Addictive Behaviors Reports 17 (2023) 100488

Contents lists available at ScienceDirect

Addictive Behaviors Reports

journal homepage: www.elsevier.com/locate/abrep

Adverse childhood experiences and their association with substance use disorders in adulthood: A general population study (Young-HUNT)

Rosalie Broekhof[a,b,*], Hans M. Nordahl[b,c], Lars Tanum[d,e], Sara G. Selvik[a,b]

[a] Namsos Hospital, Nord-Trøndelag Hospital Trust, Namsos, Norway
[b] Department of Mental Health, Faculty of Medicine and Health Sciences, NTNU – Norwegian University of Science and Technology, Trondheim, Norway
[c] St. Olavs University Hospital, Østmarka, Trondheim, Norway
[d] Department of Research and Development in Mental Health Service, Akershus University Hospital, Lørenskog, Norway
[e] Faculty for Health Science, Oslo Metropolitan University, Oslo, Norway

ARTICLE INFO

Keywords:
ACE
Childhood maltreatment
Abuse
Neglect
Substance use
Drugs

ABSTRACT

Aim: To investigate the association of adverse childhood experiences (ACEs) and substance use disorders (alcohol and illicit drug use disorders), specifically by gender, in a large longitudinal non-clinical population study.
Methods: Data from 8199 adolescents, first assessed for ACE (2006–2008), were linked with subsequent data from the Norwegian Patient Register to obtain diagnoses of a substance use disorder in adulthood (after 12–14 years' follow-up in March 2020). This study used logistic regression analysis to assess the associations between ACEs and substance use disorders with respect to gender.
Results: Adults with any history of ACEs have a 4.3-fold higher likelihood of developing a substance use disorder. Female adults had a 5.9-fold higher likelihood of developing an alcohol use disorder. Emotional neglect, sexual abuse and physical abuse were the strongest individual ACE predictors for this association. Male adults had a 5.0-fold higher likelihood of developing an illicit drug use disorder (for example stimulants such as cocaine, inhibiter such as opioids, cannabinoids and multiple drugs). Physical abuse, parental divorce and witnessed violence were the strongest individual ACE predictors for this association.
Conclusions: This study reinforces the association between ACEs and substance use disorders and exposes a gender-specific pattern. Increased attention should be paid to the meaning of individual ACEs as well as to the accumulation of ACEs in the development of a substance use disorder.

1. Introduction

The prevalence of substance use disorders in the general population is currently estimated at 8–10% (Brady, 2019) and is expected to grow in the future (Whiteford et al., 2013; Vos et al., 2017). The prevalence of substance use disorders in Norway is estimated at 6–9% for alcohol and other drugs (Kringlen et al., 2006). The World Health Organization (WHO) states "alcohol is the leading risk factor for premature mortality and disability among those aged 15 to 49 years. Harmful use of alcohol is responsible for 5.1% of the global burden of disease" (WHO, global status report on alcohol and health 2018, page XV). In relation to other substance use disorders, the WHO states that "about 5.5% of the global population aged 15–64 had used psychoactive drugs in the previous year". Death attributable to drug use is about 1.3% of the global burden of disease (WHO, world drug report 2019 page 7 and page 19). Men are more inclined to use illicit drugs than women, although the risk of their developing a substance use disorder is the same (Rockville, 2017). In general, men also have higher rates of alcohol use, but young female adults aged 12 to 20 years have slightly higher rates of alcohol misuse and binge drinking than men of the same age (Rockville, 2017).

Research on the etiology of substance use disorder has exposed the role of adverse childhood experiences (ACEs) (Afifi et al., 2020; Dube et al., 2003; Dube et al., 2006; Leza et al., 2021). ACEs are potentially traumatic events occurring in the first eighteen years of life, such as maltreatment (e.g., harsh discipline techniques, abuse, neglect), the lack of constructive adult nurturance (affection, attention, safety, or education), and household dysfunction, such as domestic violence, and parental substance abuse; causing the child to feel unsafe, unloved, rejected, and not able to develop adequately. ACEs have been associated with several mental health issues such as depression, anxiety and post-

* Corresponding author at: Department of Psychiatry, Namsos Hospital, Nord-Trøndelag Hospital Trust, 7800 Namsos, Norway.
E-mail address: Rosalie.Broekhof@hnt.no (R. Broekhof).

https://doi.org/10.1016/j.abrep.2023.100488
Received 15 September 2022; Received in revised form 15 March 2023; Accepted 25 March 2023
Available online 30 March 2023

traumatic stress disorder (Kessler et al., 2010; McLaughlin et al., 2012). The ACE study by Felitti et al., conducted from 1995 to 1997 in South California (USA), was the first to study ACEs in more detail (Felitti et al., 1998). Three types of ACE were defined: abuse, neglect and household dysfunction. Abuse included individual ACE types emotional, sexual or physical abuse. Neglect included individual ACE types physical or emotional neglect. Household dysfunction was defined as the presence of life stressors such as parental substance abuse, parental mental problems, parental divorce, economic difficulties, or witnessed violence. In the ACE study, more than 17,000 white middle class adult Americans with health insurance were retrospectively asked about abuse, neglect and household dysfunction. The researchers found that more than half of the participants had experienced more than one ACE and a quarter reported more than two individual ACEs (Felitti et al., 1998). Importantly, the ACE study also found an association between ACEs and physical and mental health problems (Felitti et al., 1998). In addition, the ACE study found that adolescents who had experienced four or more ACEs had a 4- to 12-fold increased risk of developing alcohol or drug abuse problems (Felitti et al., 1998). They also found a 2- to 4-fold higher likelihood that an individual would initiate use of illicit drugs for each experienced ACE (Dube et al., 2003).

Twelve retrospective studies conducted between 2016 and 2020 assessing the association between ACEs and substance use disorders were recently reviewed by Leza et al.(Leza et al., 2021). They found a higher prevalence of ACEs in subjects with a substance use disorder than in the general population (Leza et al., 2021). A different approach was used by Hughes et al. to assess the association between ACEs and substance use disorders (Hughes et al., 2019). They combined data from more than 14,000 young adults (aged 18 to 25 years, in educational institutions) from 10 European studies to examine the association between the sum of up to nine individual ACEs and six health outcomes, including problematic alcohol use and drug use. Compared to those with no ACEs, individuals with **at least four** ACEs were four times more likely to have problems with alcohol or drug use (Hughes et al., 2019).

