

Alcohol- and drug use among adolescents

School-related problems, childhood mental health problems, and psychiatric diagnoses

Ove Heradstveit

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Scientific environment

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List of abbreviations

Alcohol/drug use

ADP: Alcohol and drug-related problems

Mental health problems

ADHD: Attention-deficit/hyperactivity disorder

PTSD: Post-traumatic stress disorder

School-related problems

GPA: Grade point average

Instruments

ASRS: Adult ADHD Self-Report Scale

CGAS: General impairment levels, ICD-10

DPS: Diagnostic Interview Schedule for Children Predictive Scales

SDQ: Strengths and Difficulties Questionnaire

SMFQ: Short Moods and Feelings Questionnaire

SCARED: Screen for Child Anxiety Related Emotional Disorders

YCD: Youth Conduct Disorder

Statistics

ANOVA: Analysis of variance

CI: Confidence interval

OR: Odds ratios

AOR: Adjusted odds ratio

SD: Standard deviation

p: p-value

Other

BCS: Bergen Child Study

ESPAD: European School Survey Project on Alcohol and Other Drugs

HBSC: Health Behaviour in School-aged Children

ICD-10: International Classification of Diseases, 10th version

NPR: Norwegian Patient Registry

REK Vest: Regional Committee for Medical and Health Research Ethics in
Western Norway

SES: Socio-economic status

Abstract

Background

Adolescents with alcohol and drug-related problems (ADP) are at heightened risk for a range of difficulties, such as mental health problems and school-related problems. However, the nature of the association between ADP and mental health problems is complex and many questions remain unanswered. More knowledge is also needed on how ADP is related to school-problems such as poor grade achievement and absence from school, and how mental health problems affect these associations. Furthermore, previous findings are inconsistent on how mental health problems during childhood, particularly internalizing problems, are associated with ADP during adolescence. Finally, although previous research have demonstrated that adolescents with psychiatric diagnoses have higher rates of ADP compared to the general population, there is a lack of knowledge regarding which of these psychiatric diagnoses that are more strongly associated with ADP during adolescence, particularly when psychiatric comorbidity is accounted for.

Objectives

The main objective of this thesis is to investigate alcohol/drug use and its association with mental health and school-related factors among adolescents. More specifically, the objectives are to examine (a) the cross-sectional associations between ADP and school-related problems among adolescents, (b) the longitudinal associations between childhood externalizing and internalizing mental health problems and ADP during adolescence, and (c) which psychiatric diagnoses that precede the development of ADP among adolescents receiving specialist mental health care.

Methods

All papers included adolescents aged 16 to 19 years of age who had participated in the youth@hordaland survey (n=10,253), which provided self-reported data on demographics, mental health problems, and alcohol/drug use. First, utilizing data from the youth@hordaland survey in linkage with official school registry data on school grades and attendance, including a total of 7,874 individuals, the cross-sectional associations between ADP and school-related problems were investigated. Second, data from the first, second and fourth wave of the Bergen Child Study (BCS) was employed (the fourth wave was nested within the youth@hordaland survey) including a total of 2,438 individuals, and longitudinal associations between childhood externalizing/internalizing problems and ADP were analyzed. Third, data from the youth@hordaland survey was linked with the Norwegian Patient Registry (NPR), including a total of 9,408 individuals, of whom 853 had received specialist mental health care during the past four years. Psychiatric diagnoses that preceded adolescent ADP were investigated. All studies included logistic regression analyses.

Results

ADP during adolescence was consistently associated with school-related problems in cross-sectional analyses. More specifically, alcohol/drug use was associated with low grade point average (GPA), high number of days missed from school, and high number of hours missed from school (Odds ratios (ORs) ranging from 1.79 to 3.44, all $p < 0.001$). Adjusting for gender, age, socioeconomic status and co-occurring mental health problems reduced the magnitude of the estimates; however, all associations remained statistically significant.

In longitudinal analyses, childhood externalizing problems were positively associated with ADP during adolescence, particularly after the adjustment from co-occurring internalizing problems, SES, gender and age (Adjusted odds ratios (AORs) ranging from 1.24 to 1.40, all $p < 0.05$). In contrast, internalizing problems during childhood was consistently negatively associated with adolescent ADP after the adjustment from co-occurring externalizing problems, SES, gender and age (AORs ranging from 0.83 to 0.87, all $p < 0.05$).

In analyses conducted on the merged data set of the youth@hordaland survey and the Norwegian Patient Registry (NPR), higher odds for ADP were observed among adolescents that had received specialist mental health care during the past four years compared to adolescents from the general population (p 's ranging from < 0.001 to < 0.05). In unadjusted models, anxiety, depression, conduct disorders, eating disorders, ADHD, and trauma- and stressor-related disorders were all positively associated with some measure of ADP (ORs ranging from 1.60 to 4.76, all $p < 0.05$). However, anxiety and ADHD were no longer positively associated with any measure of ADP after adjusting for age, gender, SES, and psychiatric comorbidity. While trauma-related disorders, depression and conduct disorders were positively associated with increasing levels of indicators for ADP in unadjusted analyses (ORs ranging from 1.92 to 3.20, all $p < 0.05$), only trauma-related disorders remained positively associated when adjusted for age, gender, SES, and psychiatric comorbidity (AOR 2.53, $p < 0.01$).

Conclusion

ADP was consistently positively associated with school-related problems, clearly suggesting that alcohol/drug use among adolescents are important factors for school-

related functioning. Externalizing problems during childhood showed for the most part robust and consistent positive associations with ADP during adolescence, while childhood internalizing problems was negatively associated with ADP when potential confounding variables were accounted for. The occurrence of ADP was more common among adolescents who had received specialist mental health care, and among adolescents receiving specialist mental health care, individuals with trauma-related disorders had a particularly high-risk for developing ADP.

In sum, efforts aiming at improving school functioning among adolescents should be aware of the importance of reducing alcohol/drug use; early prevention initiatives to reduce future alcohol/drug involvement should target children with externalizing problems; and specialist mental health care practitioners should address issues related to adolescent alcohol/drug use, particularly among individuals with trauma-related disorders.

List of publications

- Heradstveit, O., Skogen, J. C., Hetland, J., Hysing, M. (2017): Alcohol and illicit drug use are important factors for school-related problems among adolescents. *Frontiers in Psychology*, 8.
- Heradstveit, O., Skogen, J. C., Bøe, T., Hetland, J., Pedersen, M. U., & Hysing, M. (2018). Prospective associations between childhood externalising and internalising problems and adolescent alcohol and drug use: The Bergen Child Study. *Nordic Studies on Alcohol and Drugs*, 1455072518789852.
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1. Introduction

1.1 Background for the thesis

Adolescence is characterized by an escalation of alcohol and illicit drug use (1), and alcohol- and drug-related problems (ADP) during adolescence is strongly associated with continued ADP in adulthood (2, 3). A large body of scientific literature has demonstrated that ADP are highly correlated with mental health problems (4, 5), and the interplay between mental health problems and ADP is a topic of great interest in the scientific literature within developmental psychology on alcohol/drug use (1).

The overall aim of this thesis is to contribute to a better understanding of ADP during adolescence, and how mental health problems relate to these problems. Specifically, the topics are related to how ADP is associated with school-related problems, how childhood mental health problems are associated with ADP, and which psychiatric diagnoses during adolescence that precede ADP. However, before these topics are elaborated, I will first discuss adolescence as an important developmental period, the prevalence of alcohol/drug use among adolescents, along with issues related to the conceptualization of ADP.

1.1.1 Adolescence as an important and vulnerable developmental period

Adolescence has been defined as “the period within the life span when most of a person’s biological, cognitive, psychological, and social characteristics are changing from what is typically considered childlike to what is considered adult-like” (6, 7). In

more straightforward terms, adolescence marks the transitional phase when a child develops into an adult (8). The World Health Organization (WHO) highlight the adolescent years as a developmental phase that needs explicit attention (9), in part due to rapid developmental changes on both physical, neurodevelopmental, psychological and social domains. Investment in adolescent health and wellbeing is further underscored as beneficial for adjustment both during adolescence, in adult life, and for the next generation of children (10).

Historically, adolescence is defined by the WHO as the period between 10 and 19 years of age (9), but definitions of age spans defining adolescence have been inconsistent in contemporary literature (11, 12) and the understanding of continued growth have further expanded the endpoint age of adolescence well into the 20s (13). Early adolescence has often been conceptualized as ages 10 to 14, while 15 to 19 refers to late adolescence (13); however, these time spans are not definitive, and should be regarded as approximations. Although the biological sequences of adolescence are described as highly consistent (13), there are nevertheless considerable individual differences in timing of puberty both within gender (14) and across gender (15). In addition, the age of onset of puberty and of menarcheal age has been decreasing in most European countries during the past decades (16), suggesting that onset of puberty is subject to trends and changes over time. Also, the social-role changes related to adolescence tend to vary widely across economic and sociocultural settings (13), further highlighting that the adolescence is a complex and heterogenous concept to study.

During adolescence the body gradually transforms from childlike to adult-like, with physical changes that include increased muscle growth, enhanced bodily forms, hair-growth, and changes in the voice. Also, a range of hormonal changes are in effect with implications for sexual drive, emotion, and identity formation (17). These bodily changes are accompanied by profound neurodevelopmental changes. These changes relates to the limbic system (18, 19) – involved in pleasure seeking and reward processing, emotional responses and sleep regulation – and the prefrontal cortex (18, 19) – involved in executive functions, such as decision-making, organization, impulse control and planning for the future. Not least, a range of psychological, cognitive and social changes are intrinsically bound to adolescent years (1).

Despite the problems with providing exact time spans that constitute adolescence, it must be acknowledged that the broad range of changes on most life domains make the adolescent period a time of vulnerability and adjustment (20). In particular, emotion is highlighted as an important but often overlooked aspect of decision-making (21), which may play a substantial role on health behaviors during adolescence (20). Concurrently, the choice to engage in alcohol/drug-related behaviors cannot solely be understood in terms of ‘cold’ cognitive processes – which refer to thinking processes under conditions of low emotion/arousal (20). On the contrary, recent contributions on adolescent decision-making processes highlight the significance of ‘hot’ cognitive processes, which refer to thinking processes under conditions of high emotion/arousal (20). These advances underscore the importance of considering emotional factors in the development of alcohol/drug-related behaviors during adolescence, and is

actualized during adolescence in light of the broad range of social, emotional and neurodevelopmental changes that occur during this period.

Adding to this perspective, adolescence has historically been described as a period of *storm and stress* (22), suggesting that the adolescent years represent a stressful and emotionally stormy life phase for most individuals. Conflict with parents, mood disruptions, and risk behavior is highlighted as key aspects of this view (23). The suggestions of the universality of this storm and stress hypothesis, have however been challenged in current literature (23, 24), and it is acknowledged that cultural and individual differences must be taken into account. For example, adolescent storm and stress tend to be lower in more traditional cultures compared with Western societies (23). However, in recent years Norwegian adolescents generally report low levels of conflict with parents, as well as high levels of life satisfaction (25), challenging the storm and stress hypothesis. Hence, storm and stress may rather be an individual phenomena – related to adolescents that struggle with particular life difficulties – as opposed to being a global and expected experience during the adolescent years (23). Therefore, it is important to consider how individual differences in mental health problems may affect development of alcohol/drug use and problems during adolescence.

The use of alcohol/drugs during adolescence has drawn considerable scientific interest. For example, researchers have suggested that extensive use of alcohol or drugs is associated with deviant brain functioning (26), deviant behaviors (27), school-related problems (e.g. 28), and a range of mental health problems (29). Regardless of the directionality and mechanisms involved in these associations, such findings

underscore that use of alcohol/drugs is involved in processes that may further increase the vulnerability during adolescence for both present and future adverse outcomes. Hence, the adolescent years is an important and vulnerable development period in life, and the study of alcohol/drug use during this phase is a topic of great scientific interest.

1.1.2 The prevalence of alcohol/drug use

1.1.2.1 Alcohol/drug use among adults

Within the *adult* population, the European Union (EU) is the region in the world with the highest alcohol consumption (30), with a yearly average of 12.5 liters of pure alcohol. This translates to nearly three drinks a day, or more than double the world average (30). In comparison, the yearly registered sale of alcohol in Norway to the average adult (aged 15+ years) was 6 liters of pure alcohol in 2016 (31). North America is the region with the highest regular use of cannabis – which is by far the most commonly used illicit drug worldwide (32). More specifically, among the adult population, 10.7% of adults report regular cannabis use in North America, compared with 5.2 to 5.3% in Europe, and as low as 0.4 to 1.6% in East and Southeast Asia. A range of studies have demonstrated that illicit drug use in Norway is fairly low compared with other European countries (33, 34). The prevalence of lifetime use of cannabis among Norwegian adults (16 to 64 years) has increased from 8.5% in 1985 to over 20% in 2016, but this increase is primarily explained by a cohort effect in which many individuals tried cannabis during the 1960s and still has not reached an age of above 65 (31). However, only 4% of Norwegian adults report to having used cannabis

past year and 2% past month (31), indicating that regular cannabis use have been relatively stable during the past 20 years in Norway (31).

1.1.2.2 Alcohol/drug use among adolescents

Adolescence is a particularly important period for the initiation of alcohol and illicit drug use. In order to monitor the prevalence and trends of these behaviors, the European School Survey Project on Alcohol and Other Drugs (ESPAD) has been conducted every fourth year since 1995 (33). The ESPAD survey targets 16 year old students in a large range of European countries. The most recent survey was from 2015, and included data from over 96,000 individuals from over 35 countries.

The ESPAD 2015 survey revealed that a total of 80% of the adolescents reported having consumed *alcohol*, while Norway were among the countries with a relatively low rate (57%) in this respect (35). This estimate corresponds well with results from the youth@hordaland survey in Hordaland, Norway, which investigated alcohol/drug use among adolescents aged 16 to 19 years, and revealed that 31% of the girls and 40% of the boys in the youngest age span (16-17 years) had never tried alcohol (36). Alcohol use increased with increasing age and in the oldest age spans (18-19 years) only 6% of girls and 7% of boys reported to having not tried alcohol in the youth@hordaland sample. The Health Behaviour in School-Aged Children study (HBSC) is another recurrent large-scale cross-national survey which monitors trends in health behaviors, including alcohol/drug use, and has 11 to 15 year old adolescents as its target group (37). They conclude that adolescent alcohol use has decreased in most European and North American countries since the beginning of the 21st century, and confirm that alcohol use in Norway is low compared with other Western countries (38,

39). Other studies have also demonstrated decreasing levels of alcohol use among Norwegian adolescents during the past fifteen years (40, 41) (Figure 1).

