–4 times/month	22,415 (44.9)	15,287 (44.5)	7,073 (46.2)
2–3 times/week	6,884 (13.8)	4,018 (11.7)	2,844 (18.6)
≥ 4 times/week	618 (1.2)	286 (0.8)	327 (2.1)
AUDIT—problematic use	28,240 (56.4)	20,195 (58.7)	8,045 (52.3)
Illicit substance use—*n* (%)			
Cannabis			
Never	42,110 (84.8)	30,202 (88.2)	11,760 (77.1)
1 time	2,350 (4.7)	1,408 (4.1)	929 (6.1)
2–4 times	2,884 (5.8)	1,645 (4.8)	1,223 (8.0)
5–50 times	1,642 (3.3)	762 (2.2)	870 (5.7)
> 50 times	689 (1.4)	220 (0.6)	464 (3.0)
CAST—problematic use	445 (0.9)	151 (0.4)	290 (1.9)
Stimulants	3,032 (6.1)	1,546 (4.5)	1,471 (9.7)
Depressants	793 (1.6)	471 (1.4)	315 (2.1)
LSD	1,011 (2.0)	360 (1.1)	644 (4.2)
Spice	695 (1.4)	483 (1.4)	209 (1.4)
Other illicit substances	3,692 (7.4)	2,116 (6.2)	1,556 (10.2)

NSSH thoughts non-suicidal thoughts of self-harm, *NSSH* non-suicidal self-harm, *LSD* lysergic acid diethylamide, *Spice* synthetic cannabinoid. Percentages (%) may not equal 100% due to rounding error

health risk were more likely to experience non-suicidal thoughts as cannabis consumption increased, and with problematic consumption patterns (OR = 4.75, 95% CI: 2.45–9.18). There were no observed relationships between cannabis use (frequency or problematic consumption) on non-suicidal thoughts of self-harm for men who perceived regular cannabis use as a low risk or risky activity (Table 4, columns 4–5). There was no evidence of three-way interactions (cannabis use [frequency or problematic use] x perceived health risk of regular cannabis consumption x gender) for the other measures of self-harm, thus the reader is directed to Table 3 for the previously reported two-way interaction results.

Sensitivity analysis

The number of respondents > 25 years was *n* = 9,844. The associations between frequency of alcohol use in the restricted sample (18–25 years) (Online Resource 3) largely mirrored those of the full sample (18–35 years). However, the associations between problematic alcohol consumption and self-harm outcomes were mostly attenuated. For illicit substance use (Online Resource 4), the majority of the findings were consistent between samples, though we observed some (expected) variability in the magnitude of associations.

Contrary to the primary findings, there was no interaction between frequency of cannabis use × gender × perceived

Table 2 Measures of association between alcohol use and self-harm outcomes: SHoT2018

	NSSH thoughts		NSSH		Suicidal thoughts		Suicide attempt	
	OR [95% CI]	*P* value	OR [95% CI]	*P*-value	OR [95% CI]	*P*-value	OR [95% CI]	*P*-value
Model 1								
Alcohol consumption								
Never	Referent		Referent		Referent		Referent	
Monthly or less	1.17 [1.03–1.34]	0.017	1.10 [0.91–1.32]	0.330	0.87 [0.75–1.00]	0.043	0.64 [0.41–1.00]	0.050
2–4 times/ month	1.08 [0.95–1.24]	0.222	1.03 [0.86–1.24]	0.716	0.79 [0.69–0.91]	0.001	0.67 [0.43–1.05]	0.083
2–3 times/ week	1.33 [1.15–1.55]	< 0.001	1.37 [1.12–1.69]	0.003	0.83 [0.71–0.98]	0.027	0.79 [0.47–1.33]	0.379
≥ 4 times/ week	2.47 [1.89–3.22]	< 0.001	2.23 [1.56–3.18]	< 0.001	1.61 [1.22–2.13]	0.001	2.46 [1.26–4.81]	0.008
Model 2								
AUDIT score								
Low-risk	Referent		Referent		Referent		Referent	
Problematic	1.13 [1.06–1.21]	< 0.001	1.14 [1.03–1.26]	0.010	1.09 [1.01–1.18]	0.035	1.33 [1.00–1.77]	0.052

NSSH thoughts non-suicidal thoughts of self-harm; *NSSH* non-suicidal self-harm. Models adjusted for age, financial hardship, symptoms of depression and anxiety, and gender

health risk of cannabis use on non-suicidal thoughts of self-harm (LR test $p > 0.05$). Consistent with the results for the full sample, there was evidence of a three-way interaction (problematic cannabis consumption × gender) with perceived health risk of regular cannabis consumption on non-suicidal thoughts of self-harm (Online Resource 5). Results were similar to those for the full sample.

