




ORIGINAL ARTICLE

The relationships between use of alcohol, tobacco and coffee in adolescence and mood disorders in adulthood

Ingeborg Bolstad^{1,2}  | Anni-Emilia Alakokkare^{3,4} | Jørgen G. Bramness^{1,5,6} |
Eline B. Rognli⁷  | Jonna Levola^{8,9} | Antti Mustonen^{4,10,11}  |
Jouko Miettunen^{4,12} | Solja Niemelä^{3,13}

¹Norwegian National Advisory Unit on Concurrent Substance Abuse and Mental Health Disorders, Innlandet Hospital Trust, Brumunddal, Norway

²Faculty of Social and Health Sciences, Inland University of Applied Sciences, Hamar, Norway

³Department of Psychiatry, University of Turku, Turku, Finland

⁴Center for Life Course Health Research, University of Oulu, Oulu, Finland

⁵Norwegian Institute of Public Health, Oslo, Norway

⁶Institute of Clinical Medicine, University of Tromsø – The Arctic University of Norway, Tromsø, Norway

⁷Section for Clinical Addiction Research, Oslo University Hospital, Oslo, Norway

⁸Department of Psychiatry, University of Helsinki, Helsinki, Finland

⁹Department of Psychiatry, Hospital District of Helsinki and Uusimaa, Järvenpää, Finland

¹⁰Faculty of Medicine and Health Technology, Tampere University, Tampere, Finland

¹¹Department of Psychiatry, Seinäjoki Central Hospital, Seinäjoki, Finland

¹²Medical Research Center Oulu, Oulu University Hospital and University of Oulu, Oulu, Finland

¹³Addiction Psychiatry Unit, Turku University Hospital, Turku, Finland

Correspondence

Ingeborg Bolstad, Norwegian National Advisory Unit on Concurrent Substance Abuse and Mental Health Disorders, Innlandet Hospital Trust, P.O. Box 104, 2381 Brumunddal, Norway.
Email: ingeborg.bolstad@inn.no

Funding information

Academy of Finland; Emil Aaltonen Foundation; EU QLG1-CT-2000-01643 (EUROBLCS); Juho Vainion Säätiö; NorFA; Päivikki ja Sakari Sohlbergin Säätiö; USA/NIH 2000 G DF682; Yrjö Jahanssonin Säätiö

Abstract

Introduction: Alcohol, tobacco and coffee are commonly used substances and use in adolescence has previously been linked to mood disorders. However, few large prospective studies have investigated adolescent use in relation to mental health outcomes in adulthood. The main aim of this study was to examine the prospective associations between alcohol use, cigarette smoking and coffee consumption at age 16 and subsequent mood disorders up to 33 years of age.

Methods: Data from The Northern Finland Birth Cohort 1986 Study were used and a total of 7660 participants (49.9% male) were included. Associations between alcohol use, cigarette smoking and coffee consumption at age 16 and later diagnoses of major depression and bipolar disorder were examined using multinomial logistic regression analyses.

Results: Mean number of cigarettes/day (OR, 1.23 [95% CI 1.01–1.50]) and mean volume of alcohol consumption (OR, 1.22 [95% CI 1.01–1.47]), but not frequency of excessive drinking, in adolescence were associated with increased

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDerivs](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2022 The Authors. *Acta Psychiatrica Scandinavica* published by John Wiley & Sons Ltd.

risk for subsequent bipolar disorder after adjustment for sex, parental psychiatric disorders, family structure, illicit substance use, and emotional and behavioral problems at age 16. An association between cigarette smoking and major depression attenuated to statistically non-significant when adjusted for emotional and behavioral problems. No associations were observed between adolescent coffee consumption and subsequent mood disorders.

Conclusions: This is the first study to report an association of adolescent cigarette smoking and subsequent bipolar disorder diagnosis providing grounds for further research and pointing to a place for preventive measures among adolescents.

KEYWORDS

adolescence, alcohol, bipolar disorder, coffee, major depression, mood disorder, tobacco

1 | INTRODUCTION

Alcohol, tobacco, and coffee are the most commonly used substances in the general population, and consumption is often initiated during adolescence.^{1,2} Previous research has indicated a link between use of these substances and mood disorders, though alcohol and tobacco have been subject to more investigations than coffee.^{3–9} Epidemiological prospective associations have been mostly studied for major depression (MD),^{3,7} while bipolar disorder (BP), which is characterized by manic or hypomanic episodes and is often chronic, is far less studied.⁶ Furthermore, there are only a handful of studies that have utilized prospectively collected general population data from adolescence to adulthood.^{6,7}

Importantly, due to ongoing brain development, adolescents may be particularly sensitive to the detrimental effects of substance use.^{10,11} Longitudinal studies indicate that adolescent alcohol use and cigarette smoking may cause adverse neurobiological alterations^{10–12} while the effect of coffee is unclear.^{13,14} The relationships between substance use and mood disorders are complex and in epidemiological studies they may be affected by latent factors or confounding.

Both frequency and quantity of adolescent alcohol use has been shown to associate with subsequent MD.³ Previous prospective studies have reported associations between higher levels of adolescent alcohol use,¹⁵ frequency of drinking¹⁶ bingeing,^{17–19} and alcohol use problems.²⁰ Many of the previous findings are, however, not consistent, and concurrent psychopathology and other types of substance use often confounds the relationship.^{3,18,21} Although alcohol use disorder (AUD) is associated with a four times greater risk of BP,²² there is limited evidence to support that alcohol use precipitates BP.⁶ However, previous studies have either been small,

Significant Outcomes

- Cigarette smoking and alcohol consumption in adolescence were associated with increased risk of subsequent bipolar disorder after adjustment for background variables including adolescent emotional and behavioral problems
- Associations between cigarette smoking and alcohol consumption in adolescence and subsequent major depression attenuated to nonsignificant after adjusting for adolescent emotional and behavioral problems.
- No association between adolescent coffee consumption and later affective disorders were found.