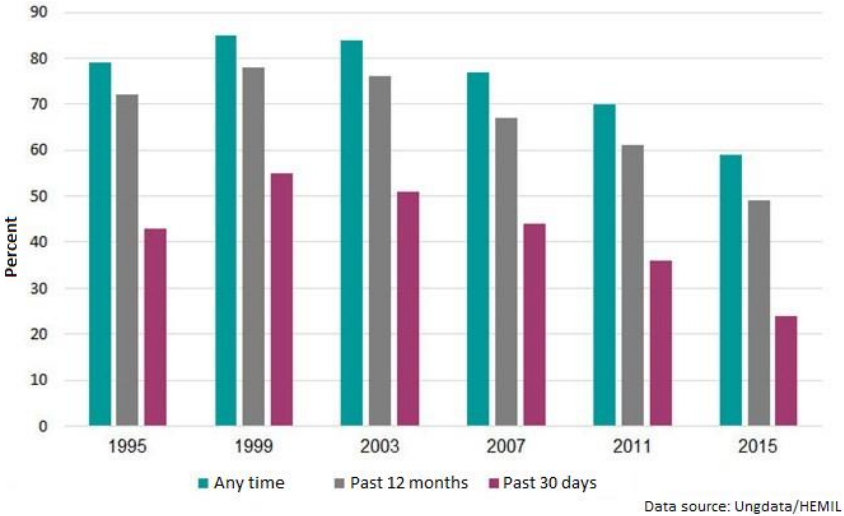


Figure 1: Proportion of Norwegian 15-16 year olds that report having drunken alcohol respectively life time use, past year, and past month (40)

The ESPAD 2015 survey reported that an average of 18% of the European adolescents had tried *illicit drugs* (35). However, large regional differences were documented, with Norway among the countries with the lowest rate of illicit drug use (7%) while the Czech Republic in comparison had a rate of 37%. The estimates for Norwegian adolescents correspond fairly well with the youth@hordaland survey which estimated that 9% of the girls and 12–13% of the boys in the combined age span from 16 to 19 years had tried illicit drugs (36). Similarly, a publication based on data from HBSC conclude that the prevalence of cannabis use vary considerable across

European and North American countries (39), but Norwegian adolescents were not included in the study. However, a recent Norwegian publication reported that cannabis use among Norwegian 15 to 16 year old adolescents has fluctuated during the past twenty years, but has overall remained fairly low compared to many European countries (31) (Figure 2).

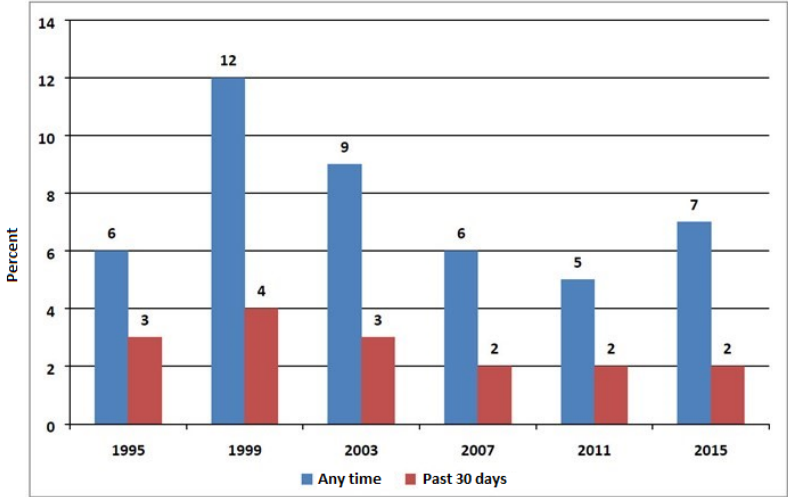


Figure 2: Proportion of Norwegian 15-16 year olds that report cannabis use, respectively lifetime use, and past month (31)

1.1.2.3 A contextual phenomenon

The considerable differences in prevalence estimates for alcohol/drug use in Western countries among both adults and adolescents demonstrate that alcohol/drug use is a highly contextualized behavior. Specifically, consumption levels and rates of users/abstainers for different substances vary across historical periods within a country (33, 42), geographical areas within the country (43), gender (44), socioeconomic levels

(45), and across the life-span for the particular individual (46). For example, alcohol use among Norwegian adolescents has decreased over the past twenty years (e.g. 47), and – compared with most European countries – Norwegian adolescents has over time had a relatively low use of both alcohol and illicit drugs (33).

Also of note, ‘drinking cultures’ or motives for drug use may differ across geographical areas, adding to the notion of alcohol/drug use as a contextual phenomenon. For example, a broad division has been made between (a) northern European countries (often referred to as *dry* countries) in which beer is the most consumed beverage, and is typically consumed in weekends or outside mealtimes; and (b) southern European countries (often referred to as *wet* countries) in which wine is most commonly used, and usually drunk to meals (48, 49). However, drinking patterns across European countries tend to converge, and this traditional split between dry and wet countries may therefore be less relevant in the current historical context (49). Some convergences has also been observed across gender, as seen by a closing gender gap in use of alcohol in recent years in the young US population (50), and on some measures of alcohol use across European countries (33). On the other hand, boys still tend to be generally overrepresented in drug use (33, 51).

1.1.3. How to conceptualize alcohol/drug-related problems (ADP)?

The contextually dependent prevalence rates of alcohol/drug use among adolescents highlight the challenging task to conceptualize alcohol- and drug-related problems (ADP).

1.1.3.1 A pathological model for conceptualization of ADP

In a strict pathological perspective, ADP may be understood as a *categorical* phenomenon, under which individuals with ADP are sharply divided from those without such problems. In accordance with a pathological model, the concept of ADP could be understood as synonymous to having symptoms that would qualify for a substance use disorder (SUD) or alcohol use disorder (AUD) diagnosis. The tenth version of the manual International Classification of Diseases (ICD-10) (52) outline the current gold standard within European countries for the understanding of which symptoms that characterize AUDs or SUDs, based on a categorical model. The strict division between diagnosis and non-diagnosis in this model highlight an underlying disease model in the conceptualization of ADP (53).

Specifically, AUDs are described in the chapter F10 of the ICD-10, while SUDs are described in the chapters F11 to F16 and F19. AUDs are separated into *alcohol abuse* alone which include an excessive use of alcohol, and *alcohol dependence*, in which there also is present symptoms of craving (a strong need to drink); loss of control (not being able to stop once you have started); physical dependence (as proved by withdrawal symptoms including nausea, sweating or shakiness when you don't drink); and tolerance (the need to drink larger amounts of alcohol to feel the same effect). The same differentiation between abuse and dependence is specified within all the variants of SUDs.

While the gold standard measurement of formal AUDs and SUDs include in-depth clinical interviews based on the diagnostic operationalization provided by the ICD-10,

such interviews are resource demanding and not always possible to achieve in the context of epidemiological, population-based studies.

1.1.3.2 A dimensional conceptualization of ADP

An alternative and complementing conceptualization of ADP highlight alcohol/drug use as a *dimensional* phenomenon (54), in which the continuum of alcohol/drug use span from ‘no use’ on the one hand to ‘substance-/alcohol use disorders’, or merely ADP, on the other hand. Between these opposites a large variety of alcohol/drug-related behaviors manifest and a person can have emerging ADP even if he or she does not qualify for a formal alcohol/drug-related diagnosis. An underlying premise for a dimensional understanding of ADP is that these problems may be present in various degrees, adding to a disease model in which alcohol/drug use is only defined as problematic among those with symptoms that qualify for either an AUD or a SUD diagnosis.

A dimensional perspective on symptoms of psychiatric diagnoses is well-known and widely used within epidemiological studies, and several studies indicate that the distribution of mental health symptoms follows a continuum from none to high symptom load in the population (55-57). There is also support for a dimensional perspective on symptoms of hazardous or extensive alcohol use (58), suggesting that alcohol problems can be arrayed along a dimension of severity. Similarly, cannabis dependence has also been demonstrated to follow an underlying continuum of severity (59).

1.2 Theoretical perspectives

Alcohol/drug use – and therefore also adolescent ADP – is affected by a range of social and individual factors operating over the course of life. A proper framework of these processes is necessary for a better understanding of why some individuals develop ADP during adolescence. This thesis builds on a social epidemiological framework and a life-course, developmental perspective, in which the dual pathway hypothesis for development of adolescent ADP is examined, and in which the shared vulnerability model is an important underlying theoretical perspective. In the following sections these perspectives are briefly outlined.

1.2.1 Developmental psychological perspectives

1.2.1.1 Social epidemiology

A substantial contribution to the contemporary psychology on development of ADP is coming from studies based on *epidemiological* methods (1, 3, 60), and the methodology of the present thesis is rooted in a psychological, epidemiological tradition. Epidemiology is the study of the distribution and determinants of health-related states or events, and the application of this study to the control of diseases and other health problems (61) including ADP. It is believed that on the basis of observable data – e.g. retrieved from surveys, interviews or registers – it is possible to detect associations between variables through means of statistical methods (61, 62). In other words, important challenges within epidemiological research is related to

ensuring the accuracy of the data in terms of reliability, validity and generalizability (63).

Different perspectives may underlie the use of epidemiological studies, and an important basis for the understanding of adolescent ADP is the present thesis is the *social epidemiological* perspective (64). Departing from clinical orientations with sole focus on individual factors – such as biology, genetics, personality, medical or psychiatric status – this perspective demonstrates the need for researchers to also investigate the role of social conditions on the production of health and diseases (64, 65), and in the context of this thesis: ADP.

In support of the notion that developmental processes have both individual and social influences, a comprehensive literature has demonstrated that risk factors for adolescent ADP include (1) *individual psychological* factors, such as conduct problems and delinquency (66-68), hyperactivity, impulsivity and disinhibited behavior (69, 70), depression (71), and positive expectancies towards alcohol/drug use (72, 73); (2) *biological* factors, such as increasing age (72, 74), being male (70, 74), and genetic vulnerability (75-78); (3) *behavioral* factors, including earlier alcohol/drug use (67, 74, 79), and low school engagement (80); (4) *social* factors, such as coming from a ‘disrupted’ family (67), parents, siblings and friends alcohol/drug use (66, 72, 81) or attitudes toward alcohol/drug use (66, 82), exposure to parental drinking (83), low parental monitoring (84), low socioeconomic status (SES) (85), contact with deviant peers (86), and peer pressure for alcohol/drug use (85); (5) *adverse life experiences*, which include childhood maltreatment and victimization (87, 88),

parental separation or divorce (85), and poor school performance (67, 89, 90); and (6) *societal* factors, such as availability of alcohol/drugs (81).

Furthermore, it is demonstrated that exposure to multiple risk factors is associated with a cumulative risk for ADP (68, 91, 92), and the cumulative load of adverse childhood experiences show a graded relationship to the risk of ADP from early adolescence into adulthood (92). However, also protective factors for development of adolescent ADP is described in literature, i.e. factors associated with a reduced probability for ADP, and includes characteristics of individual, peer, family and community influences (e.g. 85, 93).

Therefore, adolescent ADP cannot be viewed as an isolated or random phenomenon, or as merely a non-contextual intake of psychoactive substances with certain physiological and psychological effects. On the contrary, adolescent ADP but must be conceptualized as behavioral patterns that is affected and constituted by a range of social and individual influences surrounding the particular adolescent.

1.2.1.2 Bronfenbrenner's bioecological theory

An important addition to a social epidemiological perspective of ADP, may be found in Urie Bronfenbrenner's bioecological view of human development (94, 95), which have proved as a prominent theory with the field of developmental psychology during the last decades (96). He criticized much of the contemporary research on the field of developmental psychology as "the science of strange behavior of children in strange situations with strange adults for the briefest possible periods of time" (94).

Bronfenbrenner stressed that research should rather focus on how children develop in settings that is representative of their actual world, or in other words in *ecologically valid* settings (96). Therefore, the application of data from a representative, population-based sample of adolescents is a considerable strength in the present thesis, as it adheres to the need for studies on how ADP develop in a natural world setting.

Furthermore, Bronfenbrenner's theory is useful as a framework in the present thesis also in his views on the *ecology of human development* (94, 95). He proposed that children and adolescents development should be understood in the context of four interrelated systems: (1) the microsystem, (2) the mesosystem, (3) the exosystem, and (4) the macrosystem. The *microsystem* comprise the "complex of relations between the developing person and the environment in an immediate setting containing the person" (94). Such microsystems include both the family, school, and peers. However, these microsystems do not exist in isolation of each other, but are interrelated – and the matrix of interrelations between microsystems comprise the *mesosystem* (94, 95). For example, the individuals' adjustment at home may affect his/her adjustment at school, and vice versa; or an adolescents' use of alcohol/drugs in one setting may affect his/her behaviors, roles and relationships at other settings. In support of this model, it has previously been reported that ADP is associated with low school attendance (97-101), while low school attendance is in turn related to increased ADP (97, 98). In other words, the reciprocity or dynamic influence across different settings is an important contribution of the theory, and appear to have some support in the current literature.

Furthermore, a child's development is also affected by characteristics of and processes within the interrelated microsystems even when the child is not present, and

Bronfenbrenner named these external influences for the *exosystem* (94, 95). For example, the contact between parents and the teacher may constitute a range of facilitating or interrupting influences on the child's development, or conflicts between parents may affect the child even when most of the behavioral manifestations of these conflicts occur when the child is not present. Finally, Bronfenbrenner also highlighted the *macrosystem*, which is composed of historical events, cultural values, and other influences on a societal level (96). The large differences in prevalence of alcohol/drug use among adolescents across countries, support the importance of these influences (see section 1.1.2.2). In other words, the sociobiological models highlight the significance of conceptualizing ADP as a contextualized phenomenon (see section 1.1.2.3), and to interpret adolescent alcohol/drug use in light of the current historical and societal context.

In accordance with this perspective, cohort effects may play important roles in determining which specific challenges and opportunities that are most salient among adolescents as a group, and these factors constitute a historical unique context in which ADP should be understood. For example, alcohol/drug use has decreased in recent years among Norwegian adolescents (40), and these trends may reduce the overall risk for ADP in the adolescent population. However, such trends may also hypothetically contribute to larger disadvantages among those individuals that – despite changing trends – exhibit hazardous alcohol/drug use. It is possible that these individuals will face more extensive social exclusion processes due to their non-normative alcohol/drug-related behaviors, as compared with what would be the case if these behaviors were more prevalent among adolescents as a whole. These mechanisms are

related to a so-called ‘hardening’ hypothesis, implying that those individuals that remain using substances in the context of a general decline of substance use may be ‘hardened’ to cessation, (102) or exposed to more psychosocial problems, due to the continued use (41). In support of this perspective, it is well described in the literature that the extent to which one’s values, identity and behaviors are viewed as legitimate and worthy by others is a component that may affect social inclusion/exclusion processes (103). Furthermore, hardening has been demonstrated among adolescent smokers in Norway (104). However, it has not been found similar signs of hardening in relation to adolescent alcohol use, and alcohol users reported even higher levels of social acceptance and social integration than did non-users (103).