Discussion

In this large study of Norwegian university students, gender acted as an effect modifier of the association between illicit drug use and self-harm, but not alcohol use. Among women, illicit substance use was consistently associated with all forms of self-harm, whereas for men, associations were mostly weaker or not observed. In general, our findings suggest that there exists a potential high-risk subpopulation of young women who engage in illicit substance use who may be at particularly elevated risk for self-harm.

Notably, we observed associations between substance use and self-harm despite adjustment for symptoms of depression and anxiety. There is a large, longitudinal literature base linking depression [35] and anxiety [36] with suicidality. Among persons aged 18–24, odds of suicidal ideation are exceptionally elevated among those who are depressed (odds ratio: 14.3) [37]. These findings [37] highlight the magnitude of the strength of the association between depression and self-harm in younger adult samples, which may leave little room for other risk factors. Since we continued to observe many associations between alcohol and drug use with self-harm, even after controlling for known mental health risk factors for self-harm (internalizing symptoms), our findings suggest that substance use could be an independent risk factor for self-harm. However, longitudinal studies with detailed exploration of type and frequency of substance use in relation to non-suicidal and suicidal thoughts and behaviours are required. MacKinnon and Colman [37] also found that any alcohol use was associated with more than a threefold increased likelihood of suicidal ideation in those aged 18–24. In contrast, we only observed an adverse association between frequency of alcohol use and suicidality (ideation and attempt) for our most frequent use category (≥ 4 times per week), whereas less frequent alcohol use was associated with an increased likelihood of non-suicidal self-harm thoughts and behaviours.

Interestingly, for several of the alcohol consumption relationships with self-harm, we either did not observe an association, or our findings suggested a potential protective relationship (e.g., suicidal thoughts). There may be intermediary factors that may explain these associations or lack thereof. Among college students, maladaptive reasons for drinking, measured by drinking to cope with depressive symptoms, is tied to problematic drinking [38]. In turn, adaptive drinking strategies, like avoidance of drinking games, may affect the relationship from negative mood to problematic drinking patterns [38]. For university students, drinking alone but not socially may explain the association between symptoms of depression and anxiety at the start of university and later problematic drinking [39]. Based on our findings, frequent (≥ 4 times/ week) and problematic use was most consistently associated with our adverse outcomes. The potential negative consequences of less frequent alcohol use on self-harm and suicidality may depend upon the reasons for drinking, behavioural strategies, and the nature of the drinking environment.

We did not find evidence of effect modification by gender on the alcohol-self-harm relationship, which is consistent

Table 3 Measures of association between illicit substance use and self-harm by gender: SHoT2018

	Women ($n=34,431$)				Men ($n=15,394$)			
	NSSH thoughts	NSSH	Suicidal thoughts	Suicide attempt	NSSH thoughts	NSSH	Suicidal thoughts	Suicide attempt
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Model 1								
Cannabis use								
Never	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent
1 time	1.56 [1.33–1.83] ***	1.81 [1.48–2.23] ***	1.52 [1.26–1.84] ***	2.43 [1.43–4.13] **	1.00 [0.73–1.37]	0.82 [0.49–1.36]	1.21 [0.92–1.59]	0.53 [0.13–2.24]
2–4 times	1.80 [1.56–2.07] ***	1.75 [1.44–2.13] ***	1.72 [1.45–2.04] ***	1.95 [1.14–3.35] *	1.15 [0.89–1.50]	1.46 [1.02–2.08] *	1.20 [0.94–1.52]	1.40 [0.64–3.07]
5–50 times	2.04 [1.68–2.46] ***	1.99 [1.56–2.54] ***	1.90 [1.52–2.37] ***	2.33 [1.28–4.25] **	1.19 [0.88–1.60]	1.11 [0.70–1.76]	1.45 [1.12–1.88] **	2.08 [0.95–4.56]
> 50 times	2.11 [1.51–2.94] ***	2.51 [1.69–3.74] ***	1.91 [1.31–2.79] **	2.59 [1.00–6.68]	1.40 [0.99–1.98]	1.70 [1.06–2.71] *	1.63 [1.20–2.23] **	1.17 [0.40–3.44]
Model 2								
CAST score								
Less risk	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Problematic	2.16 [1.46–3.19]***	2.48 [1.59–3.87]***	2.75 [1.82–4.16]***	1.80 [0.63–5.16]	1.12 [0.74–1.69]	1.07 [0.58–1.96]	1.49 [1.05–2.13]*	1.03 [0.31–3.49]
Model 3								
Stimulant use								
None	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Yes	1.79 [1.55–2.06]***	1.82 [1.52–2.19]***	1.97 [1.68–2.31]***	2.39 [1.55–3.67]***	1.35 [1.08–1.68]**	1.43 [1.04–1.97]*	1.41 [1.15–1.72]**	1.24 [0.63–2.45]
Model 4								
Depressant use								
None	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Yes	2.02 [1.60–2.54]***	1.99 [1.50–2.64]***	2.00 [1.55–2.57]***	4.92 [3.03–8.00]***	1.54 [1.06–2.23]*	1.55 [0.90–2.65]	1.34 [0.94–1.92]	1.90 [0.73–4.94]
Model 5								
LSD use								
None	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Yes	1.97 [1.50–2.60]***	1.85 [1.30–2.62]**	1.90 [1.39–2.60]***	3.16 [1.59–6.26]**	1.27 [0.93–1.73]	1.78 [1.18–2.68]**	1.31 [0.99–1.73]	1.52 [0.63–3.65]
Model 6								
Spice use								
None	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Yes	1.66 [1.30–2.13]***	1.86 [1.37–2.54]***	1.68 [1.26–2.23]***	2.86 [1.48–5.14]**	1.74 [1.09–2.77]*	2.19 [1.20–4.02]*	1.50 [0.95–2.36]	2.33 [0.70–7.74]
Model 7								
Other drug use								
None	Referent	Referent	Referent	Referent	Referent	Referent	Referent	Referent
Yes	1.71 [1.51–1.93]***	1.76 [1.49–2.08]***	1.58 [1.36–1.84]***	1.30 [0.79–2.13]	1.04 [0.82–1.31]	1.08 [0.77–1.52]	1.12 [0.91–1.38]	1.06 [0.51–2.20]