Limitations

- Lack of information about mental health symptoms before age 16 may cause risk of undetected reversed causality between substance use and mood disorder.
- Using self-reported information may have caused underestimation of substance use.
- A relatively low number of patients with bipolar disorder gave limited power for identifying associations for consumption frequencies measured by categorical variables.

included selected populations or used only symptom-level information to determine possible BP.⁶

Both smoking status and heaviness of smoking, have been shown to associate with increased risk of subsequent MD,^{4,23} and this is presumably evident also for

adolescents.²⁴ While the association between smoking and depression has been widely studied, current knowledge is scarce for BP.⁸ Smoking is two to three times more common in BP compared to the general population,²⁵ and although smoking initiation usually precedes BP, there seems to be a complex bidirectional causality.^{26–28}

It has been postulated that coffee drinking is associated with decreased risk of MD, especially among those with high caffeine intake.^{5,29} However, previous evidence is based on mostly cross-sectional studies with adult populations alone.^{5,29} It has been speculated that caffeine may have an impact on clinical symptoms in BP,³⁰ but no prospective studies have been conducted on the matter.

In this study, we aim to examine the prospective associations between alcohol use, cigarette smoking and coffee consumption at age 15/16 and subsequent register-based diagnoses of MD and BP by the age of 32/33. A range of relevant covariates was included, such as parental lifetime psychiatric diagnoses as well as illicit drug use and psychopathology of the participants at baseline.

2 | MATERIALS AND METHODS

2.1 | Participants

The Northern Finland Birth Cohort 1986 Study (NFBC1986) is an ongoing follow-up study including all children with expected date of birth between July 1st 1985 and June 30th 1986, comprising 99% ($n = 9432$) of all children born alive in the target period from the two northernmost provinces in Finland.³¹

A two-phased follow-up study commenced when participants were aged 15/16, in year 2001/2002. First, participants and their parents were sent self-report questionnaires ($n = 9215$) regarding health and wellbeing, including questions about emotional and behavioral problems (Youth Self Report), coffee consumption and cigarette smoking ($n = 7344$). Thereafter, all participants were invited to a field study where they reported volume of alcohol consumption, frequency of excessive drinking and illicit substance use ($n = 6799$) using questionnaires.

We excluded persons who had intellectual disability (ICD-10: F70–F79) or had been diagnosed with mood disorder (ICD-10: F30.x, F31.x, F32.x, F33.x, F34.0, F34.1, F34.8, F34.9, F38.x, F39, F41.2, F53.0 or ICPC-2: P73, P76), MD ($n = 73$) or BP ($n = 2$), before the age of 16. A total of 7660 persons were included in our analysis (49.9% male) (Figure 1). Three outlier observations (≥ 1890 g/week) in the alcohol consumption variable and three outliers (≥ 88 cups/day) in the coffee consumption variable were removed from the analyses.

Informed consent was obtained from all participants and their parents. The 15/16-year follow-up study was approved by the Ethics committee of the Northern Ostrobothnia Hospital District in Finland (June 17, 1999). More information is available from the NFBC1986 webpage at <http://www.oulu.fi/nfbc/node/40696>.