In short, the bioecological theory can be viewed as an elaboration of a social epidemiological model. Both models highlight the close interplay between the individual and its context; however, the bioecological theory of Bronfenbrenner gives more saliency to the dynamic relations between different systems comprising the ecology of human development, including societal and historical factors. This theory provides an additional basis for the present thesis and underscore the complexity behind the development of ADP during adolescence and beyond.

1.2.1.3 A life-course perspective

A *life-course* perspective on ADP highlight the significance of different pathways towards alcohol/drug use, and the identification of critical events or factors that influence alcohol/drug-related behaviors during the progressing life stages (105). It is

acknowledged that early exposures may have the potential to influence development of health problems throughout life – for example, in influencing critical developmental processes or in setting in motion a series of cumulative disadvantages during childhood, adolescence and early adulthood (64). For example, early mental health problems has been highlighted as prominent factors that can affect the risk for ADP (see section 1.3.2 and 1.33), along with a range of individual, social, family and societal factors that operate in concert (see section 1.2.1.1). Hence, the development of ADP can be conceptualized as the result of intertwining chains of individual and social factors operating over the course of life. A critical concern in a life-course perspective on ADP is related to the success or failure during different life stages (106, 107). Given the rise of alcohol/drug use which is commonly observed during adolescence, an important time period is when the adolescents are aged 16 to 19 years, during which a large majority of adolescents in Norway attend upper secondary school (108). This period often involve disruptions from previous friends in order to attend a new school (e.g. 109, 110, 111), and therefore also involve the formation of new social roles.

The adolescent years are also associated with a rise in *mental health problems* (112, 113), with implications for the formation of friendship/peer relations (114), tendencies toward social approach or withdrawal (115), and school-related functioning (116). Importantly, mental health problems may contribute to the choice of whether to use or abstain from alcohol/drugs, to what extent the substances are used, and to which function the alcohol/drug use serve for the individual. In other words, the emergence of ADP during adolescence can be conceptualized to represent a continuation along developmental trajectories with roots back to childhood and early adolescence, in

which the occurrence of both prior and current mental health problems are of importance.

Regardless of its functions, causes and background, the initiation of *alcohol/drug use* marks an important milestone in many adolescents life (1). For both alcohol and illicit drugs it has been found that the major risk period for initiation of alcohol, tobacco, and most illicit drugs begins around 12 years of age and is mostly over by age 22 (117). The corresponding peak periods of risk of initiation for most drugs occur between 15 and 19 years of age (117). Early-onset alcohol/drug use is relatively rare, but is – when present – a strong predictor for continued, extensive use (118, 119) as well as being associated with prior adverse life-experiences such as witnessing domestic violence and experiencing physical or sexual abuse (120). High quit rates are observed in the first few years after initiation of illicit drugs, followed by a sharp decline in quit rates over time (117). On the other side, alcohol consumption levels often continues to rise and peaks at around 25 years of age (46), and similar patterns are found for men and women; however, with lower overall alcohol consumption levels among women (46).

1.2.1.4 Summary

A developmental psychological perspective – informed by social epidemiology, the bioecological theory, and a life-course perspective – provide a useful theoretical foundation for the investigation of how mental health problems and ADP co-occur and interplay. Important questions relate to how these problems are associated with functional problems on other domains in life, such as school-related problems. This thesis recognizes that adolescence is an important transitional period between

childhood and adult life, in which a range of developmental processes are in effect across settings, and characterized by both immediate influences (including current mental health problems) and prior influences (including childhood mental health problems), while also being inseparably related to a historical and cultural context.

1.2.2 The dual-pathway hypothesis for development of alcohol/drug use

During adolescence an escalation of both mental health problems (112, 113) and alcohol/drug use (1) is often observed. However, the nature of the association between mental health problems and alcohol and drug use is complex and different etiological pathways and mechanisms have been suggested. A recent theoretical model is based on the *dual pathway hypothesis*, suggesting that externalizing and internalizing problems constitute two separate pathways into adolescent alcohol/drug use (e.g. 1, 121).

Externalizing and internalizing problems are a frequently used dichotomization of childhood and adolescent maladjustment (122), and was originally proposed by Achenbach and colleagues during the 1960s (123). Their model distinguished between two psychopathological levels: the broad-band and the narrow-band (122). Whereas the broad-band categorized syndromes of psychopathology along eight separate categories, the narrow-band comprised only four factors, including internalizing and externalizing problems, along with other and mixed problems. According to Forns and colleagues (122) internalizing problems include inner-directed psychopathological symptoms such as anxiety, depression, social isolation, or somatic complaint.

Externalizing problems are conceptualized as outer-directed psychopathological tendencies, referring to problems that generate discomfort and conflict in other people and imply disrespect for social norms.

Since the initial proposal, the dichotomization between externalizing and internalizing problems has been widely recognized among child and adolescent researchers on psychopathology. A range of studies have documented the validity and reliability of the externalizing and internalizing factors (124, 125). It has also been demonstrated that common DSM-based diagnoses have a good fit with a two-factor model comprising internalizing and externalizing factors (126), indicating that externalizing/internalizing problems are salient factors within common forms of psychopathology. However, externalizing and internalizing show a high co-occurrence (127), and some mental health problems do not fit neatly into neither internalizing nor externalizing syndromes (122). Therefore externalizing/internalizing problems must be regarded as a non-exhaustive conceptualization of common mental health or psychopathological problems among children and adolescents.

The *externalizing* pathway towards the development of ADP has been suggested to comprise core features such as behavioral undercontrol and disinhibition / impulsivity (128, 129) and deviant behavioral tendencies (130), while externalizing personality traits such as sensation seeking have also been linked to early adolescent ADP (131, 132). Current models also emphasize that the interaction between externalizing problems and high-risk environments – such as impaired parenting, adverse social contexts, and networking with deviant peers – may further increase the risk for alcohol/drug use (128, 133-135). Specifically, children with behavioral disinhibition

may be at larger risk for selection into social groups with similarly disinhibited peers (136), and these peer groups provide opportunities and norms that promote alcohol/drug use (137). However, several studies have also highlighted that associations between externalizing symptoms (including conduct problems, impulsivity and sensation seeking) and adolescent ADP may be mediated by other individual factors such as positive alcohol expectancies (135) and drinking motives (138). It is also reported that externalizing traits, such as conduct problems and low levels of shyness, may be specifically predictive of early onset alcohol intoxication, while having less significance in relation to early onset drinking in general (139). Hence, externalizing symptoms are highlighted as risk factors which alone or in concert with other individual and social influences may contribute to the development of ADP during adolescence.

Different aspects of *internalizing* problems are hypothesized to be involved in respectively 'protective' mechanisms (reducing risk) and 'risk/vulnerability' mechanisms (increasing risk) towards ADP (140). Early inhibited temperament and emotional dysregulation are suggested as key features of internalizing problems that increase the risk for adolescent ADP (1, 141), while negative reinforcement is suggested as an important process that translate these internalizing problems into ADP (1, 142). The importance of negative reinforcement processes is described in early motivational models of addiction (e.g. 143), and highlights that escape and avoidance of negative affect is a key motive behind addictive alcohol/drug use (142). The broader *self-medication hypothesis* (144) also highlight that use of alcohol/illicit drugs may represent an attempt to 'self-medicate', or regulate, negative affect and emotional

problems. In support of these perspectives, several studies have documented that negative affect is an important feature of internalizing problems that may heighten risk for hazardous alcohol/drug involvement during adolescence and early adulthood (140, 145), and depression is frequently found to be associated with adolescent ADP (29). Similarly, high levels on the personality dimension of hopelessness have been found to predict onset of alcohol use in early adolescence (131, 132). In addition, several scientific contributions link *exposure to stress and trauma* early in life with later development of ADP (146, 147). Specifically, it has been suggested that exposure to stress/trauma may result in a dysregulated stress response (148), which is influential in producing anhedonia (149), along with depression and post-traumatic stress disorder (PTSD) (150). In turn, both anhedonia, depression and PTSD are suggested to affect motivation for alcohol/drug use during the adolescent years (151-155).

On the contrary, internalizing tendencies toward social withdrawal and fear of negative consequences are aspects suggested to decrease risk for exposure to alcohol/drug use during the adolescent years (140, 156, 157). Concurrently, symptoms of anxiety are in some studies related to decreased risk for adolescent ADP (158-161). However, the literature is highly inconsistent and inconclusive in this respect, with other studies pointing to anxiety as associated with higher risk for ADP (162-164). For example, a study by Kaplow and colleagues (165) found that adolescents with separation anxiety disorder was negatively associated with ADP, while generalized anxiety was positively associated with ADP. This finding indicate that social withdrawal is an internalizing problem that reduce risk for ADP, as social withdrawal

is naturally linked with separation anxiety, and not necessarily with generalized anxiety.

The dual pathway hypothesis holds that both externalizing and internalizing problems may be involved in developmental processes that affects the risk for ADP during adolescence and beyond. While the existing evidence base for externalizing pathway to development of ADP is strong, more research is needed to disentangle the role of internalizing problems. Adhering to a life-course social epidemiological perspective, there is a need to evaluate how both childhood and adolescent internalizing symptoms correlates with adolescent ADP, along with investigation of the role of social and demographical factors on these associations.

1.2.3 A shared vulnerability model

An additional theoretical perspective underlying the present thesis is the *shared vulnerability model* for development of ADP (166, 167). This perspective criticize a disease model which imply that problems related to different types of substances (including alcohol, marijuana, sedatives, stimulants, opiates, psychedelics) has different etiologies. Although some differences may be present across user groups of different substances, Tarter and Mezzich (168) concluded that "*there is no definitive evidence indicating that individuals who habitually and preferentially use one substance are fundamentally different from those who use another.*" On the contrary, empirical literature points to shared risk factors for high-risk alcohol use and illicit drug use (169, 170) and between different types of illicit drugs (167, 171).

Additionally, shared risk factors are also described for the development of both ADP and mental health problems (172).

The shared vulnerability model is relevant for the present thesis in several ways. First, measures of both alcohol and illicit drug use, as well as combined symptoms of ADP, will be used in all the papers, as opposed to investigating only one of these types of substance use. This multi-faceted and dimensional conceptualization of ADP enables an investigation of the extent to which vulnerability factors, such as childhood mental health problems, serve as shared risk factors across different measures of ADP or if the risk is specifically related to only particular measures of ADP, for example only illicit drug use and not alcohol-related problems, or vice versa.

Second, the analytic models applied in the present thesis aim to account for potential confounding variables which may serve as shared vulnerability factors on the associations of interest. It is demonstrated a high co-occurrence between ADP and mental health problems (173), while mental health problems has also been reported as factors which increase vulnerability for both ADP (for details, see section 1.3.3) and school-related problems (174-176). When associations between ADP and school-related problems are explored, it is therefore important to evaluate whether or not these associations are unique to the individuals with ADP, or rather that this risk may be attributed to shared vulnerability factors, such as co-occurring mental health problems. Throughout the analyses in the present thesis potential confounding is accounted for – including mental health problems, SES, gender and age – in the associations which are explored in the different papers.

Third, mental health problems may either constitute a shared vulnerability factor for ADP, or the risk for development of ADP may be better attributed to particular sub-types of mental health problems. Specifically, it is possible that symptoms of externalizing and internalizing problems in childhood are shared vulnerability factors for future development of ADP, or that only one of these types of mental health problems drives an increased risk for ADP. Similarly, it is possible for psychiatric diagnoses during adolescence are shared vulnerability factors for co-occurring ADP, or that only specific sub-types of psychiatric diagnoses are involved in increased risk for ADP.

In the present thesis, it is acknowledged that ADP must be understood in the context of a life-course social epidemiological perspective, in which associations between mental health problems and ADP are a main analytic focus. Associations between ADP and school-related problems will be investigated, accounting for the potential shared vulnerability driven by mental health and demographical factors. The externalizing and internalizing pathway towards ADP will be specifically investigated, along with an examination of psychiatric diagnoses preceding the development of ADP during adolescence.

1.3 Main topics

In the following sections I will present the main topics of the present thesis in more detail, highlighting particular knowledge gaps in current literature.

1.3.1 ADP and school-related problems

Adolescents succeeding in school, in terms of grade achievement, attendance, socioemotional health and well-being, may have a good foundation for the further transitions into early adulthood (177, 178). Education is highly correlated with both income and occupation, as well as with health-related behaviors and illness in adult life (179-181). School success may be influenced by a range of educational factors, such as intelligence and learning skills (182), effort and time spent on studies (183), self-determination (184), and general qualities of the school (185). However, the prospects of succeeding at school may also potentially be hampered by non-educational factors such as mental health problems (174-176, 186) and ADP (28, 187). Specifically, previous research has reported that ADP is associated with a range of long-term adverse school-related outcomes, such as lower high school graduation rates (188-191), lower post-secondary educational credentials (187), and higher drop-out rates from school (192-194).

More intermediate measures of school-related problems, such as poor grade achievement and low rates of school attendance, may also be relevant indicators for school-related problems. Both poor grade achievement (195) and low school attendance (185) are associated with increased risk for school dropout. Low attendance is also linked with disengagement from school (97, 98), which in turn is an influential factor for a range of adverse long-term outcomes such as dropout, delinquency and ADP during adolescence and early adulthood (196). Of note, several studies have demonstrated that ADP are related to lower self-reported attendance rates (97-101) and lower self-reported grade achievement (197-200), while other contributions report

weak or non-significant associations between alcohol use and self-reported grades (194, 201) and registry-based grades (202). Hence, the literature is not conclusive to whether ADP should be regarded as an important factor for poor grade achievement and high school-absence or not.

Furthermore, ADP is prevalent among adolescents with symptoms of common mental health problems, such as depression, anxiety, and hyperactivity/inattention (36, 203). As both externalizing and internalizing mental health problems are demonstrated as influential factors in relation to both ADP (see section 1.3.2 and 1.3.3) and to negative school-related outcomes (174-176) it may be difficult to disentangle the unique contribution from ADP on school-related problems. Therefore, in order to highlight whether associations between ADP and school-related problems is a matter of shared vulnerability from mental health problems, or represent an independent association, it is a pronounced need to account for mental health problems in analyses of associations between ADP and school-related problems.