As shown, several studies have affirmed an association between substance use disorder and ACEs (Afifi et al., 2012; Bryant et al., 2020; Choi et al., 2017; Dube et al., 2003; Fuller-Thomson et al., 2016; Hughes et al., 2019; LeTendre & Reed, 2017; Leza et al., 2021), but they have shown considerable heterogeneity in design. Most studies were retrospective or used fixed cohorts, ranging from a cohort using a specific substance to cohorts connected with a specific area with different levels of access to drugs (Bryant et al., 2020; Chandler et al., 2018; Forster et al., 2018; Fuller-Thomson et al., 2016; Kiburi et al., 2018; LeTendre & Reed, 2017; Mersky et al., 2013). It is also worth mentioning that the studies had different sample sizes and were conducted in countries with different cultural attitudes to drugs (Chandler et al., 2018; Fuller-Thomson et al., 2016; Kiburi et al., 2018; LeTendre & Reed, 2017). The population studies used different concepts of ACE, such as using accumulation scores for ACEs, or assessing only a limited number of individual ACEs, to investigate the relationship with substance use disorders (Dube et al., 2003; Fuller-Thomson et al., 2016; Hughes et al., 2019; LeTendre & Reed, 2017). This creates difficulties in generalizing the results to reach conclusions relevant to the individual types (abuse, neglect or household dysfunction) or combinations of ACEs. In addition, research taking gender differences into account in association with the link between ACEs and substance use disorders is scarce. Earlier retrospective population studies have shown diffuse results (Choi et al., 2017; Fuller-Thomson et al., 2016). Some found no gender interaction (Choi et al., 2017; Fuller-Thomson et al., 2016); others found an association between sexual abuse and alcohol in women (Fuller-Thomson et al., 2016; Widom et al., 2007) and between physical abuse and alcohol in men (Choi et al., 2017).

The main aim of our study was to explore more closely the association between ACEs and substance use disorders with respect to gender, in a large sample using a prospective study design, in order to provide clinicians with a more detailed ACE profile for those at risk of developing a substance use disorder. We followed adolescents aged 13 to 19 years from the large nonclinical Young-HUNT population study, over 12–14 years, into their adulthood to assess the occurrence of different substance use disorders. This is a novel prospective population study and contrary earlier retrospective research.

We expected to find an association between specific types of ACE (abuse, neglect and household dysfunction) and substance use disorders. Secondly, we hypothesized that ACEs (such as emotional neglect, sexual abuse or parental divorce) would have a gender-specific association with substance use disorders, particularly when the substance use disorders were split into alcohol use disorder or illicit drug use disorder. Thirdly, we hypothesized that higher accumulations of individual ACE types would result in stronger associations with substance use disorders.

2. Methods

2.1. Study population

The county of Nord Trøndelag in Norway has 135 000 inhabitants. All the inhabitants were invited to join a large population study: the HUNT study.

The Young-HUNT study is the adolescent part of this epidemiological study. The third wave of this study (the Young-HUNT 3 study) was conducted between 2006 and 2008; 10,464 adolescents were invited to participate (Holmen et al., 2014). The purpose of the Young HUNT study was to gather information on a wide variety of conditions and lifestyle factors. In the Young-HUNT 3 study, during one school hour, the students completed a self-administered questionnaire that contained over 100 health- and lifestyle-related questions, including items on exposure to traumatic events, loneliness, psychological distress, and family cohesion. In total, 8199 adolescents (78%) filled in the questionnaires: 4129 girls (50.4%) and 4070 (49.6%) boys. The mean age was 15.91 (SD = 0.03) years for the girls and 15.85 (SD = 0.03) years for the boys.

The study was approved by the Norwegian Research Committee for Medical and Health Research Ethics. Inclusion was based on written consent from participants aged 16 years and older and from parents for those under 16 years, in accordance with Norwegian law.

2.2. Norwegian Patient Register

In Norway, primary care and specialized care are provided by tax-based public services. Every Norwegian citizen has a personal identification number. Through this number, information from all public specialist health-care services in Norway is routinely reported to national patient registries. The Norwegian Patient Register (NPR) is one of those registries. The NPR gives information on diagnoses and surgical procedures, dates of admission and discharge, and dates of procedures. For each hospitalization or outpatient visit, reporting of data to the NPR is mandatory and linked to the reimbursement system. Information on substance use disorders for our study was obtained from the NPR. Diagnoses are reported as International Classification of Disease, version 10 (ICD-10) codes (World Health Organization, 1993).

2.3. Linking the Young-HUNT 3 register and the Norwegian Patient Register

Information from the NPR was linked to the Young-HUNT 3 adolescents through their personal identification numbers, in a cooperative procedure between the HUNT research department and the NPR. The diagnoses are for the period in which the Young-HUNT 3 adolescents reached adulthood (from 2012 to March 2020), 12–14 years after the adolescent data were obtained. The Norwegian Research Committee for Medical and Health Research Ethics approved this linkage. The key to the linkage of the project-specific IDs with the Norwegian personal numbers is in the hands of the HUNT Research Centre.

2.4. Measures

2.4.1. Adverse childhood experiences

The self-administered questionnaire from the Young HUNT 3 study allowed us to operationalize ACEs following the outlines given in the ACE study by Felitti et al. (Felitti et al., 1998). See Table 1 for an overview of these ACE definitions. For a full overview see Broekhof et al. (Broekhof et al., 2022). Three subtypes of ACE were recognised: abuse, neglect and household dysfunction. Abuse was further categorised as the individual ACE types emotional, sexual or physical abuse, and neglect was further categorised as the individual ACE types physical or emotional neglect. Household dysfunction was further categorised as individual ACE types parental substance abuse, parental mental problems, parental divorce, economic difficulties, or witnessed violence. The "accumulation of ACE" was the sum of these ten individual ACE types experienced.

2.4.2. Substance use disorders

Diagnoses were derived via linkage to the NPR and were based on ICD 10 diagnostic criteria (World Health Organization, 1993). The ICD 10 codes for substance use disorders in Helse-Nord Trøndelag were assigned in a multidisciplinary meeting after reviewing the necessary diagnostic instruments and patient observations. Eight substances were included in the assessment of substance use disorders: Stimulants (cocaine, stimulants and cannabinoids), inhibitors (alcohol, opioids, sedative hypnotics and cannabinoids), hallucinogens (hallucinogens and cannabinoids) and multiple drugs. Because of some missing data, tobacco was excluded. The diagnosis of a substance use disorder (one of the eight substances) was categorized in present/not present. Substance use disorders were further classified as an alcohol use disorder (present/not present) or an illicit drug use disorder (opioids, cannabinoids, sedative hypnotics, cocaine, stimulants, hallucinogens, or multiple drugs use disorder (present/not present)). The numbers for the individual illicit drugs were too small to differentiate further. The illicit drug group consisted of 86 adults, including 30 with a cannabinoid use disorder and 44 with a polysubstance use disorder. The alcohol group consisted of 50 adults.