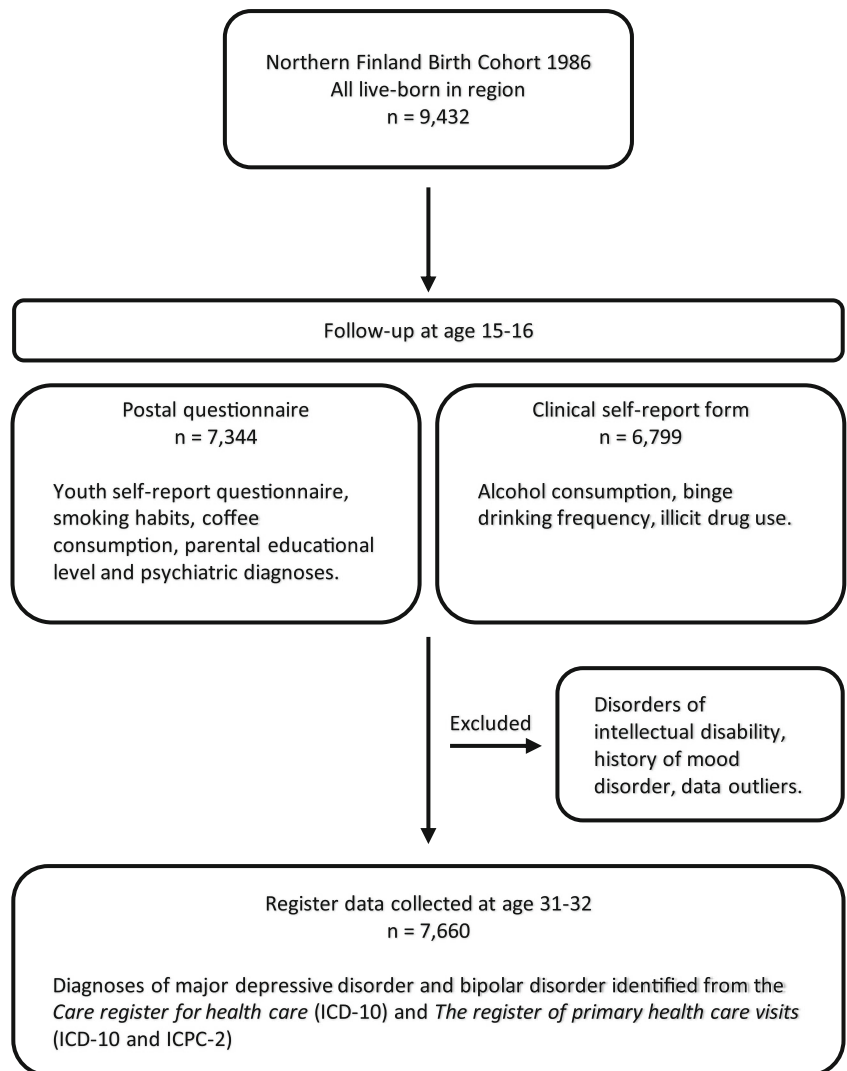
2.2 | Outcome variables

Diagnoses of mood disorders (MD or BP) were obtained from two national health care registers by the National Institute for Health and Welfare until the end of 2018, that is, by the age of 32/33. The Care Register for Health Care contains International Classification of Diseases, tenth revision (ICD-10)³² diagnosis data about patients discharged from inpatient care (1972–2018), and from 1998 onwards also on specialized outpatient care. The Register of Primary Health Care Visits includes all outpatient primary health care visits in Finland between the years 2011 and 2018. Mood disorder cases were identified using The International Classification of Primary Care 2 (ICPC-2) codes³³ and ICD-10 diagnoses. MD included ICD-10 diagnosis codes F32.x, F33.x, F34.1, F34.8, F34.9, F38.x, F39, F41.2, and F53.0, and the ICPC-2 code P76 (depressive disorder: 103 cases). The diagnostic code F53.0 (postpartum depression) was included in the analysis as the distinction is unclear and it is closely associated with previous MD episodes.³⁴ BP included ICD-10 diagnosis codes F30.x, F31.x, and F34.0 and the ICPC-2 code P73 (affective psychosis: 1 case). Of those with BP, 80% also had MD. A three-class mood disorder outcome variable was defined as (1) no mood disorder, (2) MD without BP, and (3) BP.

2.3 | Exposure variables

To collect information about *mean volume of alcohol consumption* at age 15/16, the participants were asked: “How often have you drunk [beverage] during the past 12 months?” and “How much [beverage] did you usually drink in a day when you drank it?” The included beverages were beer/cider/long drinks, light wine, wine, and spirits; the responses were converted into total grams ethanol per day. To obtain *frequency of excessive drinking* the participants were shown a visual depiction of a standard drink (equaling 12 g pure alcohol) and asked how many times during the past 30 days they had had six/four drinks or more, for boys/girls. The response options were (1) never; (2) once; (3) twice; (4) 3–5; (5) 6–9 or (6) >10 times. Based on the distribution the data were pooled into a three-class variable: (1) never, (2) once or twice, and (3) three times or more.

FIGURE 1 Flow chart of the data collection



Information about *cigarette smoking* was obtained by asking: “Have you ever smoked?” If yes, participants were asked “Do you smoke now?” with response options (1) not at all, (2) occasionally, (3) 1 day per week, (4) 2–4 days per week, (5) 5–6 days per week, and (6) 7 days a week. These two questions were combined and dichotomized to *daily smoking (no/yes)*. The question “How much do you smoke now?” was asked separately for filter and other cigarettes and summed up as a continuous variable of *number of cigarettes/day*.

Coffee consumption was determined by asking “How many cups of coffee do you drink in a day?” This was asked separately for filtered and brewed coffee and summed up as a continuous variable.

2.4 | Confounding variables

Parental educational level was defined by the highest education level achieved by either parent when participants

were 15/16 years old. This variable was categorized into (1) <12 years (without a secondary schooling degree), and (2) ≥12 years (vocational or secondary upper-level schooling). The classification of the *family structure* included (1) families with both parents living with the participant all the time, and (2) all other family types. Lifetime parental psychiatric disorder (ICD-10 diagnosis codes F00–F69, F80–F99 from approximately 1960–2001) were obtained from three nationwide registers: (1) Register of Health Care during the years 1972 to 2018 (includes inpatient care and visits to specialized outpatient health care since 1998); (2) Disability pensions of the Finnish Centre for Pensions (1965–2016); and (3) Register of Primary Health Care Visits (2011–2018). The variable was operationalized as *parental psychiatric disorder (no/yes)*. These two variables were constructed to adjust for potential factors related to genetic or environmental heredity.

Data on lifetime illicit substance use at age 15/16 were collected with several questions regarding use of cannabis, prescription drugs, inhalants and other illicit

substances, and combined into a *Illicit substance use (no/yes)* variable.

The *Youth Self Report (YSR)* was administered at age 15/16 and covers adolescents' emotional or behavioral problems the past 6 months. As the YSR possibly taps into pre-morbid or subdiagnostic mental disorder it serves as an important confounding variable. The form includes 29 items on externalizing, and 30 items on internalizing problems (from total of 118) and responses are scored with statements being (0) not true; (1) somewhat/sometimes true or (2) very true. YSR subscales with >3 missing values were excluded while subscales with ≤3 missing were replaced by the mean value of the particular subscale for that person.^{35,36} Items concerning substance use was removed from the YSR total score as illicit substance use was included separately.

2.5 | Statistical methods

Kruskal–Wallis and Chi-square-tests were used for studying the associations of background variables and mood disorders. Multinomial logistic regression analyses with odds ratios (OR) and 95% confidence intervals (CI) were used to examine associations between exposure and outcome variables.