The present thesis aims to explore associations between ADP and school-related problems focusing on several knowledge gaps in previous literature. First, the extent to which ADP is associated with negative school-related outcomes may be influenced by the conceptualization of alcohol/drug use. Alcohol use is prevalent among adolescents (e.g. 204), while only a minority of the adolescent drinkers develop more adverse ADP (e.g. 205). Nevertheless, most previous studies have used single measures of alcohol or drug use – such as either binge drinking, high-level alcohol consumption, heavy drinking, or illicit drug use – and have not attempted to account for how ADP with increasing adversity across relate to school-related problems. The present thesis

include an ordinal variable which sum up indicators for ADP, enabling the possibility to investigate how increasing number of indicators of ADP are associated with poor grades and low school attendance.

Second, previous studies on associations between ADP and grade achievement and school attendance have relied on self-reported measures of school functioning with only a few exceptions (e.g. 202, 206). A study by Balsa and colleagues (202) demonstrated that self-reported grades among adolescents with a present alcohol consumption are subject to bias, and also that the bias differs by gender. Specifically, boys tended to report deflated grades, while girls tended to reported inflated grades. Therefore, studies employing registry-based information are needed in the investigation on how ADP is associated with school-related problems. In the present thesis registry-based data on school grades and attendance will be applied.

Third, associations between ADP and school-related problems may be linked to socioeconomic status (SES), gender and mental health problems in complex ways (207). ADP and mental health are closely related phenomena (see section 1.3.2 and 1.3.3), while mental health problems are also linked with school-related problems (174-176, 186). Similarly, SES have a robust impact on both academic achievement (208) and rates of ADP (209), while gender differences are found in relation to both grade achievement (210) and rates of ADP (see section 1.1.2.2). Hence, both mental health problems, SES and gender all have the potential to confound associations between ADP and school-related problems, something which needs to be addressed. However, few studies have included mental health problems, SES and gender in analyses of associations between ADP and grade achievement and school attendance

(198, 200). The present thesis expands on this by including a range of internalizing/externalizing mental health problems as potential confounders. This enables an investigation of the extent to which observed associations between ADP and poor grades/high school absence merely should be regarded as an expression of influences from internalizing and/or externalizing symptoms. In addition, SES and gender are included in the analyses, and thus shed light on the extent to which observed associations between ADP and school-related problems are expressions of socioeconomic factors or gender on school outcomes.

Fourth, some previous studies have demonstrated that ADP is associated with low grades and high school absence (e.g. 99, 202). However, the effect sizes are often small, and it may be difficult to interpret whether the findings on lower school-related functioning should be regarded as indicators of school-related problems. In the present thesis school-related problems are defined as particularly low levels of grade achievement and particularly high levels of school absence. In this respect, the present thesis provides new knowledge with regard to how ADP is associated with short-term significant school-related problems.

1.3.2 Childhood mental health problems and adolescent ADP

As previously noted, mental health problems with an externalizing character – including symptoms such as deviancy, conduct problems and hyperactivity/inattention – are demonstrated to be potent risk factors throughout childhood and adolescence for adolescent ADP (e.g. 211, 212-215). On the other hand, it is more ambiguous to what

extent internalizing problems in childhood and throughout adolescence is associated with increased risk for adolescent ADP (e.g. 145, 216). As internalizing and externalizing symptoms often co-exist in childhood and adolescence (217, 218), it is likely that such high rates of comorbidity may obscure the unique associations between internalizing symptoms and ADP (140). Theoretical contributions have therefore recommended that developmental models of internalizing symptoms and ADP should also consider externalizing symptoms (145, 219). Although the majority of previous studies do not adhere to this recommendation (140), a growing body of research has emerged in recent years that also account for co-occurring externalizing symptoms in associations between internalizing problems and ADP (for a review, see 145).

Externalizing problems in absence of internalizing problems were in one recent study, conducted by Colder and colleagues (216), strongly associated with ADP during early adolescence (12-16 years). For combined externalizing/internalizing problems, a weak but statistically significant positive association with ADP was found. Finally, internalizing problems absent of externalizing problems was associated with lower risk for ADP. The authors stress that the failure to address co-occurring externalizing/internalizing problems is an important limitation within much of the previous research on development of ADP. In the present thesis, efforts are made to analyze internalizing problems in context of potentially co-occurring externalizing problems and vice versa, hence adhering to recent recommendations.

Furthermore, different internalizing symptoms may potentially be important in either 'risk/vulnerability' (e.g. 162, 163, 164) or 'protective' mechanisms (e.g. 216,

220, 221) towards engagement in alcohol/drug-related behaviors. Nevertheless, previous empirical work on internalizing problems and adolescent ADP often apply generalized measures of internalizing problems, and therefore fail to address the potential that different sub-types of internalizing problems may differentially affect the risk for subsequent ADP. The broader self-medication hypothesis highlight that extensive use of alcohol/drugs may be used as a means of regulating difficult emotional states (222), and particularly negative affect has been proposed as an important feature of internalizing problems that may heighten risk for hazardous alcohol/drug involvement (140, 145). However, more studies are needed to investigate to what extent negative affect is actually linked to increased risk for adolescent ADP. On the other hand, internalizing tendencies toward social withdrawal and fear of negative consequences are aspects suggested to decrease risk for exposure to alcohol/drug use (140, 156, 157). This notion is compliant with the observation that adolescent alcohol/drug use is often socially influenced by for example relations with deviant peers (130), or by spending time with peers unsupervised by parents (84). Due to the possible conflicting ‘risk’ and ‘protective’ influences related to internalizing symptomatology, an evaluation of sub-types of internalizing problems may be a promising approach. The present thesis contributes to a better understanding of the internalizing pathway toward ADP by investigating different aspects of internalizing problems, such as peer/relationship problems and general emotional problems.

1.3.3 Mental disorders and ADP during adolescence

Mental health problems have a high prevalence among children and adolescents, with an estimated one in five fulfilling criteria for a psychiatric diagnosis (112, 223-225), and one in four of the adolescents with a psychiatric diagnosis have also at least one additional psychiatric diagnosis (173), suggesting that psychiatric comorbidity is common. Furthermore, psychiatric diagnoses are even more frequent among adolescents with ADP, and previous studies have estimated that between 37 to 80% of these adolescents has at least one psychiatric disorder (29, 226, 227). Similarly, one third of the adolescents within a psychiatric inpatient setting fulfilled criteria for a substance use disorder (SUD) (228), further highlighting the large comorbidity between psychiatric diagnoses and ADP during adolescence. Mental health problems that are present in adolescence may be particularly important for the development of ADP, due to its proximity in time to a normative increase in alcohol/drug use throughout the teenage years (see section 1.1.1.2). Also, many psychiatric disorders debut during adolescence (113), highlighting the need for a specific investigation into associations between psychiatric diagnoses present during adolescent and co-occurring ADP.

In previous research it is established that psychiatric diagnoses and ADP are interconnected phenomena during adolescence, and both internalizing and externalizing mental disorders have been reported to heighten the risk for adolescent ADP. Specifically, internalizing psychiatric diagnoses such as anxiety (163, 229), depression (152, 211, 230), eating disorders (231, 232), psychotic disorders (233, 234), and post-traumatic stress disorders (152, 154) have been reported to increase risk for

ADP. However, it should also be noted that the internalizing pathway to ADP is hampered by inconsistent results (see section 1.3.2), while at the externalizing spectrum, both attention-deficit/hyperactivity disorders/ADHD (235, 236) and conduct disorders (237) have been more consistently reported to be risk factors for ADP.

However, some previous studies have suggested that the predictive value on ADP stemming from different psychiatric diagnoses differ across psychiatric diagnoses, also at the externalizing spectrum. For example, a review concluded that ADHD does not increase the risk of illicit drug use beyond the effect of conduct-related disorders (238). In other words, it was highlighted that the often observed association between ADHD and ADP may be explained by comorbidity with conduct disorders. Similarly, a study reported that having an anxiety disorder alone or depression alone did not predict ADP, while either having comorbid anxiety and depression, or having anxiety or depression and a comorbid conduct-related disorder, were both associated with co-occurring ADP (239). These findings underscore the need to evaluate comorbid psychiatric diagnoses in the study of associations between a broad range of psychiatric diagnoses and ADP.

Despite a considerable evidence base that links adolescent mental disorders with ADP, most previous studies have been limited to investigating single psychiatric problems or disorders and ADP, while very few studies have investigated the full range of common psychiatric diagnoses. A notable exception is a recent, cross-sectional Norwegian study (240) that reported illicit drug use to be four times higher among adolescents receiving psychiatric services compared to the general population. Further, it was reported that depression was the diagnosis with the highest frequencies

of alcohol and drug use, while autism had the lowest (240). However, participation in the clinical group was low and psychiatric comorbidity was not investigated. Some other studies have also applied a broader range of psychiatric diagnoses and their associations with ADP. A study by Wu and colleagues (241) explored comorbidity between a range of psychiatric diagnoses and substance use disorders (SUDs); however, their analyses were limited to associations between gender, ethnicity, and inpatient versus outpatient attenders on ADP, and no comparisons were made between diagnostic groups. A study by Boys and colleagues (242) also applied information on a broad range of psychiatric diagnoses and their associations with ADP, but a small sample did not allow differentiation between separate disorders.

Therefore, there are still considerable knowledge gaps in relation to which psychiatric diagnoses that are associated with the highest risk for ADP among adolescents. This thesis aims to explore how a broad range of psychiatric diagnoses are associated with adolescent ADP. This investigation may help to clarify whether associations between psychiatric diagnoses and ADP are best characterized as a function of shared vulnerability due to general mental distress, as would be a viable interpretation if a broad range of mental disorders were all positively associated with ADP with comparable strength. Alternatively, associations between psychiatric diagnoses and ADP could be better explained by potentially unique psychological mechanisms, as would be a possible interpretation if some mental disorders are clearly stronger positively associated with ADP compared with other diagnoses. Such findings would also add to the literature on how respectively externalizing and internalizing mechanisms contribute to adolescent ADP.

The present thesis aims to take comorbidity between different psychiatric diagnoses into account in the analyses. This is important in order to further disentangle the unique contribution from specific mental disorders on ADP, avoiding the potential blending of influences from separate psychiatric diagnoses on the observed associations. Similarly, associations between specific psychiatric diagnoses and ADP may differ across gender, age and socioeconomic status (SES), and these factors may also be important to account for when analyzing how a broad range of psychiatric diagnoses are associated with ADP.

1.4 Aims, research questions and hypotheses

The overall aim of this thesis is to contribute to a better understanding of ADP during adolescence, and how mental health problems relate to these problems. In order to achieve this aim a quantitative, epidemiological investigation is conducted of ADP in relation to school-related problems, childhood mental health problems, and psychiatric diagnoses during adolescence.

The thesis has three main research questions:

1. How is ADP associated with school-related problems and to what extent are these associations independent from the potential confounding effects of gender, age, SES and mental health problems?
2. How are childhood externalizing and internalizing problems associated with ADP during adolescence; how does the adjustment of the potential confounding

effects from SES, gender, age and co-occurring externalizing/internalizing problems in childhood affect these longitudinal associations; and how are subscales of childhood externalizing/internalizing problems associated with adolescent ADP?

3. Which psychiatric diagnoses precede ADP among adolescents that have used specialist mental health care during the past four years, and to what extent are these associations independent from the potential confounding effects from SES, gender, age and psychiatric comorbidity?

2. Methods

2.1 Data collection

To answer the particular research question of this thesis data from the youth@hordaland survey (Paper 1, 2 and 3) and the Bergen Child Study (BCS) (Paper 2) is applied. Additionally, linkages are utilized between the youth@hordaland sample and the school registry for upper secondary school in the country of Hordaland (Paper 1) and the Norwegian Patient Registry (NPR) (Paper 3).

2.1.1 The youth@hordaland survey

The youth@hordaland survey was conducted by Uni Research Health in collaboration with Hordaland County Council (Hordaland Fylkeskommune). The survey provided data on demographics, mental and physical health, use of health services, socioeconomic status, alcohol- and drug use, and more. It was carried out during early 2012, and all adolescents born between 1993 and 1995 (aged 16 to 19 years) living in Hordaland County in western Norway were invited to participate (N=19,430). Overall, Hordaland County is considered representative of Norway on both the distribution of gender and rural/urban residence, and the median household income is also similar to that of the national average (243).

The adolescents which at the time of the survey was attending upper secondary school, received information per email and one school hour was used to complete the questionnaires at school. A teacher was present during the data collection to ensure

confidentiality. In addition, the survey staff was available by phone to answer teachers or students questions in relation to the survey. Adolescents not going to school received the questionnaires by mail at their home address, and also mental health services and other institutions were contacted to let adolescents from these settings participate. All emails and text messages were sent to the adolescents and their parents by the County Council. The questionnaires used in the youth@hordaland survey were web-based, and electronic informed consent was obtained from all participants prior to the inclusion in the study. Of the 19,430 individuals comprising the target population, a total of 10,253 adolescents chose to participate, giving a participant rate of 53%.

In accordance with the regulations from the REC and Norwegian health authorities, adolescents aged 16 years and older can make decisions regarding their own health (including participation in research), and thus gave consent themselves to participate in the current study. Parents/guardians have the right to be informed, and in the current study, all parents/guardians received written information about the study in advance.

2.1.2 The Bergen Child Study (BCS)

The BCS was conducted by Uni Research Health in collaboration with the municipality of Bergen. The BCS is a longitudinal total population study which followed up a cohort of children born between 1993 and 1995 in all public and private schools in the city of Bergen, and the fourth wave of the BCS was nested within the youth@hordaland survey. Bergen is the second largest city of Norway, with a total population of around 235,000. The BCS survey collected data from parents, teachers

and by self-report, and the protocol for the study is well described in previous publications (e.g. 244). For more information about the BCS and related publications see uni.no/en/bergen-child-study. The recruitment for the BCS was carried out at school level. All 79 primary schools in Bergen took part in the study, including 68 ordinary public schools, in addition to four special education public schools and seven private schools (244). The special education schools included only children with mental retardation, while private schools included various religious or ideological orientations, and one international school in which the teaching language was English (244).

In total, the BCS included four consecutive waves. The first wave was carried out during autumn 2002 and had a target population of 9,430 primary school children aged 7–9 years. Informed consent to participate was received from 7,007 (74%) of the parents prior to the inclusion in the study. The second wave of the BCS was conducted four years later during spring 2006, and 5,683 children aged 11–13 years of age participated (60% of original target population). Two years later a third wave was conducted at a time when the children were 13 to 15 years of age; however, a very low response rate (18%) precluded the use of the third wave, and data from this wave is therefore not used in the present thesis. During the winter/spring of 2012, when the adolescents were 16–19 years of age they were again asked to participate, as the fourth wave of the BCS was nested within the youth@hordaland survey (see section 2.1.1).