Table 1
Overview of the ACE definitions operationalized from the Young HUNT 3 study.

Type of ACE	ACE definitions from the Young HUNT 3 study
Abuse	
Sexual Abuse	An adult or someone about their age had put the adolescent in sexually uncomfortable/abusive situations.
Physical Abuse	The adolescent was violently hurt, threatened or physically harassed.
Emotional Abuse	The adolescent felt useless at times, was uncomfortable in their own family and experienced much arguing in their family.
Neglect	
Emotional Neglect	The adolescents felt no support in their family, felt often lonely and described their relationship with immediate family as bad.
Physical Neglect	The adolescents had almost no outside school activities, ate only 1 meal or less a day and had been drinking alcohol/been intoxicated.
Household dysfunction	
Parental substance abuse	At least one of the parents of the adolescent had an alcohol problem.
Parental mental illness	At least one of the parents of the adolescent had mental health problems.
Divorced parents	The parents of the adolescent were separated, divorced, or lived separately for more than one year.
Economic difficulties	The adolescent experienced the financial situation of their family, as worse compared to most others.
Witnessed violence	The adolescent had seen others being violently hurt.

2.4.3. Statistics

Descriptive analysis was used for Table 1. Logistic regression analysis was used to assess the associations between subtypes of ACE, individual ACE types and accumulated ACE scores and a substance use disorder. The ACE with the lowest −2 log likelihood ratio and significance was considered the strongest association for the development of a substance use disorder. Analyses were also conducted with respect to gender. An odds ratio higher than 1 was considered as a risk for developing a substance use disorder. SPSS version 28.0 was used for the analyses.

3. Results

The Young-HUNT 3 population included 4070 boys (mean age 15.85 years; standard deviation 0.03 years) and 4129 girls (mean age 15.91 years; standard deviation 0.03 years). Of the total 8199 adolescents, 65.8% (N = 5398) had experienced at least one ACE subtype, and 28% (1514) of those had experienced more than one. Household dysfunction was the most prevalent subtype of ACE. Of all the Young-HUNT 3 participants (8199), 'only' 136 (1.7%) developed a substance use disorder. However, of those 136 adults with a substance use disorder, 121 (89%) had experienced ACEs. Thus, an adult with a history of ACE has a 4.3-fold higher risk of developing a substance use disorder than an adult without a history of ACE.

Emotional neglect was most often associated with substance use disorders; 5% of all participants who had experienced emotional neglect subsequently developed a substance use disorder. Physical abuse and witnessed violence were associated most often with the development of illicit drug use disorder (Table 2).

Overall, all three subtypes of ACE were associated with significantly increased risks of developing a substance use disorder (Table 3). Those who had experienced household dysfunction had a 3.3-fold higher risk of developing a substance use disorder. When investigated with respect to gender, the odds of developing a substance use disorder were significant for female adults who had experienced a subtype of ACE. The odds ratios showed that neglect was not significantly associated with a substance use disorder for males but was highly significantly associated for females. Participants who had experienced any of the individual ACE types except for two (parental substance use and parental mental problems) showed significantly increased risks of developing a substance use disorder.

The experience of any ACE by females gave a 5.9-fold higher risk of developing an alcohol use disorder (Table 4). The strongest predictors for female adults were household dysfunction and neglect, with significant odds ratios of 4.6 and 4.5. Emotional neglect, physical and sexual abuse were the strongest individual ACE predictors, with significant odds ratios of 15.6, 4.7 and 5.2, respectively. For male adults, the accumulation of individual ACE subtypes and parental divorce were the best predictors for developing an alcohol use disorder.

For illicit drug use disorder, the association with ACE subtypes showed the opposite trend. For females, there were no significant associations between subtypes of ACE and developing an illicit drug use disorder (Table 5). The best predictor was an accumulation of individual ACE types, where the risk of developing an illicit drug use disorder increased 1.4-fold for every individual ACE type experienced. For men, experiencing any type of ACE gave a 5-fold higher risk of developing an illicit drug use disorder. The strongest predictors for male adults were abuse and household dysfunction, with significant odds ratios of 3.8 and

Table 2
Descriptive overview of the number (percentage) of Young-HUNT 3 study participants exposed to ACE who developed substance use disorders in general, and alcohol use disorder or illicit drug use disorder specifically.

Subtype ACE	Individual ACE type	Participants with ACE	Participants developing substance use disorder*	Participants developing alcohol use disorder	Participants developing illicit drug use disorder
Abuse	Emotional abuse	230	10 (4%)	7	3
	F	173	5	5	0
	M	57	5	2	3
	Physical abuse	1177	46 (4%)	14	32
	F	502	13	9	4
	M	675	33	5	28
	Sexual abuse	430	14 (3%)	8	6
	F	324	9	7	2
	M	106	5	1	4
Neglect	Emotional neglect	126	6 (5%)	6	0
	F	97	6	6	0
	M	29	0	0	0
	Physical neglect	471	13 (3%)	4	9
	F	222	4	1	3
	M	249	9	3	6
Household dysfunction	Parental substance	618	14 (2%)	5	9
	abuse	346	5	2	3
	F	272	9	3	6
	M				
	Parental mental	1299	19 (1.5%)	7	12
	health	665	8	4	4
	F	634	11	3	8
	M				
	Parental divorce	2421	66 (3%)	27	39
	F	1292	20	11	9
	M	1129	46	16	30
	Economic	1271	37 (3%)	13	24
	difficulties	615	13	7	6
	F	656	24	6	18
	M				
	Witnessed violence	1810	48 (3%)	14	34
	F	722	10	6	4
	M	1088	38	8	30

* Percentages were calculated from the total number of participants who had experienced that ACE type.
F = female, M = male.

4.3. Physical abuse, witnessed violence and parental divorce were the strongest individual ACE predictors, with odds ratios of 3.7, 2.3 and 2.1, respectively.

4. Discussion

The results of our study have confirmed the association between ACEs and substance use disorders. The results showed a 4.3-fold higher likelihood for an adult with a history of ACE to develop a substance use disorder than an adult with no history of ACE. When restricted to gender or type of substance use disorder, these likelihoods are even higher.