The continuous exposure variables (grams/alcohol, cups/coffee and cigarettes/day) were standardized with standard deviation (SD), that is, change in OR reflects steps of one SD. Predefined models with adjustment for the following covariates were utilized: Model 1: sex; Model 2: also family structure and parental psychiatric disorder; Model 3: also illicit substance use; Model 4: also

TABLE 1 Background variables and consumption of alcohol, cigarettes and coffee in adolescence by mood disorder diagnosis in adulthood

		No mood disorder <i>n</i> = 6696 (87.4%)	Major depression <i>n</i> = 879 (11.5%)	Bipolar disorder <i>n</i> = 85 (1.1%)	Test of difference <i>p</i> Value
Female	<i>n</i> (%)	3215 (48.0)	562 (63.9)	63 (74.1)	<0.001 ^a
Cohabiting parents	<i>n</i> (%)	4483 (78.7)	508 (68.6)	49 (68.1)	<0.001 ^a
Parent ≥12 years of education	<i>n</i> (%)	2187 (37.7)	282 (37.7)	30 (42.9)	0.671 ^a
Parent psychiatric diagnosis	<i>n</i> (%)	2400 (35.8)	432 (49.1)	48 (56.6)	<0.001 ^a
Lifetime illicit substance use, age 16	<i>n</i> (%)	702 (12.2)	164 (22.9)	24 (32.4)	<0.001 ^a
Youth Self-Report total score	Median (IQR)	23.0 (14.0–34.0)	31.3 (20.0–46.0)	33.0 (24.0–46.0)	<0.001 ^b
Alcohol consumption					
Grams/day	Median (IQR)	0.5 (0.0–2.9)	0.8 (0.0–4.6)	2.4 (0.0–8.7)	<0.001 ^b
Frequency of excessive drinking ^c					
None	<i>n</i> (%)	3522 (61.2)	405 (56.6)	36 (48.0)	<0.001 ^a
1–2 times	<i>n</i> (%)	1726 (30.0)	215 (30.0)	26 (34.7)	
≥3 times	<i>n</i> (%)	506 (8.8)	96 (13.4)	13 (17.3)	
Cigarette smoking					
Smoking habit					
Not at all	<i>n</i> (%)	4000 (66.7)	466 (58.8)	33 (41.8)	<0.001 ^a
1–6 days a week	<i>n</i> (%)	1258 (21.0)	177 (22.3)	21 (26.6)	
Every day	<i>n</i> (%)	742 (12.4)	150 (19.9)	25 (31.6)	
Cigarettes/day	Median (IQR)	0.0 (0.0–0.0)	0.0 (0.0–0.2)	0.0 (0.0–0.6)	<0.001 ^b
Cigarettes/day	Mean (SD)	1.6 (4.1)	2.5 (5.0)	3.9 (6.4)	
Coffee consumption					
≥1 cup of coffee/day	<i>n</i> (%)	1177 (39.9)	231 (41.6)	27 (45.0)	0.415 ^a
Cups of coffee/day	Median (IQR)	0.0 (0.0–0.2)	0.0 (0.0–0.2)	0.0 (0.0–0.3)	0.850 ^b
Cups of coffee/day	Mean (SD)	1.8 (4.4)	1.7 (2.9)	1.9 (3.0)	

Abbreviations: IQR, Interquartile range (25th and 75th percentile); SD, standard deviation.

^aChi Square test.

^bKruskal–Wallis test.

^cLast 30 days.

TABLE 2 Multinomial logistic regression of effect of alcohol, cigarette and coffee consumption in adolescence on mood disorder in adulthood

	<i>n</i>	Major depression		Bipolar disorder	
		OR (95% CI)	<i>p</i> Value	OR (95% CI)	<i>p</i> Value
Alcohol					
Grams/day ^a					
Model 1	6562	1.19 (1.10–1.29)	<0.001	1.41 (1.23–1.62)	<0.001
Model 2	5607	1.16 (1.07–1.27)	0.001	1.37 (1.17–1.59)	<0.001
Model 3	5594	1.08 (0.99–1.19)	0.100	1.28 (1.08–1.51)	0.004
Model 4	5349	1.06 (0.96–1.17)	0.244	1.22 (1.01–1.47)	0.036
Frequency of excessive drinking ^b					
Model 1	6545				
1–2 times		1.07 (0.90–1.28)	0.440	1.44 (0.87–2.40)	0.157
≥3 times		1.66 (1.30–2.12)	<0.001	2.54 (1.34–4.84)	0.004
Model 2	5592				
1–2 times		1.05 (0.86–1.27)	0.646	1.33 (0.77–2.29)	0.309
≥3 times		1.64 (1.26–2.14)	<0.001	1.62 (0.74–3.58)	0.229
Model 3	5578				
1–2 times		0.93 (0.76–1.13)	0.457	1.11 (0.63–1.97)	0.721
≥3 times		1.24 (0.93–1.65)	0.144	1.08 (0.46–2.52)	0.867
Model 4	5334				
1–2 times		0.89 (0.73–1.10)	0.272	1.05 (0.59–1.86)	0.877
≥3 times		1.09 (0.81–1.48)	0.557	0.85 (0.35–2.09)	0.729
Cigarettes					
Daily smoking (no/yes) ^c					
Model 1	6872	1.63 (1.34–1.98)	<0.001	3.19 (1.97–5.16)	<0.001
Model 2	6016	1.44 (1.15–1.79)	0.001	2.49 (1.43–4.33)	0.001
Model 3	5362	1.20 (0.93–1.55)	0.155	2.09 (1.12–3.91)	0.021
Model 4	5283	1.07 (0.82–1.39)	0.612	1.83 (0.98–3.45)	0.059
Cigarettes/day ^a					
Model 1	6718	1.21 (1.13–1.29)	<0.001	1.43 (1.25–1.65)	<0.001
Model 2	5882	1.18 (1.10–1.26)	<0.001	1.34 (1.14–1.59)	0.001
Model 3	5246	1.11 (1.02–1.20)	0.021	1.27 (1.05–1.54)	0.012
Model 4	5164	1.07 (0.98–1.17)	0.157	1.23 (1.01–1.50)	0.039
Coffee					
Cups of coffee/day ^a					
Model 1	6854	1.01 (0.92–1.10)	0.924	1.09 (0.88–1.34)	0.437
Model 2	5995	0.98 (0.88–1.09)	0.728	0.98 (0.70–1.38)	0.915
Model 3	5344	0.97 (0.85–1.10)	0.605	0.90 (0.56–1.45)	0.670
Model 4	5267	0.95 (0.83–1.09)	0.483	0.87 (0.52–1.46)	0.607