2.1.3 Registry-based data

The present thesis applies data from two additional registries: The official school registry for students in upper secondary school in Hordaland County (Paper 1), and the national patient registry (NPR) (Paper 3). Data from these registries was merged with the youth@hordaland survey for individuals that had provided an informed consent to the use of data from these registries. Among the 10,253 individuals aged 16 to 19 years included in the full youth@hordaland survey, 9,408 (91.8%) individuals gave their consent to use data from national registries. Additionally, specific consent to the use of school-registry data was asked for, and a total of 9,569 (93.3%) of the youth@hordaland sample consented to the use of this register.

2.1.3.1 The school registry

The official school registry in Hordaland County collects data on all students which is registered at upper secondary schools in the County, which includes both vocational and general studies. Data were provided by the Hordaland County Council and was merged with the main dataset from the youth@hordaland, something that was made possible through the personal identification number. This merged dataset was used in the study presented in this thesis (Paper 1). The school registry provided data on academic grades and days and hours missed from school for the adolescents in upper secondary school. The data on school grades included achieved grades from past semester, while data on attendance rates included each individuals' registered days and hours missed from school during the past semester.

2.1.3.2 The national patient registry

The National Patient Registry (NPR) is the official national registry in Norway on specialist mental health care services and is owned by the Norwegian Health Ministry (245). The NPR includes information on all patients that is either waiting for or having received services from the specialist health care services in Norway. One of the purposes of NPR is to facilitate research which can contribute to a greater knowledge regarding the use of health care services, treatment effects, diagnoses and type of interventions (246). It is indicated that the validity is high for most, but not all, types of somatic and psychiatric diagnoses in the Swedish national patient registry (247). A recent Norwegian study concluded that clinical diagnoses of schizophrenia and bipolar disorder in the NPR were accurate and consistent, as validated by research-based structural diagnostic interviews (248), supporting similar findings from other Nordic countries (249, 250). However, the quality of psychiatric diagnoses registered in the NPR remain currently unknown (248), something which is an important area for future investigations.

A dataset from the NPR was made available from the Norwegian Health Ministry and was merged with the youth@hordaland survey. This merged dataset was used in the study which is presented in this thesis (Paper 3). The NPR provided data on specialist mental health care use from January 2008 to December 2011, at a time when the adolescents born between 1993 and 1995 were in the age span from 12 to 18 years of age, and before youth@hordaland participation. The NPR included data from different levels of specialist mental health care services, including both traditional

consultations at the mental health care clinics, outpatient visits from professionals at home, and inpatient hospital admissions.

In Norway the tenth version of the International Classification of Diseases (ICD-10) is the diagnostic manual which is adhered to within specialist mental health care (52). NPR data included frequency and amount of contact with the specialist mental health care, Axis 1 psychiatric diagnoses, general impairment levels (CGAS), referral information, and more. Psychiatric diagnostic evaluations were made by professional mental health practitioners, and were based on clinical interviews with children/adolescents, parents and teachers, observations and psychological tests. All diagnoses were registered in the NPR with ICD-10 codes (see Appendix). Due to the relatively small sample of adolescents receiving specialist mental health care, all psychiatric diagnoses were categorized into a set of broader diagnostic categories (for details, see section 2.3.3).

2.2 Measures

2.2.1 Potential ADP

Self-reported measures of alcohol- and illicit drug use were collected during the youth@hordaland survey, and were used as explanatory variables (Paper 1) and outcome variables (Paper 2 and 3). The following estimates on alcohol/drug use are based on the full youth@hordaland sample (n=10,253).

2.2.1.1 Single measures of potential ADP

Ever tried alcohol: A dichotomous variable was based on the single item ‘Have you ever tried alcohol?’ (Yes/No). In the youth@hordaland sample a total of 7,525 (77.3%) of the adolescents reported having tried alcohol.

Ever tried illicit drugs: Another dichotomous variable was based on a single item ‘Have you ever tried hash, marijuana or other narcotic substances?’ (Yes/No). In the youth@hordaland sample a total of 999 (10.3%) of the adolescents reported having tried illicit drugs.

High-level alcohol consumption: Items measuring self-reported glasses of beer, cider, wine, spirits and illegally distilled spirits usually consumed during 14 days were added up. 5,474 (53.4%) individuals in the sample reported any usual alcohol consumption. The high-level alcohol consumption variable was defined as the above 90th gender-specific percentile alcohol consumption among the adolescents with any usual alcohol consumption, and a dichotomous variable was created for high-level alcohol consumption. In the youth@hordaland sample, 560 (5.5%) adolescents reported high-level alcohol consumption, comprising 10.2% of those with any usual alcohol consumption. For the purpose of secondary analyses, an ordinal gender-specific variable of alcohol consumption was also constructed, including the following ordinal levels: ‘never consumed alcohol’, ‘no present consumption of alcohol’, ‘0.1 to 19.9th percentile’, ‘20 to 49.9th percentile’, ‘50 to 79.9th percentile’, ‘80 to 89.9th percentile’, and ‘90 to 100th percentile alcohol consumption’ (36).

Frequent alcohol intoxication: Frequency of alcohol intoxication was measured based on the question: ‘Have you ever consumed so much alcohol that you were clearly intoxicated (drunk)?’ The original item had five categories ranging from ‘No, never’ to ‘Yes, more than 10 times’. Frequent alcohol intoxication was defined as drinking so much that one was clearly intoxicated more than 10 times (36), and on this basis a dichotomous variable was created. In the youth@hordaland sample 1,936 (18.9%) of the adolescents reported frequent alcohol intoxication.

A positive CRAFFT score: An additional measure for potential alcohol and drug-related problems were constructed on the basis of the six-item, validated scale CRAFFT. This scale has been designed to identify possible alcohol-and drug related problems among adolescents, and has been demonstrated to have acceptable sensitivity and specificity at a cut-off of ≥ 2 (251), and it has been found to have a good concurrent validity in a population-based sample of adolescents (252). In addition, confirmatory factor analyses in the youth@hordaland-survey indicated a reasonably good fit for a single latent construct (alcohol/drug-related problems) for the whole sample χ^2 (df 8) = 288.14, $p < 0.0001$, CFI = 0.97, RMSEA = 0.060. The conclusion was that there is good support for the factorial and construct validity of CRAFFT. A dichotomous variable separating those above the cut-off of ≥ 2 on CRAFFT from those below the cut-off were calculated. In the youth@hordaland sample 2,062 (21.2%) of the adolescents reported a positive CRAFFT score. The Cronbach’s alpha for the CRAFFT scale was 0.67 in the youth@hordaland sample, while the omega internal consistency coefficient was 0.88.

2.2.1.2 Increasing levels of indicators on APD

In order to provide a dimensional variable of ADP, an ordinal variable was constructed which summed up dichotomous scores on frequent alcohol intoxication (0/1), high-level alcohol consumption (0/1), a positive CRAFFT-score (0/1), and having tried illicit drugs (0/1). This ordinal variable divided adolescents to five groups, spanning from 0 to 4 of the selected indicators for ADP. In the youth@hordaland sample 5,821 (64.3%) reported none, 1,719 (19.0%) reported one, 926 (10.2%) reported two, 487 (5.4%) reported three, and 107 (1.2%) reported four of these potential indicators of ADP. This variable will be referred to as *increasing levels of indicators on APD* in the present thesis.

2.2.2 Mental health problems

Mental health problems were collected by adolescent self-report (Paper 1), by parent and teacher report during childhood (Paper 2), and finally as formal psychiatric diagnoses registered in the NPR during adolescence (Paper 3). In addition, self-reported mental health symptoms were used to investigate differences between adolescents from the youth@hordaland-survey that consented to the linkage with the NPR compared with those that refused to consent (Paper 3).

2.2.2.1 Self-reported symptoms of adolescent mental health problems

Self-reported symptoms on mental health problems during adolescence were measured in the youth@hordaland survey (see section 2.1.1), and included symptoms of depression, anxiety, ADHD, and conduct problems. These measures were applied as

control variables in the cross-sectional sample (n=7,874) with merged data between the youth@hordaland and the school-registry (Paper 1).

Symptoms of *depression* was measured using the short version of the Mood and Feelings Questionnaire (SMFQ) (253). The SMFQ consist of 13 items assessing depressive symptoms rated on a 3-point scale, ranging from ‘Not true’, ‘Sometimes true’ and ‘True’. A continuous measure of the SMFQ has been validated among Norwegian adolescents (254), supporting its use in population-based samples.

Symptoms of *anxiety* were assessed by using the five-item inventory SCARED, which is a short form of the 41-item full version screening inventory for anxiety disorders (255). Its usefulness as a screening instrument for anxiety have been demonstrated in both clinical (255, 256) and population based samples (257) of adolescents.

Symptoms of *inattention and hyperactivity* were identified using an official Norwegian translation of the Adult ADHD Self-report Scale (ASRS) (258). This is an 18-item self-report scale, consisting of nine items that measure symptoms of inattention, and nine items that measure symptoms of hyperactivity/impulsivity, and in which responses are given on a 5-point scale ranging from ‘Never’ to ‘Very often’. The ASRS scale is evaluated as a reliable self-reporting rating scale for symptoms of attention-deficit/hyperactivity disorder (ADHD) for both adolescents and adults (259).

Symptoms of *conduct problems* were measured using the Youth Conduct Disorder (YCD) instrument. This scale consist of 8 items which are part of the Diagnostic Interview Schedule for Children Predictive Scales (DPS) (260). The DPS scale has

been shown to accurately determine adolescents who are at high probability of meeting diagnostic criteria for conduct disorder (260).

2.2.2.2 Parent- and teacher reported externalizing and internalizing problems during childhood

Childhood externalizing and internalizing problems was measured in the BCS (see section 2.1.2) with the Strengths and Difficulties Questionnaire (SDQ) scale (261), and was completed separately by parents and teachers at T1 and T2 of the BCS.

Externalizing/internalizing problems were applied as explanatory variables in the longitudinal sample (n=2,438) of paper 2.

The SDQ is a screening questionnaire for children and adolescents aged 4–16 years of age, consisting of 25 items which describe positive and negative characteristics of children within five subscales: (1) emotional problems (2) conduct problems (3) hyperactivity-inattention problems (4) peer/relationship problem and (5) pro-social behavior (not used in this thesis). Each item is scored on a three-point scale; not true, somewhat true, and certainly true, with total subscale scores each ranging from 0 to 10. An externalizing problems scale is constructed by merging the subscales of conduct problems and hyperactivity-inattention problems, an internalizing problems scale is constructed by merging the subscales of emotional problems and peer/relationship problems, and a total problem score is constructed by merging the subscales of emotional, conduct problems, hyperactivity-inattention, and peer/relationship problems scale (262).

The SDQ has been validated in various countries (244, 263, 264), and a recent review found that the psychometric properties of the SDQ are strong and recommended its use as a screening instrument (265). Importantly, the use of broader internalizing and externalizing scales from the SDQ is found to be acceptable in low-risk samples (124), has a good fit with the included subscales (266), and is relatively ‘uncontaminated’ by each other (125). Additionally, the prosocial scale have low correlation with the other four subscales (262, 266), and is related to skills that are not conceptually restricted to neither externalizing nor internalizing problems (262), supporting its exclusion from the analyses of the present thesis.

In the present thesis, an externalizing problems scale was constructed by merging the subscales of conduct problems and hyperactivity-inattention problems, while an internalizing problems scale was constructed by merging the subscales of emotional problems and peer/relationship problems. The responses from teachers and parents from T1 and T2 were summed to single, continuous variables. Moderate correlations between parent and teacher reports were found for both the externalizing problems scale ($R=0.51$) and the internalizing problems scale ($R=0.47$), which were evaluated as acceptable. The Cronbach’s α of the SDQ scales ranged from 0.81 to 0.85 in the longitudinal BCS sample ($n=2,438$).

A single, continuous *externalizing* problems variable was constructed, including 2,263 individuals (55.5% girls). Of note, the number of individuals in this variable were somewhat lower than the full sample of 2,438 subject as only individuals with valid reports on externalizing problems at both T1 and T2 were included in the variable. Externalizing problems ranged from 0 to 57 ($M=9.72$, $SD=7.86$). For the

purpose of secondary analyses, separate subscales were also constructed for conduct problems (M=2.26, SD=2.75) and hyperactivity/inattention (M=7.47, SD=5.91).

Similarly, a single, continuous *internalizing* problems variable was constructed, including 2,266 individuals (55.4% girls), in which only individuals with valid responses on internalizing problems at both T1 and T2 were included. Internalizing problems ranged from 0 to 53 (M=6.02, SD=6.58). For the purpose of secondary analyses, it was also constructed a subscale for emotional problems (M=3.23, SD=3.86) and peer/relationship problems (M=2.79, SD=3.71).

2.2.2.3 Formal Axis 1 psychiatric diagnoses during adolescence

Psychiatric diagnoses given within specialist mental health care were retrieved from the NPR (see section 2.1.3.2) and were applied as explanatory variables in the follow-up sample (n=9,408) with merged data between the youth@hordaland survey and the NPR (Paper 3). As noted, 853 adolescents had received specialist mental health care during the past four years. A total of 103 Axis I diagnostic codes were detected (including F- and R-codes), as well as the codes for 1-000 (“No proven diagnosis on Axis I”) and 1-999 (“Not sufficient information to code on Axis 1”). All these diagnostic and administrative codes adhered to the ICD-10 diagnostic manual (52).

The variables for *psychiatric diagnoses* were constructed on the basis of the full range of ICD-10 codes available in the NPR dataset, in which all the codes mentioned above were assigned to a simple set of broader diagnostic categories, including (1) anxiety (n=132); (2) depression (n=172); (3) conduct disorders (n=32); (4) attention-

deficit/hyperactivity disorder (ADHD, n=154); (5) autism spectrum disorders (n=46); (6) eating disorders (n=40); (7) trauma-related disorders (n=66); (8) psychotic disorders (n=10); (9) other diagnoses (n=84); (10) and no diagnosis (n=329). The operationalization of the diagnostic categories used in the paper is summarized in the Appendix. Of note, none of the adolescents in the NPR were registered with any substance or alcohol-related diagnoses.

Psychiatric comorbidity was operationalized as having a valid registration of an Axis I-psychiatric diagnosis in addition to having at least one psychiatric diagnosis from a different diagnostic category. Among the 524 adolescents with a psychiatric diagnosis, 133 individuals (25.4%) had at least one comorbid psychiatric diagnosis. Psychiatric comorbidity rates spanned from 28.8% among individuals with trauma-related disorders to 70.0% among those with a psychotic disorder.