NSSH thoughts non-suicidal thoughts of self-harm; *NSSH* non-suicidal self-harm. Models adjusted for age, financial hardship, and symptoms of depression and anxiety

*$p<0.05$

**$p<0.01$

***$p<0.001$

Table 4 Measures of association between cannabis use, gender, and perceived risk of cannabis use on health (low risk versus risky), on non-suicidal thoughts of self-harm

	Women		Men	
	Low risk	Risky	Low risk	Risky
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Model 1				
Cannabis use				
Never	Referent	Referent	Referent	Referent
1 time	1.29 [1.00–1.66]*	1.56 [1.27–1.91]***	1.03 [0.69–1.53]	0.91 [0.54–1.54]
2–4 times	1.21 [0.97–1.50]	2.11 [1.74–2.56]***	1.23 [0.90–1.69]	0.86 [0.53–1.41]
5–50 times	1.27 [1.00–1.63]	3.04 [2.22–4.16]***	1.08 [0.76–1.53]	1.33 [0.70–2.52]
> 50 times	1.39 [0.95–2.04]	3.36 [1.64–6.89]**	1.31 [0.89–1.93]	1.29 [0.55–3.04]
Model 2				
CAST score				
Less risk	Referent	Referent	Referent	Referent
Problematic	1.13 [0.69–1.85]	4.75 [2.45–9.18]***	1.10 [0.69–1.76]	0.92 [0.37–2.26]

Models adjusted for age, financial hardship, and symptoms of depression and anxiety

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

with other work which suggests that the gender gap in problematic alcohol use is shrinking among university students [5]. In their meta-analysis, Miranda-Mendizabal and colleagues [16] ascertained that alcohol and drug abuse disorders, but not non-abuse use, were longitudinal risk factors for suicide attempts among both young men and women. This differs somewhat from our findings, which clearly demonstrate a gendered relationship between illicit substance use and all forms of self-harm. Reasons for the between-study differences in illicit drug findings may result from sample differences. In their review focusing on gender differences, Miranda-Mendizabal et al. [16] included longitudinal population-based studies of young persons 12–26 years. Besides our use of a different study design (cross-sectional), our sample was older (18–35 years) and potentially exposed to more everyday stress. The period of life spent pursuing higher education can include short or prolonged intervals of financial uncertainty, as well as academic and social stressors. This period also reflects a transition to adulthood and independence, sometimes living away from family and increasing personal responsibility (e.g., health care). Without more information, we cannot determine whether our sample had higher perceived stress, but if yes, it is possible that students may represent a population particularly worthy of mental health supports.

Among men in the present study, we did not observe a relationship between any form of illicit substance use and suicide attempt, while among women, we observed associations across nearly the full range of illicit substances. The pattern of findings among young women may suggest a possible causal pathway not accounted for by symptoms of depression and anxiety, or gender differences in reasons for drug use. In our study, men had equal or higher past-year drug use of all illicit substances, but the strength of associations with self-harm were nearly always greater in magnitude for women. Similar to our gendered results, Evans-Polce et al. [40] reported higher rates of substance use among young men, but consistently stronger relationships between sensation seeking and substance use among women. In particular, the strongest evidence for a gender difference in the relationship between sensation seeking and substance use was found for marijuana use [40]. Sensation seeking, an inclination towards risk-taking and novelty-seeking, is also associated with incident self-harm among young persons in some modelling [41]. As observed here, young women who both perceived cannabis use as a health risk and were cannabis users, were more likely to experience non-suicidal thoughts. Based on our findings, it is possible that women who perceive cannabis use as risky for their health, may use cannabis as a form of sensation seeking or self-harm, which could at least partially explain the strength of some the observed associations. Unfortunately, we did not have access to information on these measures, precluding such analyses.