Note: OR = Odds ratio; 95% CI = 95% confidence interval of OR. Reference group: No mood disorder. *Model 1*: Adjustment for sex; *Model 2*: Additional adjustment for parental psychiatric disorder and family structure; *Model 3*: Additional adjustment for illicit substance use; *Model 4*: Additional adjustment for YSR.

^aFor continuous variables change in OR reflects steps of one standard deviation.

^bReference group: no excessive drinking last 30 days.

^cReference group: no daily smoking.

YSR total score. Results were considered statistically significant at $p < 0.05$.

In the current study, there were fewer participants in the follow-up at age 15/16 among inhabitants of urban areas (80% vs. 85%, $p < 0.001$), males (78% vs. 84%, $p < 0.001$), and among participants with maternal (77% vs. 82%, $p < 0.001$) or paternal (79% vs. 81%, $p < 0.008$) history of psychiatric disorders. Therefore, to address potential attrition bias we used inverse probability weighting for sex, parental psychiatric disorder and urbanicity.³⁷ The associations were still significant and of similar magnitude in the weighted analyses as in the unweighted analyses (Tables S1 and S2).

To evaluate our findings from the regression analyses against potential confounding factors, we calculated *E*-values (Table S3). An *E*-value with the lower bound of the CI represents the minimum strength of association between unmeasured confounding factors and outcome that would be required to explain away the association between exposure and outcome variables presented in a regression analysis. An *E*-value that is relatively large in comparison to the OR indicates that the association is unlikely to be explained by unmeasured confounding factors. To control for effect of smoking on alcohol consumption and vice versa, additional regression models were added (Table S4) as sensitivity analyses. Linear regression and multicollinearity diagnostics with variance inflation factor (VIF) scores were used to detect correlation between multiple covariates. $VIF > 5$ was used as an indicator of multicollinearity.

Statistical analyses were performed using SPSS version 25 and R version 3.6.0 (sensitivity analysis).

3 | RESULTS

Of the total sample of 7660 individuals, 879 (11.5%) were diagnosed with MD and 85 (1.1%) with BP by the age of 33. Associations between background variables and mood disorders are displayed in Table 1.

The multinomial logistic regression analyses are shown in Table 2. An association between alcohol consumption and BP remained statistically significant even in the model adjusted for sex, family structure, parental psychiatric disorder, illicit drug use, and YSR total score (Model 4) (OR, 1.22 [95% CI, 1.01–1.47]). The association between alcohol consumption and MD was significant when adjusting for sex, parental psychiatric disorder and family structure (OR, 1.16 [95% CI, 1.10–1.29]) but attenuated after further adjustment.

There were modest associations between frequency of excessive drinking ≥ 3 times/month and both mood disorders in Model 1: (OR, 1.66 [95% CI, 1.30–2.12]) for MD

and (OR, 2.54 [95% CI, 1.34–4.84]) for BP. After adjustment for parental variables the association with BP attenuated, while the association with MD was significant (OR, 1.64 [95% CI, 1.26–2.14]) but attenuated after further adjustment for illicit substance use.

The association between number of cigarettes/day and BP remained statistically significant even in Model 4 (OR, 1.23 [95% CI, 1.01–1.50]), while the association with MD was statistically significant in Model 3 (OR, 1.11 [95% CI, 1.02–1.20]), but not with further adjustments. When examining daily smoking (no/yes), the association with BP was significant in Model 3 (OR, 2.09 [95% CI, 1.12–3.91]), but not the association with MD.

Associations between coffee consumption in adolescence and adulthood mood disorder were not seen.

The inverse probability weighted regression models confirmed our findings (Tables S1 and S2). VIFs in Model 4 for both alcohol consumption and cigarettes smoking were < 1.2 . When adding alcohol consumption (g/day) as a covariate to the cigarette smoking models and cigarettes/day to the alcohol consumption models the associations attenuated to non-significant (Table S4).

4 | DISCUSSION

In this prospective study based on a large birth cohort linked with registry data, adolescent cigarette smoking was associated with increased risk for subsequent BP, and this was true after adjustment for sex, any parental psychiatric disorder, family structure, illicit substance use, and emotional and behavioral problems at age 15/16. The associations between cigarette smoking and MD attenuated to statistically non-significant in the last adjustment steps. Adolescent mean volume of alcohol consumption (but not frequency of excessive drinking) was associated with subsequent BP after all four steps of adjustments. No associations were observed between adolescent coffee consumption and subsequent mood disorders.