2.2.3 School-related problems

School-related problems were used as our main outcome measures in Paper 1, and included low school grades, high number of days missed from school, and high number of hours missed from school. The data was retrieved from the official school registry for upper secondary schools in the county of Hordaland, Norway (see section 2.1.3.1).

2.2.3.1 Low school grades

In Norway, secondary schools use a scale running from 1 to 6, with 6 being the highest grade (outstanding competence), 2 being the lowest passing grade (low level of

competence), and a 1 is a “fail” (no qualified competence). The grade point average (GPA) was calculated as the average of the student's grades during their time at the school. Mean combined GPA in the sample was 3.85 (standard deviation 0.80). Based on the continuous distribution of GPA in the sample, GPA was dichotomized under/above the 10th gender-specific percentile, constructing a variable indicating low GPA for adolescents scoring below this threshold. 859 (10.9%) of the adolescents of the sample had a low GPA.

2.2.3.2 High number of days and hours missed from school

Official registry-based data on attendance rates were also provided by official registry data from the Hordaland County, and they included both days and school hours of absence for the last semester (6 months). The mean number of days missed in the sample was 4.02 (standard deviation 5.04), while the mean number of hours missed was 7.51 (standard deviation 11.10). Based on the continuous distribution in the sample of respectively days and hours missed from school, two variables were constructed indicating high number of days and high number of hours missed from school for adolescents which were dichotomized under/above the 90th gender-specific levels of respectively number of days and hours they did not attend school. 721 (9.2%) of the adolescents in the sample had a high number of days missed, and 767 (9.7%) had a high number of hours missed from school.

2.2.4 Demographic measures in adolescence

All the demographic measures applied in this thesis were retrieved at a time when the individuals were adolescents, spanning from 16 to 19 years of age.

2.2.4.1 Age and gender

Age and gender on all participants were retrieved from the Norwegian Population Registry. These variables were used as potential confounding variables in all the three papers that comprise the present thesis.

2.2.4.2 Socioeconomic status (SES)

Several measures of self-reported socioeconomic status (SES) were collected, and included perceived family economy, maternal educational attainment, and paternal educational attainment. These variables have been used in a range of previous publications from the BCS and youth@hordaland (267, 268). *Perceived family economy* was reported as either ‘equal to others’, ‘better than others’, or ‘poorer than others’. A previous study revealed that family economy was a significant predictor of mental health problems (267). *Parental educational attainment* was also reported on both mother and father, and the responses were divided into only primary school, high school, or more than four years of University or higher education. The variables of perceived family economy and maternal and paternal educational attainment were all used as a measures of self-reported family SES, and were included as potential confounding variables in all three papers.

2.3 Study samples

Common for all the samples was that we employed data from the youth@hordaland survey, which had a total of 10,257 individuals, which were all were living in Hordaland and were born between 1993 and 1995. Among these, 4 individuals had not valid information on the age variable extracted from the personal identification number. In paper 1 all 10,257 adolescents were included. In paper 2 and 3 these four individuals were excluded and the total number of participants in the youth@hordaland survey was updated to 10,253, which is the number applied in this thesis. Due to different use of additional data sources in the three papers, the final study samples for each paper differed correspondingly, as further highlighted in the following sections.

2.3.1 Paper 1

In paper 1, aiming to explore associations between ADP and school-related problems, some individuals did not consent to use data from the school registry (n=682), while some individuals had missing information on either school registry data (n=1,190) or alcohol- and illicit drug use (n=511). Therefore, the final sample for this paper consisted of a total of 7,874 adolescents (76.8% of the full youth@hordaland sample). Compared with the excluded individuals from the full youth@hordaland sample, these individuals were somewhat younger, had higher maternal and paternal education attainment, and had more symptoms of depression and inattention/hyperactivity. However, effect sizes for these differences were consistently small (Cohens d's ranging from 0.06 to 0.16).

2.3.2 Paper 2

In paper 2, which explored longitudinal associations between childhood mental health problems and adolescent alcohol/drug use, only children born between 1993 and 1995 living in the city of Bergen were invited. The data stem from the first, second and fourth waves of the BCS (see section 2.1.2), while the third wave was excluded due to the low response rate (18%). For the ease of reading, the three included waves used in this paper are labeled T1, T2 and T3 in this thesis. The final study sample included only those that had valid parent or teacher responses on the Strengths and Difficulties Questionnaire (SDQ) at both T1 and T2, and which also had participated in the youth@hordaland survey (T3). Hence, the sample comprised a total of 2,438 individuals. Compared with the excluded individuals from the full youth@hordaland sample, the included adolescents comprised somewhat more girls ($d=0.07$, $p<0.01$), had higher parental educational attainment (d 's ranging from 0.29 to 0.35, $p<0.001$), had more often tried illicit drugs ($d=0.09$, $p<0.001$), and had lower mean levels of externalizing/internalizing problems (d 's ranging from 0.18 to 0.20, $p<0.001$). However, these effect sizes were overall small.

2.3.3 Paper 3

Om paper 3, which aimed to explore which psychiatric diagnoses that preceded alcohol/drug use, data from the youth@hordaland survey and the NPR was applied. Among the 10,253 individuals aged 16 to 19 years included in the full

youth@hordaland survey, 845 (8.2%) individuals did not consent to use data from national registries (see section 2.1.3). These individuals were therefore excluded, and the final sample included a total of 9,408 individuals. Compared with the full youth@hordaland sample, these non-included individuals were slightly older (17.6 versus 17.4 years, $p < 0.001$), had more frequently high-level alcohol consumption (8.5 % versus 5.9 %, $d = 0.11$, $p < 0.01$), and had more frequently symptoms of conduct problems (0.68 versus 0.54, $d = 0.11$, $p < 0.01$). Furthermore, out of the 9,408 individuals which comprised the sample for Paper 3, a total of 853 (9.1%) adolescents had at least one registration in NPR and therefore constituted the group of adolescents which had received specialist mental health care services during the last four years. Thus, these 853 adolescents will be referred to as the clinical sample.

2.4 Representativeness and generalizability

In the present thesis the target population is adolescents born in 1993 to 1995 living in Bergen (paper 2) and in Hordaland (paper 1 and 3), and an overarching aim is to shed light on development of ADP and how ADP is associated with mental health problems and school-related problems among adolescents. In order to generalize results drawn from a given study sample to a larger population, a range of considerations should be made.

First, the *representativeness* of the sample must be evaluated. In the process of inferring from a sample to the source from which it is drawn, it is a great aid to have a representative sample (63, 269). The present thesis apply data from a large

community-based sample of adolescents, and has a considerable strength in the high number of participants that have participated in the survey. However, this does not imply that the sample is *fully representative*. Regarding the representativeness of the BCS, a previous publication suggest that the participants in the first wave of the study (which included 74% of the full target population) had fewer mental health problems and tended to have a higher socio-economic status compared with non-participants (244). However, the effect size of these differences were reported to be small (244), suggesting that the representativeness of the sample may be acceptable. There are also some indications of selective drop-out throughout the waves of the BCS (270), something which may contribute to reducing the representativeness of the sample. Selective dropout is a well-known challenge in longitudinal cohort studies (271). However, while selective dropout is likely to affect prevalence rates of both mental health problems and alcohol/drug use, regression models is proposed to be only marginally affected by selective drop-out (271) as measures of associations tend to be less vulnerable than prevalence rates (244, 272). This notion was confirmed in the BCS (270), suggesting that selective drop-out in the BCS, and hence the sub-optimal representativeness, do not seriously affect the opportunities to calculate the associations of interest for this thesis.

Regarding representativeness of the youth@hordaland-survey, only a total of 53% of the target population (see section 2.1.1) participated in the survey, and no data are available from the non-responders. Therefore, it is difficult to evaluate how and to what extent the youth@hordaland sample differ from the adolescents which did not participate in the survey. All individuals in the target population was invited to

participate in the study, but the data collection was to a large extent located at an upper secondary school-setting, and individuals attending school are somewhat over-represented in the study. Therefore, it cannot be ruled out that non-participation may have resulted in a not fully representative sample. However, school-participation in Norway is generally high, therefore contributing to diminish this potential source of this selection bias. According to national, Norwegian statistics, a total of 92% of adolescents in the target age group was attending upper secondary school at the time (108), while the corresponding percentage in the included youth@hordaland sample was 98%. Also of note, due to the linkage with school-registry data (paper 1), and linkage with patient-registry data (paper 3), additional differences occur between the samples of this thesis and the youth@hordaland/BCS original samples (for details, see section 2.3). Despite these shortcomings, the generally high representativeness due to the application of population-based samples, comprise overall a strength of the present thesis.

Second, the *generalizability* of the findings should also be discussed.

Generalizability refer to the extent to which research findings can be considered to be relevant to the larger group (i.e. adolescents) that the findings are supposed to represent, and not only to the particular sample that were used in the study (273). Hence, whereas representativeness primarily relate to the ability to draw *statistical* inferences, generalizability is related to the possibilities to draw broader *scientific* inferences (269). In order to ensure a high generalizability, it is necessary to employ designs that allow meaningful analyses, and therefore that the particular studies are informed by both theory and previous empirical findings. For example, although a

sample is fairly representative of the population it is supposed to represent, findings of overall associations within the sample may not necessarily apply to every subgroup of the sample, but may constitute an ‘average effect’ from subgroups that potentially differ considerably in terms of the associations of interest (269). Therefore, generalizability may be increased when associations are investigated across relevant subgroups. The present thesis is informed by recent scientific literature in order to ensure research questions and statistical analytic strategies which promote a proper generalizability.

2.5 Statistical analyses

2.5.1 Descriptive statistics and representativeness analyses

All analyses of the present thesis were performed using STATA V.14.0 (274), with the exception that the omega internal consistency coefficient for the CRAFFT questionnaire was calculated in R (275). Descriptive analyses of the samples compared with the full youth@hordaland sample were applied using t-tests for mean group differences on explanatory, outcome and demographical variables across included versus non-included adolescents of the sample, along with Cohens d-tests for estimation of group differences by means. These differences are highlighted in section 2.3 above for each paper with respect to representativeness analyses. Additional descriptive analyses are described for paper 3 under section 3.3 in which differences between the clinical sample and the general population are described in terms of ADP outcomes.

2.5.2 Logistic regression analyses

In paper 1, logistic regression analyses were conducted for the associations between ADP and school-related problems. Adjusted models took into account the potential confounding effects from age, gender, and SES; as well as the potential confounding effects from age, gender, SES, and symptoms of mental health problems.

In paper 2, logistic regression analyses were conducted for the associations between externalizing/internalizing problems and ADP during adolescence. In adjusted analyses it was accounted for the potential confounding effects of externalizing problems on the association between internalizing problems and ADP, and the potential confounding effects from internalizing problems on the association between externalizing problems and ADP. It was also accounted for the additional potential confounding effects from gender, age and SES. Secondary analyses included unadjusted and adjusted associations between sub-scales of externalizing/internalizing problems and ADP.

In paper 3, logistic regression analyses were conducted on the associations between psychiatric diagnoses and ADP, while adjustments were made for the potential confounding effects from psychiatric comorbidity, and finally for the potential confounding effects from psychiatric comorbidity, SES, gender, and age.

2.6 Ethical considerations

Epidemiological questionnaire surveys are a widely used data collection method within social sciences (276), and provide an effective means of delivering the same

questions to a relatively large sample of persons. Although community based surveys provide a relatively non-intrusive research method, there are nevertheless important ethical considerations that should be undertaken (277, 278), including ethical issues relates to confidentiality and informed consent (279). Other considerations include the effort to ensure a high quality in the preparation and implementation of the survey, in the statistical analyses, and in the reporting of the results from studies that use data from the survey (279). Also, it is an ethical concern to provide relevant information and support during the conduction of the survey.

The present thesis has been informed by these ethical concerns. Formal ethical approval for the study was ensured prior to the conduction of the data collection or merging of datasets. The BCS was approved by the Regional Committee for Medical and Health Research Ethics in Western Norway (REK Vest), and permission to collect and store data was given by the Data Inspectorate in Norway. The youth@hordaland survey in general and the linkages with school-registry (2011/811/REK Vest) and the NPR (2012/1467/REK vest) was also approved by REK Vest. The Norwegian Health Ministry which administers the NPR also provided their approval for the use of the registry in linkage with the youth@hordaland.

Measures were taken to ensure the confidentiality of the participants of both the BCS and the youth@hordaland survey. The personal identification number of all participants was used along with an encryption key to link variables to a dummy identification number, ensuring a high quality of the dataset, and also hiding the personal identity of the participants from the datasets. Similarly, the personal

identification number was used to merge datasets properly, while keeping the participants anonymous for all researchers handling the data.

Informed consent was retrieved from all individuals participating in the study. According to Norwegian rules and regulations, it is possible for adolescents aged 16 years or older to give consent to participate in research studies, but parents should be informed. All parents received information on the BCS study prior to the inclusion in the data collection, while only adolescents that provided an informed, written consent prior to the data collection were included in the youth@hordaland survey. Additionally, the adolescents had the opportunity to provide consent to participation in the youth@hordaland survey only, or to also allow for the linkage of the survey with national registries in general or only to the school-registry.

In order to ensure a high scientific quality of the work, all papers of the present thesis have been done in collaboration between the PhD candidate and the co-authors of each particular paper. This collaboration has included all phases of the scientific process, including planning, preparation of data, conduction of the statistical analyses, interpretation of the analyses, and writing of the manuscripts. Furthermore, all papers have been submitted to well-known peer-reviewed journals, therefore contributing to a high quality throughout the scientific process.

Finally, in order to provide access to medical care, easy accessible information on mental health services was made available for the adolescents who participated in the youth@hordaland study. A direct phone number to the research staff was provided, by which they could call to receive more information. Also, personnel within school

health services were informed about the survey, and therefore enabled to be present for the adolescents by the time they answered the questionnaire.

2.7 Overview of the papers

To summarize: The first study in the current thesis is a cross-sectional study with the main aim to evaluate how ADP is associated with school-related problems, including low GPA and high number of days and hours missed from school. The data was retrieved from a linkage between the youth@hordaland survey and the official school-registry for upper secondary schools in Hordaland municipality.

The second study has a longitudinal design with the main aim to analyze the prospective associations between childhood externalizing and internalizing problems and ADP during adolescence. The data was from the first, second and fourth wave of the BCS, and the last wave of the BCS was nested within the youth@hordaland survey.

The third study is a follow-up study with the main aim to investigate which psychiatric diagnoses that precede ADP among individuals which have used specialist mental health care. The youth@hordaland survey was merged with data from the NPR, from which information on the adolescents' psychiatric diagnoses was retrieved.