Adult females with a history of ACE had a 5.9-fold higher likelihood of developing an alcohol use disorder. The strongest individual predictors for this association were emotional neglect, sexual abuse and physical abuse. Adult males with a history of ACE had a 5.0-fold higher likelihood of developing an illicit drug use disorder. Physical abuse, parental divorce and witnessed violence were the strongest individual predictors for this association. The accumulation of individual ACE types is not necessarily the best predictor of the development of a specific substance use disorder.

These odds ratios follow the same trends seen in earlier retrospective research (Afifi et al., 2020; Felitti et al., 1998; Hughes et al., 2017; Hughes et al., 2019). Some studies presented the odds of an association between more than four individual ACE types in any one individual and a substance use disorder (Felitti et al., 1998; Hughes et al., 2019) and these odds were, as expected, higher. In other studies, ACEs were assessed individually but were associated with self-reported alcohol or drug use, not with clinical diagnoses of a substance use disorder (Afifi et al., 2020; Fuller-Thomson et al., 2016).

This study adds new information on the association of ACEs with substance use disorders, including odds ratios restricted according to gender and type of substance use disorder, with the added advantage of a prospective population study design. An explanation for the associations seen in our study could lie in the effects of ACEs on neuropsychological development. ACEs are not only severe and potentially traumatic events; they can disrupt a child's development (Cook et al., 2005). ACEs can lead to insecure attachments in children (Cook et al., 2005), and interfere with the neurobiological development of the brain. The review of Teicher et al. found consistent evidence for the potential harmful effects of childhood maltreatment (abuse and neglect) on the brain's development (Teicher et al., 2016) and how maltreatment most likely affects trajectories of brain development that are involved in threat detection, emotional regulation, and reward anticipation (Teicher et al., 2016). Substance use can have a role in emotional regulation. Earlier research addresses differences in coping with the same ACEs across gender (Slopen et al., 2016) and general differences in coping between men and women (Leban & Gibson, 2020). For example, in this study, physical abuse was a strong predictor for female adults for developing an alcohol use disorder and for men for developing an illicit drug use disorder. Leban et al. assessed ACEs in association with delinquency and substance use and found that men are more likely to adopt maladaptive coping, while women were more likely to internalize (Leban & Gibson, 2020).

Earlier research has also shown that more men than women use illicit drugs and that the prevalence of alcohol abuse is the same for both genders (Nolen-Hoeksema & Hilt, 2006; Rockville, 2017; Sutherland & Willner, 1998; Vasilenko et al., 2017), as indicated in our study. Females tend to wait longer to seek professional help for their alcohol problems

Table 3
Association of exposure to subtypes of ACE, individual types of ACE and accumulated ACE scores with the development of a substance use disorder. The group who developed a substance use disorder comprised 42 females and 94 males.

	−2 log likelihood	Odds ratio (95% CI)	β	p
Any ACE				
Any ACE	1345	**4.3 (2.5 – 7.3)**	**1.5**	**<0.001**
F	456	**4.2 (1.6 – 10.7)**	**1.4**	**0.003**
M	869	**4.2 (2.1 – 8.0)**	**1.4**	**<0.001**
Subtype of ACE				
Any type of abuse	1352	**2.9 (2.1 – 4.2)**	**1.1**	**<0.001**
F	460	**2.7 (1.4 – 5.1)**	**1.0**	**0.002**
M	870	**3.1 (2.0 – 4.7)**	**1.1**	**<0.001**
Any type of neglect	1378	**2.0 (1.2 – 3.4)**	**0.7**	**0.006**
F	461	**3.5 (1.6 – 7.3)**	**1.2**	**0.001**
M	893	1.5 (0.7 – 3.0)	0.4	0.3
Any type of household dysfunction	1352	**3.3 (2.1 – 5.2)**	**1.1**	**<0.001**
F	462	**2.5 (1.2 – 5.3)**	**0.9**	**0.014**
M	870	**3.6 (2.0 – 6.6)**	**1.3**	**<0.001**
Individual ACE type				
Emotional abuse	1377	**2.8 (1.5 – 5.5)**	**1.0**	**0.002**
F	465	3.1 (1.2 – 8.1)	1.1	0.2
M	888	**4.2 (1.6 – 10.9)**	**1.4**	**0.003**
Physical abuse	1352	**3.1 (2.2 – 4.5)**	**1.1**	**<0.001**
F	459	**3.3 (1.7 – 6.4)**	**1.2**	**<0.001**
M	875	**2.8 (1.8 – 4.3)**	**1.0**	**<0.001**
Sexual abuse	1379	**2.1 (1.2 – 3.7)**	**0.8**	**0.009**
F	461	**3.3 (1.5 – 6.9)**	**1.2**	**0.002**
M	892	2.2 (0.9 – 5.4)	0.8	0.1
Emotional neglect	1380	**3.1 (1.3 – 7.1)**	**1.1**	**0.009**
F	456	**7.3 (3.0 – 17.8)**	**2.0**	**>0.001**
M	893	0	−17.5	0
Physical neglect	1348	**3.2 (2.0 – 5.0)**	**1.2**	**<0.001**
F	467	1.8 (0.7 – 5.3)	0.6	0.2
M	892	1.6 (0.8 – 3.3)	0.5	0.2
Parental substance abuse	1383	1.4 (0.8 – 2.5)	0.4	0.2
F	468	1.5 (0.6 – 3.8)	0.4	0.4
M	893	1.5 (0.7 – 3.0)	0.4	0.3
Parental mental problems	1384	0.9 (0.5 – 1.4)	−0.2	0.6
F	469	1.2 (0.6 – 2.7)	0.2	0.6
M	893	0.7 (0.4 – 1.3)	−0.3	0.3
Parental divorce	1363	**2.3 (1.6 – 3.2)**	**0.8**	**<0.001**
F	464	**2.0 (1.1 – 3.7)**	**0.7**	**0.03**
M	875	**2.0 (1.7 – 3.9)**	**0.9**	**>0.001**
Economic difficulties	1372	**2.1 (1.4 – 3.0)**	**0.7**	**<0.001**
F	461	**2.6 (1.3 – 5.0)**	**1.0**	**0.005**
M	887	**1.8 (1.1 – 2.9)**	**0.6**	**0.01**
Witnessed violence	1372	**2.0 (1.4 – 2.8)**	**0.7**	**<0.001**
F	468	1.5 (0.7 – 3.0)	0.4	0.3
M	886	**1.9 (1.2 – 2.9)**	**0.6**	**0.003**
Accumulated ACE score				
Accumulation of individual ACEs	1336	**1.5 (1.4 – 1.7)**	**0.4**	**<0.001**
F	448	**1.6 (1.3 – 1.9)**	**0.4**	**<0.001**
M	864	**1.5 (1.3 – 1.7)**	**0.4**	**<0.001**

CI = confidence interval, F = female, M = male.
ACE subtype abuse includes emotional, sexual and physical abuse; ACE subtype neglect includes physical and emotional neglect. ACE subtype household dysfunction includes parental substance abuse, parental mental problems, parental divorce, economic difficulties and witnessed violence.