Adolescent cigarette smoking, when examined as number of cigarettes/day, was associated with subsequent risk of BP independently of a range of covariates, including baseline mental health (YSR) and parental psychiatric disorders. In line with our findings, recent Mendelian randomization studies have indicated that cigarette smoking seems to be a causal risk factor for BP.^{27,38} Also, a recent Norwegian cohort study reported a prospective association between adolescent smoking and later prescription for mood-stabilizers, a proxy for BP.³⁹ However, the association between smoking and BP could be bidirectional,²⁷ and a possible causation from BP to smoking is supported by the fact that smoking is more common among persons with BP than in the general population,²⁵ and that there is a heavy

genetic load for bipolar disorder.⁴⁰ Despite these findings, this is to the best of our knowledge the first study to report an association of adolescent cigarette smoking and subsequent BP, which provide grounds for further research.

Increased risk for MD among smokers has been reported in meta-analyses for both adults⁴¹ and adolescents,²⁴ suggesting that smoking may be causally linked to MD. However, in our study, the association between cigarette smoking and MD attenuated to a non-significant level when adjusted for YSR total score. Although most previous studies have adjusted for demographics and adolescent alcohol and drug use,^{24,42} they have failed to take into account adolescent emotional and behavioral problems like the current study does. Thus, the present study may challenge the causality implied by others, indicating that smoking may be a consequence of major depression rather than a risk factor.

The mean volume of alcohol consumption in adolescence was associated with BP in adulthood, even after multiple adjustments. Frequency of excessive drinking, however, did not predict BP in the same way. There is a lack of studies concerning adolescent alcohol consumption and later BP, as most previous research on adolescent alcohol use has focused on unipolar depression^{16,43–45} and depressive symptoms⁴⁶ as outcomes.

The association between adolescent alcohol use and subsequent MD was weaker than for BP and was attenuated when adjusting for illicit drug use and YSR, much like what was found for smoking and MD. The findings agree with a previous report from our group,²¹ which also found frequency of excessive drinking to be unrelated to later mood disorder. However, several studies identify binge drinking in adolescence as a better predictor than mean volume for adverse mental health outcomes in adolescent age¹⁸ and adulthood.⁴⁷ It may be that the present study have too low power for revealing a relationship between frequency of drinking and mood disorders. Furthermore, other studies have found associations between alcohol-related problems and drinking frequency with later MD,^{16,20,44} but this could be because these studies set higher limits for alcohol consumption, even addressing alcohol problems, or because the current study adjusted for illicit substance use and emotional and behavioral problems in adolescence.

We observed no association between coffee consumption and subsequent mood disorders in the current study. Previous findings concerning coffee consumption and mood disorders mainly point to an inverse relationship where coffee seem to decrease the risk of MD in adults.^{48–51} Less is known about how coffee and caffeine affect adolescents, but positive cross-sectional associations have been reported.⁵² Consumption of other caffeinated beverages, such as energy drinks has become substantial,⁵³ but were not included in the current study

as they were not marketed when data collection took place. The coffee exposure in the studied adolescents was relatively low and the association between coffee and mood disorders may be different in samples with higher consumption of caffeinated beverages. Possible subsequent effects of caffeine intake in adolescence is an important issue that still needs more research.

A major strength of the current study is NFBC1986 being one of the largest ongoing birth cohort studies and it has high genetic and ethnic homogeneity. We also used several nationwide registers with little missing information for the mental health outcomes. Mood disorder outcomes included in the study were taken from both primary and specialized health care. This was done to ensure a broad enough capture of outcome. Although the specificity of diagnosis from the two settings is unknown, underdiagnosis of mood disorders may represent a greater concern, as many go undiagnosed.⁵⁴ In addition, some patients are more likely to get in contact with the health care system, such as patients with comorbid personality disorders, and thus they may be overrepresented in the registers. Attrition bias and unmeasured confounding were controlled for and did not influence the findings. Furthermore, the data included a wide range of information that made it possible to address many potential confounders. It could be a limitation that we did not have information about symptoms prior to age 15/16, and reversed causality between mental health symptoms and substance use cannot be ruled out. Diagnostic information on comorbid psychiatric disorder at age 15/16 was not included, and self-reported substance use measures as used in this study are known to underestimate substance use⁵⁵ and may lead to underestimation of true associations. Lastly, the number of BP cases was potentially too low to produce robust estimates with frequency of excessive drinking. More research with longitudinal design is needed to further examine the individual effects of volume of consumption and pattern of drinking on mood disorders in adulthood.

5 | CONCLUSIONS

Our findings demonstrate that both adolescent cigarette smoking and alcohol consumption are associated with increased risk for subsequent mood disorders. These relationships are relatively well established for MD, but the current study points to the relationships being even more pronounced for BP. We were not able to demonstrate any relationship between coffee consumption and mood disorders.

ACKNOWLEDGMENTS

We thank all cohort members and researchers who have participated in the study. We also wish to acknowledge

the work of the NFBC project center, and statistician Hannu Vähänikkilä for his assistance.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

PEER REVIEW

The peer review history for this article is available at <https://publons.com/publon/10.1111/acps.13506>.

DATA AVAILABILITY STATEMENT

NFBC data is available from the University of Oulu, Infrastructure for Population Studies. Permission to use the data can be applied for research purposes via electronic material request portal. In the use of data, we follow the EU general data protection regulation (679/2016) and Finnish Data Protection Act. The use of personal data is based on cohort participants' written informed consent at his/her latest follow-up study, which may cause limitations to its use. Please, contact NFBC project center (nfbcprojectcenter@oulu.fi) and visit the cohort website (www.oulu.fi/nfbc) for more information.