3. Results

3.1 Paper 1. ADP and school-related problems

The final sample consisted of 7,874 participants from the youth@hordaland sample. Descriptive characteristics of the full youth@hordaland sample are described in section 2.2 in relation to the included variables. Also, as described in section 2.3.1, there were some differences between the included individuals of the final sample for this paper and the excluded individuals from the youth@hordaland on some of the variables; however, these differences were consistently small.

The results of logistic regression analyses clearly showed that adolescents with indications of ADP had more school-related problems than adolescents without these indications. All measures of alcohol/drug use (including ever tried alcohol, ever tried illicit drugs, high-level alcohol consumption, frequent alcohol intoxication, and a positive CRAFFT score) were associated (all $p < 0.001$) with low GPA (Odds ratios (OR) ranging from 1.82 to 2.21), high number of days missed from school (ORs ranging from 1.79 to 3.04) and high number of hours missed from school (ORs ranging 2.17 to 3.44). The strength of the estimates were somewhat reduced after adjusting for age, gender, SES, and mental health problems; however, all associations were still statistically significant (Adjusted odds ratios (AORs) ranging from 1.44 to 2.31, all $p < 0.05$).

The results of ordinal logistic regression analyses between increasing levels of indicators on APD and school-related problems showed consistently positive associations, in which adolescents with the highest number of indicators for ADP also

had higher odds for low GPA, high number of days missed from school, and high number of hours missed from school. Monotonous trends (all $p < 0.001$) were found in all these associations in both unadjusted and adjusted analyses.

Additionally, increasing ordinal levels of alcohol consumption were associated with higher odds for low GPA, high number of days missed from school, and high number of hours missed from school. All associations between ordinal levels of alcohol consumption and school-related problems showed statistically significant monotonous trends (all $p < 0.001$) in both the unadjusted and fully adjusted models.

3.2 Paper 2. Childhood externalizing/internalizing problems and adolescent ADP

The final sample consisted of 2,438 participants. Common for all the participants of the sample were that they participated in T1, T2 and T3 of the BCS. As outlined in section 2.3.2, there were some differences between the included individuals of the longitudinal sample for this paper and the excluded individuals from the youth@hordaland survey. These differences were from small to medium size, and importantly were small for all measures of alcohol/drug use and symptoms of youth self-reported externalizing/internalizing problems.

Externalizing problems were positively associated with illicit drug use, a positive CRAFFT score, and frequent alcohol intoxication (ORs ranging from 1.17 to 1.29, all $p < 0.01$), and with increasing levels of indicators on APD (OR=1.21, $p < 0.001$), in unadjusted analyses. In fully adjusted models (adjusting for SES, gender, age and

internalizing problems), externalizing problems were positively associated with all single measures of alcohol/drug use (AORs ranging from 1.24 to 1.40, all $p < 0.05$), as well as with increasing levels of indicators on APD (AOR=1.38, $p < 0.001$). Both subscales of externalizing problems, including SDQ conduct problems and SDQ hyperactivity/inattention, were for the most part positively associated with increasing levels of indicators on APD even in fully adjusted models (AORs ranging 1.19 to 1.23, all $p < 0.05$).

Internalizing problems were negatively associated with having tried alcohol and frequent alcohol intoxication (ORs ranging from 0.89 to 0.90, all $p < 0.05$) in unadjusted analyses. After adjusting for SES, gender, age and externalizing problems, internalizing problems were negatively associated with all single measures of alcohol/drug use (AORs ranging from 0.83 to 0.88, all $p < 0.05$). Furthermore, internalizing problems had a statistically significant association with increasing levels of indicators on APD in the fully adjusted model (AOR=0.84, $p = 0.001$). Finally, neither of the internalizing subscales were significantly associated with increasing levels of indicators on APD (p -values ranging from 0.15 to 0.67).

In secondary analyses, associations between externalizing/internalizing problems and ordinal levels of indicators for alcohol/drug use were analyzed stratified by gender. However, no substantial gender differences were found, as the same patterns of associations were evident across gender, with similar magnitude of associations.

3.3 Paper 3. Psychiatric diagnoses preceding adolescent ADP

The final sample comprised 9,408 individuals, which had all participated in the youth@hordaland survey and consented to the use of registry data, and the included individuals were similar to the full youth@hordaland sample with few exceptions (see section 2.3.3). Within the final sample, a total of 853 (9.1%) had at least one registration in NPR and therefore constituted *the clinical sample* of this paper, implying that these adolescents had received specialist mental health care services during the last four years. The other individuals of the sample (n=8,555) comprised *the general population*, implying that they had not received specialist mental health during the past four years.

Descriptive analyses applying t-tests revealed that individuals from the clinical sample had significantly (all $p < 0.05$) more girls ($d = 0.12$) and had lower self-reported SES (d 's ranging from 0.16 to 0.17) compared with the general population sample. Although individuals in the clinical sample were no more likely to having tried alcohol ($p = 0.57$), they reported more often frequent alcohol intoxication ($d = 0.09$, $p < 0.05$), high-level alcohol consumption ($d = 0.12$, $p = 0.01$), positive CRAFFT-scores ($d = 0.20$, $p < 0.001$), illicit drug use ($d = 0.29$, $p < 0.001$), and increasing levels of indicators on APD ($d = 0.27$, $p < 0.001$) compared with the general youth@hordaland population. Of note, these differences were of relatively small size (ranging from $d = 0.09$ – 0.29).

Logistic regression analyses were conducted for associations between psychiatric diagnoses and self-reported ADP. Anxiety, depression, conduct disorders, ADHD, eating disorders, and trauma-related disorders were all positively associated with at least some measure of potential ADP (ORs ranging from 1.60 to 4.76, all $p < 0.05$) in unadjusted analyses, while depression, conduct disorders and trauma-related disorders

were also positively associated with increasing levels of indicators on APD (ORs ranging from 1.92 to 2.82, all $p < 0.01$). When adjusting for potential confounding variables – including psychiatric comorbidity, SES, gender and age – both anxiety and ADHD were no longer positively associated with ADP. Depression, conduct disorders eating disorders, and trauma-related disorders were positively associated with at least some measure of potential ADP (AORs ranging from 1.60 to 4.70, all $p < 0.05$). Only trauma-related disorders were still positively associated with increasing levels of indicators on APD in adjusted models (AOR=2.53, $p < 0.01$).

Autism was negatively associated with frequent alcohol intoxication in both unadjusted (OR=0.30, $p < 0.05$) and fully adjusted models (AOR=0.22, $p < 0.05$). Adolescents from the clinical sample with no Axis 1-psychiatric diagnosis had positive associations in both unadjusted models with several single measures of potential ADP (ORs ranging from 1.51 to 1.74, all $p < 0.01$) and increasing levels of indicators on APD (OR=1.46, $p < 0.01$). After adjustment for SES, gender and age, there were still positive associations with both single ADP measures (AORs ranging from 1.74 to 1.86, all $p < 0.05$) and increasing levels of indicators on APD (AOR=1.50, $p < 0.01$).

4. Discussion

4.1 Summary of findings

The results of the present thesis suggest that adolescents with ADP experience more school-related problems than individuals without a problematic use of alcohol/drugs. Childhood externalizing problems show robust and consistent associations with adolescent ADP, while childhood internalizing problems is negatively associated with ADP after adjustment from co-occurring externalizing problems. A range of psychiatric diagnoses during adolescence are positively associated with ADP, while trauma-related disorders, conduct problems and depression showed the most robust associations. Importantly, adolescents with trauma-related disorders demonstrated as a particularly high-risk group for ADP among adolescents receiving specialist mental health care services.

4.2 Interpretation of findings

4.2.1 ADP and school-related problems

The aim of the first paper of the thesis was to investigate how ADP is associated with school-related problems and to what extent these associations are independent from the potential confounding effects of gender, age, SES and mental health problems. The results demonstrate that ADP were consistently and independently associated with school-related problems. In this respect, our study supports several previous studies which have reported that adolescent ADP are associated with lower academic

achievement (e.g. 197, 199, 200) and increased absence from school (e.g. 99, 101).

The results however contradict some recent studies which indicate that ADP should not be regarded as particularly important factors for school-related functioning (194, 201, 202).

It is important to consider possible reasons for these inconsistencies in previous results. First, earlier investigations that fail to demonstrate positive associations between ADP and school-related problems may have been tampered by the way school-related problems are measured. Previous investigations – with only a few exceptions (e.g. 202, 206) – have relied on self-reported data on school-related problems, something which potentially may flaw the conclusions. A recent study demonstrated that self-reported grades are highly vulnerable to bias, and that this bias also differed by gender (202). Balsa and colleagues therefore recommended that future investigations should give high priority to ensure non-biased data on school-related problems (202). The present thesis adheres to this recommendation, applying registry data on school-related problems, something which should be considered as a considerable strength compared with the majority of earlier studies.

Furthermore, some of the inconsistencies in the previous literature on how ADP is associated with school-related outcomes may be related to the failure in many previous studies to include potentially relevant confounding factors such as mental health problems, SES and gender (207). As some developmental models conceptualize ADP among adolescents as expressions of a broader tendency towards either internalizing problems or externalizing problems (e.g. 1), observed associations between ADP and school-related problems may therefore be hypothesized to merely be a marker of these

broader tendencies. In support of this notion, a study by Hemphill and colleagues (101) reported that most of the association between alcohol use and school grades and school attendance disappeared when a range of individual, family, peer and school-related confounders – including mental health problems – were accounted for.

Despite the inclusion of common mental health problems as potential confounding variables in the associations between ADP and school-related problems, the results of the present thesis consistently demonstrated positive associations between all measures of ADP and all measures of school-related problems, in both unadjusted and adjusted models. These findings suggest that ADP is an important factor for school-related problems among adolescents, and that the association between ADP and school-related problems could not be attributed to vulnerability factors which are shared across those with and without adolescent ADP. However, it should be noted that residual confounding due to non-observed third variables cannot be excluded, such as genetic factors, peer relationships, or adverse family characteristics, all of which could potentially affect both ADP and school-related problems. The potential influence of these factors on the association between ADP and school-related problems were however beyond the scope of this thesis.

The conceptualization of ADP may also play an important role. A previous study reported that binge drinking, but not alcohol use without bingeing, were associated with somewhat lower GPA (200), highlighting that the actual operationalization and measure of ADP may affect the extent to which positive associations are detected. It also raises the question on whether the association between ADP and school-related problems are specific to only certain patterns of alcohol/drug use. A previous study

reported a dose-response effect between cannabis use and results on standardized assessment test at age 16 (198), suggesting that dimensional aspects of ADP may be important to take into account. Nevertheless, no previous studies have investigated how increasing levels of indicators on APD or increasing levels of alcohol consumption correspond to negative school-related outcomes, such as GPA or school attendance. Therefore, the application of a variety of measures on ADP adds to the contribution from the present thesis. In short, the results indicate that positive associations between ADP and negative school-related outcomes were not restricted to only a certain type of drinking pattern, and that the magnitude on the association with the school-related problems only slightly varied across different measures of ADP. Higher number of total indicators on potential ADP, as well as increasing levels of alcohol consumption, was consistently associated with increasing odds for school-related problems. These findings further strengthen the interpretation of ADP as an important factor for school-related problems.

It may be useful to consider these findings in light of the bioecological model (94, 280) in order to provide a better understanding of how ADP and school-related problems are subject to a considerable co-variation. Specifically, alcohol/drug use – which is most salient in a spare time / peer group setting – was in the present thesis found to be associated with problems evident at school. These findings highlight the dependencies across different microsystems surrounding the individuals. However, due to the cross-sectional design of the study, it cannot be concluded on the directionality of the findings. Previous findings have suggested that ADP is associated with subsequent school-related problems (198, 281), while school-related problems is

also linked with subsequent ADP (282). Hence, it is likely that ADP and school-related problems have a reciprocal nature. In short, ADP and school-related problems appear to be concepts with a considerable co-variation, highlighting the importance of not viewing ADP as an isolated health-behavior, but as a multifaceted, complex problem with a disruptive potential for the further development from adolescence into the adult years.

4.2.2 Mental health problems and development of ADP

The present thesis aims to investigate how childhood externalizing and internalizing problems, and adolescent psychiatric diagnoses, are associated with ADP during adolescence. Importantly, these research questions address both childhood and adolescent antecedents of ADP, and both dimensional and categorical measures are used to conceptualize mental health problems.

Previous literature have provided empirical support for a *dimensional* understanding of common mental health problems (55-57), and an important strength of a dimensional measure of mental health problems is that it taps continuous symptom loads of mental health problems that not necessarily imply the presence of problems above a clinical cutoff (283). The use of dimensional measures of externalizing and internalizing problems applied in paper 2, is suitable for studies within a general population, and particularly useful in highlighting how externalizing/internalizing problems operate as general risk or protective factors in the development of ADP.

Previous studies also provide substantial support for a *categorical* conceptualization of mental health problems, i.e. psychiatric diagnoses, which is extensively summarized and operationalized in the ICD-10 diagnostic manual (52). One substantial strength of using psychiatric diagnoses as a measure of mental health problems, is that the presence of a psychiatric diagnosis not only imply a thorough evaluation of an individual's symptoms, but also that these symptoms are evaluated to be sufficiently impairing for daily functioning to qualify for a formal diagnosis. Therefore, the application of psychiatric diagnoses may be particularly suitable for an exploration of how mental health problems are associated with adolescent ADP in adolescents with clinically impairing mental health problems.

In the following sections the results from papers 2 and 3 are outlined and summarized from respectively the analyses of childhood, dimensional mental health problems and adolescent ADP, and adolescent categorical mental health problems (psychiatric diagnoses) and ADP.

4.2.2.1 Dimensional mental health problems and adolescent ADP

The dual-pathway model for development of ADP is a main theoretical framework that has informed the design for paper 2 of the present thesis, underscoring externalizing and internalizing problems as potential developmental pathways into development of adolescent ADP.

4.2.2.1.1 Childhood externalizing problems and ADP

Results from this thesis suggest that teacher- and parent-reported dimensional symptoms of childhood *externalizing* problems are associated with higher odds for

adolescent ADP. These findings were for the most part consistent across different conceptualizations and measures of ADP, for increasing levels of indicators on APD, and across subtypes of externalizing problems, i.e. conduct problems and hyperactivity/inattention. More specifically, externalizing problems were consistently associated with adolescent ADP after the adjustment for SES, gender, age and co-occurring internalizing problems. Secondary analyses also revealed positive associations between inattention/hyperactivity and ADP after adjustment for the confounding effects from SES, gender, age, conduct problems, and internalizing problems. Similarly, positive associations were found for associations between conduct problems and ADP, also after the adjustment for the confounding effects from SES, gender, age, hyperactivity/inattention, and internalizing problems.