(Rockville, 2017); earlier research has mentioned fear of social sanctions associated with drinking (Nolen-Hoeksema & Hilt, 2006).

As a result of the respected ACE study (Felitti et al., 1998), the accumulation of ACEs has been emphasized as an important tool for exploring associations. More recently, the accumulation of ACEs has been discussed with respect to its over-simplification and lack of information on which ACEs are involved (Lacey & Minnis, 2020). This study confirms the importance of knowing which individual ACE types are involved and their patterns in the association with (specific) substance use disorders. That said, the accumulation of individual ACE types could be helpful in relation to substance use disorders where there is not such a clear pattern.

Earlier research has suggested that abuse, especially sexual or physical abuse, and witnessed violence are predictors of alcohol and drug use disorders (Bryant et al., 2020; Fuller-Thomson et al., 2016; Kiburi et al., 2018; LeTendre & Reed, 2017). Our study shows that all but two of the individual ACE types, parental substance use and parental mental health, are related to substance use disorders in general. This is in contrast to the findings of earlier studies (Bryant et al., 2020; Choi et al., 2017; Rhee et al., 2019). Choi et al. found, in a large cohort of 50 + adults, that parental substance use or mental illness together with physical or sexual abuse were the strongest predictors of the development of any substance use disorder (in both women and men) (Choi et al., 2017). This was affirmed in a younger population study (Afifi et al., 2020) that assessed self-reported alcohol and cannabis use rather than clinical diagnoses of substance use disorders. Our results differ from those of the earlier studies, possibly because of their retrospective assessment of ACE and the timing of data gathering in adulthood. Our data were gathered at the time of young adulthood. The associations with parental substance use and parental mental health may well

Table 4
Association of exposure to subtypes of ACE, individual types of ACE and the accumulated ACE scores with the development of an alcohol use disorder. The group who developed alcohol use disorder comprised 23 female and 27 male adults.

	−2 log likelihood	Odds ratio (95% CI)	β	p
Any ACE				
Any ACE	597	**3.8 (1.6–9.0)**	**1.3**	**0.002**
F	275	**5.9 (1.4 – 25.2)**	**1.8**	**0.02**
M	320	2.8 (0.9 – 8.0)	1.0	0.06
Subtype of ACE				
Any type of abuse	601	**2.5 (1.4 – 4.5)**	**0.9**	**0.002**
F	274	**4.0 (1.8 – 9.2)**	**1.4**	**<0.001**
M	324	1.6 (0.7 – 3.8)	0.5	0.3
Any type of neglect	603	**2.9 (1.4 – 6.0)**	**1.1**	**0.004**
F	277	**4.5 (1.7 – 11.4)**	**1.5**	**0.002**
M	324	1.7 (0.5 – 5.8)	**0.6**	0.4
Any type of household dysfunction	598	**3.3 (1.5–7.0)**	**1.2**	**0.002**
F	276	**4.6 (1.4 – 15.4)**	**1.5**	**0.01**
M	321	2.5 (1.0 – 6.7)	0.9	0.06
Individual ACE type				
Emotional abuse	598	**5.8 (2.7 – 13.0)**	**1.8**	**<0.001**
F	275	**6.5 (2.4 – 17.7)**	**1.9**	**<0.001**
M	321	**5.8 (1.3 – 25.1)**	**1.8**	**0.02**
Physical abuse	603	**2.3** (1.3 – 4.3)	**0.8**	**0.007**
F	274	**4.7 (2.0 – 11.0)**	**1.6**	**<0.001**
M	325	1.1 (0.4 – 3.0)	0.1	0.8
Sexual abuse	602	**3.5 (1.6 – 7.5)**	**1.2**	**0.001**
F	275	**5.2 (2.1 – 12.8)**	**1.7**	**<0.001**
M	325	1.4 (0.2 – 10.7)	0.4	0.7
Emotional neglect	595	**9.1 (3.8 – 21.8)**	**2.2**	**<0.001**
F	265	**15.6 (6.0 – 40.4)**	**2.7**	**<0.001**
M	324	0	−16	
Physical neglect	609	1.4 (0.5 – 4.0)	0.4	0.5
F	285	0.8 (0.1 – 6.0)	−0,2	0.8
M	324	1.9 (0.6 – 6.5)	0.7	0.3
Parental substance abuse	609	1.4 (0.5 – 3.5)	0.3	0.5
F	285	1.0 (0.2 – 4.5)	0.04	1.0
M	324	1.8 (0.5 – 5.9)	0.6	0.4
Parental mental problems	610	0.9 (0.4 – 1.9)	0.3	0.7
F	285	1.1 (0.4 – 3.2)	0.04	0.9
M	324	0.7 (0.2 – 2.3)	0.6	0.5
Parental divorce	597	**2.8 (1.6 – 4.9)**	**1.0**	**<0.001**
F	282	2.0 (0.9 – 4.6)	0.7	0.09
M	313	**3.8 (1.8 – 8.3)**	**1.3**	**<0.001**
Economic difficulties	606	**1.9 (1.0 – 3.6)**	**0.7**	**0.04**
F	281	**2.5 (1.0 – 6.1)**	**0.9**	**0.04**
M	324	1.5 (0.6 – 3.7)	0.4	0.4
Witnessed violence	609	1.4 (0.7 – 2.6)	0.3	0.3
F	284	1.7 (0.7 – 4.3)	0.5	0.3
M	325	1.2 (0.5 – 2.6)	0.1	0.7
Accumulated ACE score				
Accumulation of individual ACEs	588	**1.5 (1.3 – 1.8)**	**0.4**	**<0.001**
F	266	**1.7 (1.3 – 2.1)**	**0.5**	**<0.001**
M	320	**1.4 (1.0 – 1.8)**	**0.3**	**0.02**

CI = confidence interval, F = female, M = male.
ACE subtype abuse includes emotional, sexual and physical abuse; ACE subtype neglect includes physical and emotional neglect. ACE subtype household dysfunction includes parental substance abuse, parental mental problems, parental divorce, economic difficulties and witnessed violence.

develop over time.