ORCID

Ingeborg Bolstad  <https://orcid.org/0000-0001-7316-6309>

Eline B. Rognli  <https://orcid.org/0000-0002-7248-3019>

Antti Mustonen  <https://orcid.org/0000-0002-3259-2122>

REFERENCES

- ESPAD Group. *ESPAD Report 2019: Results from the European School Survey Project on Alcohol and Other Drugs*. EMCDDA Joint Publications, Publications Office of the European Union, Luxembourg; 2020.
- Branum AM, Rossen LM, Schoendorf KC. Trends in caffeine intake among U.S. children and adolescents. *Pediatrics*. 2014;133(3):386-393.
- Cairns KE, Yap MB, Pilkington PD, Jorm AF. Risk and protective factors for depression that adolescents can modify: a systematic review and meta-analysis of longitudinal studies. *J Affect Disord*. 2014;169:61-75.
- Fluharty M, Taylor AE, Grabski M, Munafò MR. The association of cigarette smoking with depression and anxiety: a systematic review. *Nicotine Tob Res*. 2016;19(1):3-13.
- Kang D, Kim Y, Je Y. Non-alcoholic beverage consumption and risk of depression: epidemiological evidence from observational studies. *Eur J Clin Nutr*. 2018;72(11):1506-1516.
- Lalli M, Brouillette K, Kapczinski F, de Azevedo CT. Substance use as a risk factor for bipolar disorder: a systematic review. *J Psychiatr Res*. 2021;144:285-295.
- Li J, Wang H, Li M, et al. Effect of alcohol use disorders and alcohol intake on the risk of subsequent depressive symptoms: a systematic review and meta-analysis of cohort studies. *Addiction*. 2020;115(7):1224-1243.
- Marangoni C, Hernandez M, Faedda GL. The role of environmental exposures as risk factors for bipolar disorder: a systematic review of longitudinal studies. *J Affect Disord*. 2016;193:165-174.
- Puddephatt JA, Irizar P, Jones A, Gage SH, Goodwin L. Associations of common mental disorder with alcohol use in the adult general population: a systematic review and meta-analysis. *Addiction*. 2022;117(6):1543-1572.
- Gogliettino AR, Potenza MN, Yip SW. White matter development and tobacco smoking in young adults: a systematic review with recommendations for future research. *Drug Alcohol Depend*. 2016;162:26-33.
- Lees B, Debenham J, Squeglia LM. Alcohol and cannabis use and the developing brain. *Alcohol Res*. 2021;41(1):11.
- Mineur YS, Picciotto MR. Biological basis for the co-morbidity between smoking and mood disorders. *J Dual Diagn*. 2009;5(2):122-130.
- Godos J, Pluchinotta FR, Marventano S, et al. Coffee components and cardiovascular risk: beneficial and detrimental effects. *Int J Food Sci Nutr*. 2014;65(8):925-936.
- van Calker D, Biber K, Domschke K, Serchov T. The role of adenosine receptors in mood and anxiety disorders. *J Neurochem*. 2019;151(1):11-27.
- Pape H, Rossow I. Less adolescent alcohol and cannabis use: more deviant user groups? *Drug Alcohol Rev*. 2021;40(1):118-125.
- Edwards AC, Heron J, Dick DM, et al. Adolescent alcohol use is positively associated with later depression in a population-based U.K. cohort. *J Stud Alcohol Drugs*. 2014;75(5):758-765.
- Manninen L, Poikolainen K, Vartiainen E, Laatikainen T. Heavy drinking occasions and depression. *Alcohol Alcohol*. 2006;41(3):293-299.
- Pedrelli P, Shapero B, Archibald A, Dale C. Alcohol use and depression during adolescence and young adulthood: a summary and interpretation of mixed findings. *Curr Addict Rep*. 2016;3(1):91-97.
- Best D, Manning V, Gossop M, Gross S, Strang J. Excessive drinking and other problem behaviours among 14-16 year old schoolchildren. *Addict Behav*. 2006;31(8):1424-1435.
- Marmorstein NR. Longitudinal associations between alcohol problems and depressive symptoms: early adolescence through early adulthood. *Alcohol Clin Exp Res*. 2009;33(1):49-59.
- Sarala M, Miettunen J, Koskela J, et al. Frequent intoxication and alcohol tolerance in adolescence: associations with psychiatric disorders in young adulthood. *Addiction*. 2020;115(5):888-900.
- Hunt GE, Malhi GS, Cleary M, Lai HM, Sitharthan T. Comorbidity of bipolar and substance use disorders in national surveys of general populations, 1990-2015: systematic review and meta-analysis. *J Affect Disord*. 2016;206:321-330.
- Talati A, Keyes KM, Hasin DS. Changing relationships between smoking and psychiatric disorders across twentieth century birth cohorts: clinical and research implications. *Mol Psychiatry*. 2016;21(4):464-471.
- Chaiton MO, Cohen JE, O'Loughlin J, Rehm J. A systematic review of longitudinal studies on the association between depression and smoking in adolescents. *BMC Public Health*. 2009;9(1):356.
- Heffner JL, Strawn JR, DelBello MP, Strakowski SM, Anthenelli RM. The co-occurrence of cigarette smoking and bipolar disorder: phenomenology and treatment considerations. *Bipolar Disord*. 2011;13(5-6):439-453.
- Thomson D, Berk M, Dodd S, et al. Tobacco use in bipolar disorder. *Clin Psychopharmacol Neurosci*. 2015;13(1):1-11.