Our findings on the association between cannabis use and self-harm merit special attention, particularly as it pertains to young women who perceive such use to be risky for their health. Longitudinal work should seek to replicate our findings, especially since our observed associations demonstrated that no matter their frequency of cannabis use, young women were more likely to experience all forms of self-harm. Given the potential for harm to one's health, advocates

have called for an emphasis on prevention and intervention services as part of cannabis legalization policy frameworks [42]. Within this large Norwegian sample, 1.4% of students reported using cannabis more than 50 times, and approximately 1% reported problematic cannabis use. Understanding how gender and risk perception interact with alcohol and illicit substance use to increase risk of self-harm among student populations may assist in the identification of young persons who may be most at-risk of suicide. Elucidating pathways to self-harm and substance use among university students may help in earlier recognition of those at risk of other adverse outcomes which may negatively impact their future, such as drop-out [43] and delayed educational attainment [44].

Strengths and limitations

In terms of external generalizability, students pursuing higher education tend to be less representative than other general population samples [45], though represent an important and sizeable target population for the delivery of mental health care services [46]. Surveys that cover sensitive or stigmatizing topics, such as illicit substance use and mental health, may underestimate the true proportion of respondents who engage in substance use or experience ill mental health [47, 48]. If under-reported, some of our estimated effect sizes may be attenuated. In some cases, the low prevalence of illicit substance use (e.g., Spice use: 1.4%) combined with the low prevalence of the outcome (e.g., suicide attempt for males: 0.4%) may have affected statistical power, potentially limiting our ability to detect a statistical relationship. Other study limitations include the fact that we did not examine the potential for differences by sexual orientation or gender diversity, population groups who are known to experience higher rates of self-harm and suicidality [49]. This study was not pre-registered and should be considered exploratory. SHoT2018 is a general student health survey and while our measures of self-harm were drawn or adapted from international surveys [29, 30], a validated self-harm specific measure was not administered. Finally, given our cross-sectional study design, the temporal ordering of substance use and self-harm is unknown, thus introducing the possibility of reverse causality: that engagement in self-harm leads to substance use, as found elsewhere [50].

This study also had a number of strengths, including the ability to tease apart the potential effects of numerous illicit substances. To date, illicit substances have mostly been studied as a collective entity, possibly due to the large sample sizes required to examine their association with self-harm and by gender. Our considerable sample of young women ($n = 34{,}431$) and men ($n = 15{,}394$) allowed us to examine relationships between less frequently used and studied illicit drugs (e.g., depressants, LSD) and our past year self-harm outcomes. Smaller samples may have precluded such comparisons, especially for young men, since they had a lower prevalence of self-harm outcomes in the present study. We controlled for important confounders, including symptoms of depression and anxiety, and conducted sensitivity analyses of those 18–25 years, which yielded mostly similar findings. We were able to differentiate between past-year self-harm with and without suicidal intent, the latter of which has been studied to a lesser degree.

Conclusions

For many, the pursuit of higher education falls within a developmental period characterized by a risk of new onset of mental disorders, and increased mortality and morbidity due to suicidal behaviours and substance use [51]. Understanding which subpopulations may be especially amenable to intervention or for whom urgent care is most needed, is important to reducing the personal suffering and the public health burden of self-harm. There already exists an unmet need for student access to mental health services, and student welfare organizations, public health and universities have a crucial role to play in supporting such care [52]. This demand for services is likely to be exacerbated with evidence of increasing rates of self-harm presentations to emergency departments among adolescents, especially girls [53], suggesting disparities in access to care. As student welfare organizations, public health and universities set out to increase their delivery of mental health services, triage will be an important consideration [52], and findings from the present study suggest that substance use should be considered given the strength of the observed findings with self-harm, especially for women.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00127-021-02209-3.

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Author contributions All authors contributed to study conceptualization and design. Data analysis was performed by Dr. IC. The first draft of the manuscript was prepared by Ms. NGH. All authors provided feedback and approved the final manuscript.

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Data availability Details regarding data access are available from the Norwegian Institute of Public Health (https://www.fhi.no/en/more/access-to-data/).

Code availability STATA code can be made available upon request.

Declarations

Conflicts of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Ethics approval The Regional Committee for Medical and Health Research Ethics in Western Norway approved SHoT2018 (no. 2017/1176).

Consent to participate Participants provided informed consent (electronically).

Consent for publication Not applicable.

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