4.1. Strengths and limitations

An important strength of this study is the prospective design. ACEs were carefully operationalized in the Young-HUNT 3 study from 2006 to 2008 (Broekhof et al., 2022). The Young-HUNT 3 participants were linked to the national patient registry to obtain substance use diagnoses at the time of adulthood, 12–14 years later. Earlier research was retrospective in design and carried out in a general or clinical population. We assessed the whole population and also assessed females and males separately. This exposed different patterns of ACEs for predicting alcohol use disorder and illicit drug use disorder. This study did not take into account other factors that could influence this association. The increased risk of developing a substance use disorder with a history of ACE is an important marker, but not a causal relationship. Also, no assumptions can be made on the associations of ACE and the characteristics of the illicit drugs in our study. Numbers were too small to differentiate between hallucinogens, stimulants, and inhibitors. This means that the participants with an illicit drug use disorder use drugs with different effects on the central nervous system.

Our study population consisted of relatively young adults in a rural population in Nord Trøndelag (Norway). Earlier research that focused on rural and urban differences in drug use has stressed access to the drugs as an important factor (Warren et al., 2015, 2017). Access to drugs is a prerequisite for developing a substance use disorder. In a study of 513,909 college students in the USA, rural and urban differences in alcohol and illicit drug use were directly related to the perceived ease of access (Warren et al., 2015). Access to alcohol was perceived to be significantly easier for rural students than for urban students. However, urban students were perceived to have easier access to illicit substances (Warren et al., 2015, 2017). That ‘only’ 136 of 8199 adults developed a

Table 5
Association of exposure to subtypes of ACE, individual types of ACE and accumulated ACE scores with the development of an illicit drug use disorder. The group who developed illicit drug use disorder comprised 19 female and 67 male adults.

	−2 log likelihood	Odds ratio (95% CI)	β	p
Any ACE				
Any ACE	929	**4.5 (2.2 – 9.0)**	**1.5**	**<0.001**
F	239	3.0 (0.9 – 10.3)	1.1	0.08
M	662	**5.0 (2.1 – 11.6)**	**1.6**	**<0.001**
Subtype of ACE				
Any type of abuse	931	**3.1 (2.0 – 4.8)**	**1.1**	**<0.001**
F	242	1.6 (0.6 – 4.4)	**0.4**	0.4
M	657	**3.8 (2.4 – 6.3)**	**1.3**	**<0.001**
Any type of neglect	954	1.5 (0.8 – 3.1)	0.4	0.2
F	241	2.3 (0.7 – 8.1)	0.9	0.2
M	683	1.4 (0.6 – 3.2)	0.3	0.5
Any type of household dysfunction	935	**3.2 (1.8 – 5.8)**	**1.2**	**<0.001**
F	242	1.5 (0.6 – 3.9)	**0.4**	0.4
M	662	**4.3 (2.0 – 9.0)**	**1.5**	**<0.001**
Individual ACE type				
Emotional abuse	955	1.3 (0.4 – 40)	0.2	0.7
F	241		−16	
M	680	**3.4 (1.0 – 11.3)**	**1.2**	**0.04**
Physical abuse	927	3.6 (2.3 – 5.6)	**1.3**	**<0.001**
F	241	1.9 (1.6 – 5.8)	0.7	**0.2**
M	659	**3.7 (2.3 – 6.1)**	**1.3**	**<0.001**
Sexual abuse	954	1.4 (0.6 – 3.1)	0.3	0.5
F	242	1.4 (0.3 – 6.0)	0.3	0.7
M	681	2.4 (0.9 – 6.8)	0.9	0.09
Emotional neglect	952	0	−17	
F	242	0	−16	
M	682	0	−17	
Physical neglect	952	1.9 (1.0 – 3.9)	0.7	0.06
F	240	3.3 (1.0 – 11.5)	1.2	0.06
M	682	1.5 (0.7 – 3.6)	0.4	0.3
Parental substance abuse	954	1.4 (0.7 – 2.9)	0.4	0.3
F	241	2.1 (0.6 – 7.1)	0.7	0.3
M	683	1.4 (0.6 – 3.2)	0.3	0.5
Parental mental problems	955	0.9 (0.5 – 1.6)	−0.2	0.6
F	242	1.4 (0.5 – 4.2)	0.3	0.6
M	682	0.7 (0.3 – 1.5)	−0.3	0.4
Parental divorce	945	**2.0 (1.3 – 3.1)**	**0.7**	**0.002**
F	240	2.0 (0.8 – 4.9)	0.7	0.1
M	674	**2.1 (1.3 – 3.5)**	**0.8**	**0.002**
Economic difficulties	946	**2.1 (1.3 – 3.4)**	**0.8**	**0.002**
F	239	**2.7 (1.0 – 7.0)**	**1.0**	**0.05**
M	678	**1.9 (1.1 – 3.3)**	**0.7**	**0.02**
Witnessed violence	942	**2.3 (1.5 – 3.6)**	**0.8**	**<0.001**
F	242	1.3 (0.4 – 3.8)	0.2	0.7
M	673	**2.3 (1.4 – 3.7)**	**0.8**	**0.001**
Accumulated ACE score				
Accumulation of individual ACE	928	**1.5 (1.3 – 1.7)**	**0.4**	**<0.001**
F	238	**1.4 (1.0 – 1.8)**	**0.3**	**0.03**
M	658	**1.6 (1.3 – 1.8)**	**0.4**	**<0.001**

CI = confidence interval, F = female, M = male.
ACE subtype abuse includes emotional, sexual and physical abuse; ACE subtype neglect includes physical and emotional neglect. ACE subtype household dysfunction includes parental substance abuse, parental mental problems, parental divorce, economic difficulties and witnessed violence.

substance use disorder in our study is probably because of the population being rural. On the other hand, that 121 of those 136 adults had experienced an ACE is of great concern; this prevalence is very close to other studies (Afifi et al., 2020; Felitti et al., 1998; Hughes et al., 2019). The odds ratios and distribution of substance use disorders in our study are in line with earlier research on various other study populations (Nolen-Hoeksema & Hilt, 2006; Rockville, 2017; Sutherland & Willner, 1998; Vasilenko et al., 2017). The prevalence of ACEs in our study population did not differ much from that in the original ACE study (Broekhof et al., 2022).