27. Vermeulen JM, Wootton RE, Treur JL, et al. Smoking and the risk for bipolar disorder: evidence from a bidirectional Mendelian randomisation study. *Br J Psychiatry*. 2021;218(2):88-94.
28. Martínez-Ortega JM, Goldstein BI, Gutiérrez-Rojas L, Sala R, Wang S, Blanco C. Temporal sequencing of nicotine dependence and bipolar disorder in the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). *J Psychiatr Res*. 2013;47(7):858-864.
29. Grosso G, Micek A, Castellano S, Pajak A, Galvano F. Coffee, tea, caffeine and risk of depression: a systematic review and dose-response meta-analysis of observational studies. *Mol Nutr Food Res*. 2016;60(1):223-234.
30. Frigerio S, Strawbridge R, Young AH. The impact of caffeine consumption on clinical symptoms in patients with bipolar disorder: a systematic review. *Bipolar Disord*. 2021; 23(3):241-251.
31. Miettunen J, Haapea M, Björnholm L, et al. Psychiatric research in the northern Finland birth cohort 1986—a systematic review. *Int J Circumpolar Health*. 2019;78(1):1571382.
32. World Health Organization, ed. *The ICD-10 Classification of Mental and Behavioural Disorders: Clinical Descriptions and Diagnostic Guidelines*. 2nd ed. World Health Organization; 2004.
33. World Organization of National Colleges Academies and Academic Associations of General Practitioners/Family Physicians. *ICPC-2: International Classification of Primary Care*. 2nd ed. Oxford University Press; 1998.
34. Batt MM, Duffy KA, Novick AM, Metcalf CA, Epperson CN. Is postpartum depression different from depression occurring outside of the perinatal period? A review of the evidence focus. *Am Psychiatr Publ*. 2020;18(2):106-119.
35. Miettunen J, Murray GK, Jones PB, et al. Longitudinal associations between childhood and adulthood externalizing and internalizing psychopathology and adolescent substance use. *Psychol Med*. 2014;44(8):1727-1738.
36. Achenbach TM, Rescorla LA. *Manual for the ASEBA School-Age Forms & Profiles*. University of Vermont, Research Center for Children, Youth & Families; 2001.
37. Haukoos JS, Newgard CD. Advanced statistics: missing data in clinical research—part 1: an introduction and conceptual framework. *Acad Emerg Med*. 2007;14(7):662-668.
38. Yuan S, Yao H, Larsson SC. Associations of cigarette smoking with psychiatric disorders: evidence from a two-sample Mendelian randomization study. *Sci Rep*. 2020;10(1):13807.
39. Rognli EB, Bramness JG, von Soest T. Smoking in early adulthood is prospectively associated with prescriptions of antipsychotics, mood stabilizers, antidepressants and anxiolytics. *Psychol Med*. 2021;1-10.
40. Smoller JW, Finn CT. Family, twin, and adoption studies of bipolar disorder. *Am J Med Genet C Semin Med Genet*. 2003; 123c(1):48-58.
41. Luger TM, Suls J, Vander Weg MW. How robust is the association between smoking and depression in adults? A meta-analysis using linear mixed-effects models. *Addict Behav*. 2014; 39(10):1418-1429.
42. Ritt-Olson A, Unger J, Valente T, et al. Exploring peers as a mediator of the association between depression and smoking in young adolescents. *Subst Use Misuse*. 2005;40(1):77-98.
43. Brière FN, Rohde P, Seeley JR, Klein D, Lewinsohn PM. Comorbidity between major depression and alcohol use disorder from adolescence to adulthood. *Compr Psychiatry*. 2014; 55(3):526-533.
44. Fergusson DM, Boden JM, Horwood LJ. Tests of causal links between alcohol abuse or dependence and major depression. *Arch Gen Psychiatry*. 2009;66(3):260-266.
45. Mason WA, Kosterman R, Haggerty KP, et al. Dimensions of adolescent alcohol involvement as predictors of young-adult major depression. *J Stud Alcohol Drugs*. 2008;69(2):275-285.
46. Marmorstein NR. Longitudinal associations between depressive symptoms and alcohol problems: the influence of comorbid delinquent behavior. *Addict Behav*. 2010;35(6):564-571.
47. Viner RM, Taylor B. Adult outcomes of binge drinking in adolescence: findings from a UK national birth cohort. *J Epidemiol Community Health*. 2007;61(10):902-907.
48. Lucas M, Mirzaei F, Pan A, et al. Coffee, caffeine, and risk of depression among women. *Arch Intern Med*. 2011;171(17): 1571-1578.
49. Navarro AM, Abasheva D, Martínez-González M, et al. Coffee consumption and the risk of depression in a middle-aged cohort: the SUN project. *Nutrients*. 2018;10(9):1333-1343.
50. Omagari K, Sakaki M, Tsujimoto Y, et al. Coffee consumption is inversely associated with depressive status in Japanese patients with type 2 diabetes. *J Clin Biochem Nutr*. 2014;55(2):135-142.
51. Ruusunen A, Lehto SM, Tolmunen T, Mursu J, Kaplan GA, Voutilainen S. Coffee, tea and caffeine intake and the risk of severe depression in middle-aged Finnish men: the Kuopio Ischaemic Heart Disease Risk Factor Study. *Public Health Nutr*. 2010;13(8):1215-1220.
52. Richards G, Smith A. Caffeine consumption and self-assessed stress, anxiety, and depression in secondary school children. *J Psychopharmacol*. 2015;29(12):1236-1247.
53. Gunja N, Brown JA. Energy drinks: health risks and toxicity. *Med J Aust*. 2012;196(1):46-49.
54. Torvik FA, Ystrom E, Gustavson K, et al. Diagnostic and genetic overlap of three common mental disorders in structured interviews and health registries. *Acta Psychiatr Scand*. 2018;137(1):54-64.
55. Searles JS, Helzer JE, Walter DE. Comparison of drinking patterns measured by daily reports and timeline follow back. *Psychol Addict Behav*. 2000;14(3):277-286.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Bolstad I, Alakokkare A-E, Bramness JG, et al. The relationships between use of alcohol, tobacco and coffee in adolescence and mood disorders in adulthood. *Acta Psychiatr Scand*. 2022;146(6): 594-603. doi:10.1111/acps.13506