5. Conclusions

Our study found a 4.3-fold higher likelihood that young adults with a history of ACE would develop a substance use disorder. This is a substantial increase with respect to the estimated prevalence of 8–10% for substance use disorders in the general population. The recognition of ACEs as a risk factor for developing a substance use disorders later in life is not embedded in daily practice. Clinicians would be advised to at least give as much attention to the individual ACE types as to the accumulation of ACEs when investigating the association between ACEs and substance use disorders. Higher screening rates were seen under clinicians with knowledge on ACEs (Tink et al., 2017). Early identification of ACEs can contribute to minimize (the effects of) substance use disorders later in life. Also, targeted prevention and early intervention could have significant impact for those identified with specific ACEs and having a higher risk for specific substance use disorders. Emotional neglect, sexual abuse and physical abuse are strong individual predictors for female adults developing an alcohol use disorder. For male adults, physical abuse, parental divorce and economic problems are strong individual predictors for developing an illicit drug use disorder.

CRediT authorship contribution statement

Rosalie Broekhof: Conceptualization, Methodology, Formal analysis, Validation, Writing – original draft, Visualization. **Hans M. Nordahl:** Conceptualization, Supervision, Validation. **Lars Tanum:** Supervision, Validation. **Sara G. Selvik:** Conceptualization, Validation, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

References

Afifi, T. O., Henriksen, C. A., Asmundson, G. J. G., & Sareen, J. (2012). Childhood maltreatment and substance use disorders among men and women in a nationally representative sample. *Canadian Journal of Psychiatry. Revue canadienne de psychiatrie, 57*(11), 677–686. https://doi.org/10.1177/070674371205701105

Afifi, T. O., Taillieu, T., Salmon, S., Davila, I. G., Stewart-Tufescu, A., Fortier, J., … MacMillan, H. L. (2020). Adverse childhood experiences (ACEs), peer victimization, and substance use among adolescents. *Child Abuse & Neglect, 106*, Article 104504. https://doi.org/10.1016/j.chiabu.2020.104504

Brady, K. T. (2019). Improving Our Understanding of Substance Use Disorders. *The American Journal of Psychiatry, 176*(2), 87–89. https://doi.org/10.1176/appi.ajp.2018.18121391

Broekhof, R., Nordahl, H. M., Bjørnelv, S., & Selvik, S. G. (2022). Prevalence of adverse childhood experiences and their co-occurrence in a large population of adolescents: A Young HUNT 3 study. *Social Psychiatry and Psychiatric Epidemiology*. https://doi.org/10.1007/s00127-022-02277-z

Bryant, D. J., Coman, E. N., & Damian, A. J. (2020). Association of adverse childhood experiences (ACEs) and substance use disorders (SUDs) in a multi-site safety net healthcare setting. *Addictive Behaviors Reports, 12*, Article 100293. https://doi.org/10.1016/j.abrep.2020.100293

Chandler, G. E., Kalmakis, K. A., & Murtha, T. (2018). Screening Adults With Substance Use Disorder for Adverse Childhood Experiences. *Journal of Addictions Nursing, 29*(3), 172–178. https://doi.org/10.1097/jan.0000000000000233

Choi, N. G., DiNitto, D. M., Marti, C. N., & Choi, B. Y. (2017). Association of adverse childhood experiences with lifetime mental and substance use disorders among men and women aged 50+ years. *International Psychogeriatrics, 29*(3), 359–372. https://doi.org/10.1017/S1041610216001800

Cook, A., Spinazzola, J., Ford, J., Lanktree, C., Blaustein, M., Cloitre, M., … van der Kolk, B. (2005). Complex Trauma in Children and Adolescents. *Psychiatric Annals, 35*, 390–398. https://doi.org/10.3928/00485713-20050501-05

Dube, S. R., Felitti, V. J., Dong, M., Chapman, D. P., Giles, W. H., & Anda, R. F. (2003). Childhood abuse, neglect, and household dysfunction and the risk of illicit drug use: The adverse childhood experiences study. *Pediatrics, 111*(3), 564–572. https://doi.org/10.1542/peds.111.3.564

Dube, S. R., Miller, J. W., Brown, D. W., Giles, W. H., Felitti, V. J., Dong, M., & Anda, R. F. (2006). Adverse childhood experiences and the association with ever using alcohol and initiating alcohol use during adolescence, 444.e441-410 *Journal of Adolescent Health, 38*(4). https://doi.org/10.1016/j.jadohealth.2005.06.006.

Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., … Marks, J. S. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. *American Journal of Preventive Medicine, 14*(4), 245–258.

Forster, M., Grigsby, T. J., Rogers, C. J., & Benjamin, S. M. (2018). The relationship between family-based adverse childhood experiences and substance use behaviors among a diverse sample of college students. *Addictive behaviors, 76*, 298–304. https://doi.org/10.1016/j.addbeh.2017.08.037

Fuller-Thomson, E., Roane, J. L., & Brennenstuhl, S. (2016). Three Types of Adverse Childhood Experiences, and Alcohol and Drug Dependence Among Adults: An Investigation Using Population-Based Data. *Substance use & misuse, 51*(11), 1451–1461. https://doi.org/10.1080/10826084.2016.1181089

Holmen, T. L., Bratberg, G., Krokstad, S., Langhammer, A., Hveem, K., Midthjell, K., … Holmen, J. (2014). Cohort profile of the Young-HUNT Study, Norway: A population-based study of adolescents. *International Journal of Epidemiology, 43*(2), 536–544. https://doi.org/10.1093/ije/dys232

Hughes, K., Bellis, M. A., Hardcastle, K. A., Sethi, D., Butchart, A., Mikton, C., … Dunne, M. P. (2017). The effect of multiple adverse childhood experiences on health: A systematic review and meta-analysis. *The Lancet. Public health, 2*(8), e356–e366. https://doi.org/10.1016/S2468-2667(17)30118-4

Hughes, K., Bellis, M. A., Sethi, D., Andrew, R., Yon, Y., Wood, S., … Zakhozha, V. (2019). Adverse childhood experiences, childhood relationships and associated substance use and mental health in young Europeans. *European Journal of Public Health, 29*(4), 741–747. https://doi.org/10.1093/eurpub/ckz037

Kessler, R. C., McLaughlin, K. A., Green, J. G., Gruber, M. J., Sampson, N. A., Zaslavsky, A. M., … Williams, D. R. (2010). Childhood adversities and adult psychopathology in the WHO World Mental Health Surveys. *The British Journal of Psychiatry, 197*(5), 378–385. https://doi.org/10.1192/bjp.bp.110.080499

Kiburi, S. K., Molebatsi, K., Obondo, A., & Kuria, M. W. (2018). Adverse childhood experiences among patients with substance use disorders at a referral psychiatric hospital in Kenya. *BMC Psychiatry, 18*(1), 197. https://doi.org/10.1186/s12888-018-1780-1

Kringlen, E., Torgersen, S., & Cramer, V. (2006). Mental illness in a rural area: A Norwegian psychiatric epidemiological study. *Social Psychiatry and Psychiatric Epidemiology, 41*(9), 713–719. https://doi.org/10.1007/s00127-006-0080-0

Lacey, R. E., & Minnis, H. (2020). Practitioner Review: Twenty years of research with adverse childhood experience scores - Advantages, disadvantages and applications to practice. *Journal of Child Psychology and Psychiatry and Allied Disciplines (Cambridge), 61*(2), 116–130. https://doi.org/10.1111/jcpp.13135

Leban, L., & Gibson, C. L. (2020). The role of gender in the relationship between adverse childhood experiences and delinquency and substance use in adolescence. *Journal of Criminal Justice, 66*, Article 101637. https://doi.org/10.1016/j.jcrimjus.2019.101637

LeTendre, M. L., & Reed, M. B. (2017). The Effect of Adverse Childhood Experience on Clinical Diagnosis of a Substance Use Disorder: Results of a Nationally Representative Study. *Substance use & misuse, 52*(6), 689–697. https://doi.org/10.1080/10826084.2016.1253746

Leza, L., Siria, S., López-Goñi, J. J., & Fernández-Montalvo, J. (2021). Adverse childhood experiences (ACEs) and substance use disorder (SUD): A scoping review. *Drug and Alcohol Dependence, 221*, Article 108563. https://doi.org/10.1016/j.drugalcdep.2021.108563

McLaughlin, K. A., Greif Green, J., Gruber, M. J., Sampson, N. A., Zaslavsky, A. M., & Kessler, R. C. (2012). Childhood adversities and first onset of psychiatric disorders in a national sample of US adolescents. *Archives of General Psychiatry, 69*(11), 1151–1160. https://doi.org/10.1001/archgenpsychiatry.2011.2277

Mersky, J. P., Topitzes, J., & Reynolds, A. J. (2013). Impacts of adverse childhood experiences on health, mental health, and substance use in early adulthood: A cohort study of an urban, minority sample in the U.S. *Child Abuse & Neglect, 37*(11), 917–925. https://doi.org/10.1016/j.chiabu.2013.07.011

Nolen-Hoeksema, S., & Hilt, L. (2006). Possible contributors to the gender differences in alcohol use and problems. *The Journal of General Psychology, 133*(4), 357–374. https://doi.org/10.3200/genp.133.4.357-374

Rhee, T. G., Barry, L. C., Kuchel, G. A., Steffens, D. C., & Wilkinson, S. T. (2019). Associations of Adverse Childhood Experiences with Past-Year DSM-5 Psychiatric and Substance Use Disorders in Older Adults. *Journal of the American Geriatrics Society, 67*(10), 2085–2093. https://doi.org/10.1111/jgs.16032

Rockville, M. S. A. a. M. H. S. A. (2017). Results from the 2016 National Survey on Drug Use and Health: Detailed Tables. In C. f. B. H. S. a. Quality. (Ed.).

Slopen, N., Shonkoff, J. P., Albert, M. A., Yoshikawa, H., Jacobs, A., Stoltz, R., & Williams, D. R. (2016). Racial Disparities in Child Adversity in the U.S.: Interactions With Family Immigration History and Income. *American Journal of Preventive Medicine, 50*(1), 47–56. https://doi.org/10.1016/j.amepre.2015.06.013

Sutherland, I., & Willner, P. (1998). Patterns of alcohol, cigarette and illicit drug use in English adolescents. *Addiction (Abingdon, England), 93*(8), 1199–1208. https://doi.org/10.1046/j.1360-0443.1998.93811998.x

Teicher, M. H., Samson, J. A., Anderson, C. M., & Ohashi, K. (2016). The effects of childhood maltreatment on brain structure, function and connectivity. *Nature Reviews Neuroscience, 17*(10), 652–666. https://doi.org/10.1038/nrn.2016.111

Tink, W., Tink, J. C., Turin, T. C., & Kelly, M. (2017). Adverse Childhood Experiences: Survey of Resident Practice, Knowledge, and Attitude. *Family Medicine, 49*(1), 7–13.

Vasilenko, S. A., Evans-Polce, R. J., & Lanza, S. T. (2017). Age trends in rates of substance use disorders across ages 18–90: Differences by gender and race/ethnicity. *Drug and Alcohol Dependence, 180*, 260–264. https://doi.org/10.1016/j.drugalcdep.2017.08.027

Vos, T., Abajobir, A. A., Abate, K. H., Abbafati, C., Abbas, K. M., Abd-Allah, F., Abdulkader, R. S., Abdulle, A. M., Abebo, T. A., Abera, S. F., Aboyans, V., Abu-Raddad, L. J., Ackerman, I. N., Adamu, A. A., Adetokunboh, O., Afarideh, M., Afshin, A., Agarwal, S. K., Aggarwal, R., . . . Murray, C. J. L. (2017). Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet*, *390*(10100), 1211-1259. https://doi.org/10.1016/S0140-6736(17)32154-2.

Warren, J. C., Smalley, K. B., & Barefoot, K. N. (2015). Perceived ease of access to alcohol, tobacco and other substances in rural and urban US students. *Rural and Remote Health, 15*(4), 3397.

Warren, J. C., Smalley, K. B., & Barefoot, K. N. (2017). Recent Alcohol, Tobacco, and Substance Use Variations between Rural and Urban Middle and High School Students. *Journal of Child & Adolescent Substance Abuse, 26*(1), 60–65. https://doi.org/10.1080/1067828x.2016.1210550

Whiteford, H. A., Degenhardt, L., Rehm, J., Baxter, A. J., Ferrari, A. J., Erskine, H. E., … Vos, T. (2013). Global burden of disease attributable to mental and substance use disorders: Findings from the Global Burden of Disease Study 2010. *Lancet, 382*(9904), 1575–1586. https://doi.org/10.1016/s0140-6736(13)61611-6

Widom, C. S., White, H. R., Czaja, S. J., & Marmorstein, N. R. (2007). Long-term effects of child abuse and neglect on alcohol use and excessive drinking in middle adulthood. *Journal of Studies on Alcohol and Drugs*, *68*(3), 317-326. 10.15288/jsad.2007.68.317.

World Health Organization. (1993). The ICD-10 classification of mental and behavioural disorders. *World Health Organization*.