These results embrace both theoretical and empirical literature that highlight the significance of the externalizing pathway to ADP among adolescents (1, 216). Specifically, a range of previous publications have demonstrated both conduct problems (29, 215) are robust childhood predictors for the development of ADP. On the other side, associations between hyperactivity/inattention and subsequent ADP are somewhat more unclear. A recent comparative meta-analysis revealed that childhood ADHD were only linked with nicotine dependence during adolescence, while being positively associated with illicit drug use by adulthood (284). One publication demonstrated that associations between early inattention problems and ADP were largely mediated via the association between conduct and inattention problems (215). A recent literature review also revealed that there is no evidence to conclude that

inattention/hyperactivity symptoms increase the risk of illicit drug use beyond the effect of conduct-related disorders (238).

In summary, the findings of the present thesis suggest that both childhood hyperactivity/inattention and conduct problems are important childhood factors associated with an increased risk for adolescent ADP. However, the associations were somewhat stronger and more consistent in relation to the full externalizing scale, possibly indicating that that overall externalizing behavioral tendencies are more potent predictors for subsequent ADP, compared with high symptoms on either conduct problems or hyperactivity/inattention alone. Moreover, it cannot be ruled out that conduct problems mediate the association between inattention/hyperactivity and adolescent ADP, as this question were beyond the scope of this thesis.

4.2.2.1.2 *Childhood internalizing problems*

The results further indicate that parent- and teacher-reported dimensional *internalizing* problems during childhood are negatively associated with ADP in late adolescence (16 to 19 years of age). Only the full SDQ internalizing problems scale – and not the subscales alone – was negatively associated with ADP in the present thesis, and only in the fully adjusted model, following the adjustment for SES, gender, age, and co-occurring externalizing problems. These findings support a recent contribution by Colder and colleagues (219), and adds to previous knowledge that internalizing problems are negatively associated with ADP in early adolescence (12 to 16 years of age) (165, 216, 221). These findings also correspond with a more recent

contribution from Colder and colleagues that internalizing problems throughout adolescence were associated with a reduced risk for ADP (219). However, some important nuances were revealed.

First, although associations between childhood internalizing problems and adolescent ADP consistently tended to have a negative direction, these associations were only statistically significant for some of the measures of potential ADP in unadjusted analyses. These findings points to a fairly modest ‘protective’ role of childhood internalizing problems on the development of adolescent ADP. Second, when adjusting for SES, gender, age and co-occurring externalizing problems, the negative association between childhood internalizing problems and ADP was strengthened. More specifically, internalizing problems was negatively associated with all single measures of potential ADP as well as increasing indicators of potential ADP in fully adjusted models. In other words, the present thesis suggests that childhood internalizing problems reduce the odds for both dichotomous measures of potential ADP as well as symptoms at the high end of a dimensional conceptualization of ADP during adolescence. Third, none of the internalizing peer/relationship problems subscale were robustly negatively associated with increasing levels of APD.

These findings oppose some previous publications which report that early internalizing problems are associated with an increased risk for adolescent ADP (165, 285-287). However, many studies have failed to account for co-occurring externalizing problems when investigating associations between internalizing problems and ADP (216), and may therefore have overestimated the unique contribution from internalizing problems as a risk factor for ADP. Furthermore, a substantial

heterogeneity within internalizing symptomatology in childhood may contribute to conflicting findings in previous research (219). For example, childhood depressive symptoms have been associated with an increased risk for ADP (29), also after the adjustment for co-occurring externalizing problems (71, 288). Symptoms of generalized anxiety are reported to be positively associated with ADP, while symptoms of separation anxiety are negatively associated (165).

Yet another factor that may contribute to previous inconsistent findings are the age or timing on which the internalizing symptoms are present (219). Studies of social anxiety in childhood tend to show either no association with later ADP or low levels of subsequent alcohol/drug use (289, 290), while symptoms of social anxiety presenting during adolescence have been reported as a risk factor for ADP (291). Colder and colleagues (216, 219) hypothesized that co-occurring internalizing/externalizing problems during early adolescence may protect individuals from alcohol/drug involvement due to peer norms in favor of low alcohol/drug use during this period in life. When alcohol/drug use turns progressively more normative throughout the adolescent years, internalizing problems may gradually turn to a risk factor for ADP, according to their hypothesis. However, the results of their study did not support this prediction, as patterns of interactions between internalizing problems, externalizing problems and adolescent alcohol use were very similar across the time span from early to late adolescence (219). In other words, their study revealed that internalizing problems had robust negative associations with ADP throughout adolescence, something which correspond well with findings from paper 2 in the present thesis.

In sum, the present thesis is aligned with previous findings linking generalized internalizing problems during childhood with reduced odds for adolescent ADP (216, 221). A previous study showed that separation anxiety disorder delayed the onset of alcohol use compared with peers (165), highlighting that internalizing problems may be involved in protective processes toward alcohol/drug use exposure through cautious behaviors and social withdrawal from peers during adolescence. Fearfulness, social withdrawal and avoidance have all been suggested as internalizing factors that may protect adolescents from engaging in alcohol/drug use (219), possibly due to a lower selecting into peer groups characterized by increased alcohol/drug use (292). The results of the present thesis are inconclusive in relation to which mechanisms that link internalizing problems with a reduced risk for adolescent ADP. Importantly, neither the internalizing peer/relationship problems scale, in which social withdrawal tendencies are prominent (293), nor the emotional problems scale had robust negative associations with ADP. At the contrary, only the full internalizing problems scale demonstrated statistically significant negative associations with ADP.

The lack of significant associations between emotional problems and ADP in the present thesis is also an interesting finding. Emotional problems may theoretically both increase risk for alcohol/drug use through negative, depressive affect (1, 140) – and decrease the risk through fear of negative consequences for deviant behaviors along with general carefulness (140, 156, 157). As the SDQ scale of emotional problems includes both items on depressed affect and nervousness/anxiety, it is possible that such opposing ‘risk/vulnerability’ versus ‘protective’ mechanisms are blurred. Therefore, although we did not find evidence that internalizing problems may also be

involved in ‘risk processes’ – i.e. heighten the risk – for ADP (e.g. 212, 294, 295), we cannot rule out this possibility. As Hussong and colleagues (140) note in their article describing a developmental psychopathology framework for the internalizing pathway to alcohol use disorders, a range of factors may affect the extent to which internalizing problems increase the future risk for APD or not, such as coping expectancies and motives for alcohol/drug use, initiation of alcohol/drug use with the goal of self-medication effects, and an escalation of alcohol/drug use to the point of addiction (140).

Importantly, a recent study by Virtanen and colleagues (296) which followed adolescents into the adult years clearly indicated that internalizing problems predicted alcohol problems. In other words, the results of the present thesis do not rule out that internalizing problems may serve as a risk factor of ADP for subgroups of individuals with internalizing problems, or that internalizing problems may be involved in risk processes for ADP over a period of time that extends beyond adolescence.

4.2.2.2 ADP among adolescents receiving specialist mental health care services

Results from this thesis reveal that ADP was substantially higher among adolescents who had received specialist mental health care compared to adolescents who had not received such services during the past four years (paper 3). These patterns were consistent across multiple measures of potential ADP, except the extent to which the adolescents had ever used alcohol, in which there were no significant differences between the groups. Furthermore, adolescents in the clinical sample also had higher

increasing levels of indicators on APD, including combinations of illicit drug use, high-level alcohol consumption, frequent alcohol intoxication and a positive CRAFFT score. Effect sizes were however in the small to moderate range for differences in ADP across the clinical sample and the general population, suggesting that differences in ADP across adolescents receiving specialist mental health care services and other adolescents are fairly modest on group-level. Nevertheless, these findings underscore that adolescents with mental health problems have a somewhat heightened risk for ADP.

Although these findings are not surprising, previous studies on this topic are very rare. These findings do however lend some support to a recent cross-sectional, Norwegian study (240) which demonstrated that illicit drug use was significantly higher among adolescents receiving psychiatric services compared to the general population (240). However, they also reported a significantly lower risk of being a current alcohol user in their clinical sample, whereas results from the present thesis reveal overall higher rates of ADP in the clinical sample, including several measures of high-risk alcohol use. A possible explanation for this discrepancy against the previous Norwegian study, may be the inclusion of more extensive measures of ADP in the present thesis. Importantly, they only included lifetime alcohol use as their measure of alcohol-related problems, which in the present thesis was the only alcohol measure that did not differ between the clinical group and adolescents from the general population.

In summary, paper 3 of the present thesis present novel information that suggest heightened odds for ADP among adolescents receiving specialist mental health care

services. However, it is important to note that not all psychiatric diagnoses posed adolescents at risk for ADP, and comorbidity with other psychiatric diagnoses also played an important role. These critical nuances are outlined in more detail in the following sections.

4.2.2.3 Categorical mental health problems and adolescent ADP

Whereas the dual-pathway model for development of ADP may be a useful framework for the study of associations between dimensional mental health problems and development of ADP, not all psychiatric diagnoses fit well into the two factors of externalizing and internalizing problems (122). Therefore, a more general model of categorical measures of mental health problems were applied in the design of paper 3, in which a set of broader psychiatric diagnostic groups were defined. These diagnostic groups comprised anxiety, depression, ADHD, conduct disorders, autism, eating disorders, trauma-related disorders, and other diagnoses.

Some of these psychiatric diagnoses can be categorized as externalizing disorders (ADHD and conduct disorders), and some can be categorized as internalizing disorders (anxiety and depression). However, other diagnoses (autism, eating disorders, and trauma-related disorders) do not fit well into neither the externalizing nor internalizing category (122). A useful model which dealt with the broader factor structure of common psychiatric diagnoses, proposed the following five factors: (1) internalizing problems, (2) externalizing problems, (3) disorders linked to abuse and neglect, (4) pervasive developmental disorders, and (5) other problems (122). Although the present

thesis have not explicitly used this five factor model as an analytic framework, this model may nevertheless be useful in the discussion of the results from of associations between psychiatric diagnoses and adolescent ADP. The outline of the further discussion will therefore roughly adhere to these five categories.

4.2.2.3.1 Externalizing problems and adolescent ADP

The results from this thesis highlight that externalizing disorders (conduct disorders and ADHD) were important markers of heightened risk for ADP, corresponding with the findings related to childhood dimensional externalizing problems. However, conduct disorders was a more robust marker for ADP compared with ADHD, and psychiatric comorbidity accounted for most of the variance between ADHD and ADP.

Conduct disorders: More specifically, *conduct disorder*-diagnoses were positively associated with most single measures of ADP and increasing levels of indicators on APD, pointing to a significant role of conduct problems on adolescent ADP. These findings support the results from paper 2 that suggested robust positive associations between dimensional conduct problems during childhood and adolescent ADP. In addition, these findings also adhere to a range of previous studies that have pointed to positive associations between externalizing problems – in which conduct problems are an integrated part – and ADP (e.g. 211, 297, 298).

When adjusting for the potential confounding from psychiatric diagnoses, as well as SES, gender and age, conduct problems were however only positively associated with illicit drug use, but this association was fairly strong. After the adjustment for

comorbidity with other psychiatric disorders, conduct disorders were still significantly positively associated with increasing levels of indicators on APD while the association was not statistically significant after the additional adjustment from SES, gender and age. However, the association with ADP was still clearly in a positive direction. These findings suggest that conduct problems is associated with an independent risk for illicit drug use among adolescents, while the risk for alcohol-related problems appears is potentially influenced by sociodemographic characteristics of adolescents with conduct problems.

The bioecological model, which points to a close interplay between different levels of influence surround the individual, may contribute to explain these findings. As observed in this thesis, conduct problems were independently associated with increased risk for illicit drug use, suggesting that this risk is fairly indiscriminant of other individual and social characteristics. However, factors such as SES comes more into play in the extent to which conduct problems increase the risk for hazardous alcohol use. Previous studies have pointed to a range of social factors that serve as risk factors for ADP, such as coming from a ‘disrupted’ family (67), parents, siblings and friends alcohol/drug use (66, 72, 81) or attitudes toward alcohol/drug use (66, 82), low parental monitoring (84), low socioeconomic status (SES) (85), contact with deviant peers (86), and peer pressure for alcohol/drug use (85). Although the present thesis do not explicitly investigate the mechanisms that link conduct problems with alcohol-related problems, it is likely that differences across these social risk factors, may contribute to the variance in ADP among adolescent with conduct disorders. Also of note, the comorbidity rate was high among adolescents with conduct disorders, and it

is likely that conduct problems may have contributed to ADP also through interaction with other diagnoses, such as anxiety/depression (299) and ADHD (300).

In summary, findings from the present thesis nevertheless suggest that conduct problems is a robust marker for ADP in adolescents receiving specialist mental health care services – particularly in relation to illicit drug use.

ADHD: *ADHD*-diagnoses were only positively associated with illicit drug use, while no other significant positive associations were detected for neither single measures of ADP nor for increasing levels of indicators on APD. These findings add strength to the interpretation that externalizing psychiatric diagnoses may be particularly influential in relation to illicit drug use. However, *ADHD*-diagnoses was no longer positively associated with either illicit drug use or other measures of ADP when psychiatric comorbidity was accounted for as a potential confounding variable.

These findings shed light on a range of previous findings, and add important nuances to the role of *ADHD* in adolescent ADP. First, a comparative meta-analytic investigation of associations between childhood *ADHD* and adult ADP, revealed that *ADHD* symptoms were positively associated with ADP during early adulthood (284). However, only a slightly increased risk for adult alcohol-related problems were observed, while positive associations were frequently stronger for adult drug-related problems (284). The present thesis adds to this knowledge by linking *ADHD* specifically with illicit drug use during adolescence. Second, whereas a large body of previous studies have indicated positive associations between *ADHD* symptoms and adolescent ADP (for a review of the literature, see 236), most investigations have not

controlled for associated psychopathology (301). Therefore, this thesis adds to the existing knowledge base, highlighting the importance of considering co-occurring psychiatric diagnoses. Third, a recent literature review indicated that ADHD does not increase the risk of adolescent illicit drug use beyond the effect of conduct-related disorders (238). The present thesis supports this notion, as the magnitude of the association between ADHD and illicit drug use was reduced after the adjustment for other comorbidity psychiatric diagnoses. Fourth, a recent study among adolescents with ADHD revealed that the presence of comorbid anxiety or depression substantially increased the positive association with alcohol use (299), and adolescents with comorbid ADHD and conduct disorders had a 3- to 5-fold increased likelihood of alcohol use compared to those with neither disorder (300). Hence, the findings from this thesis do not rule out the possibility that ADHD may be important for adolescent ADP, as symptoms related to hyperactivity/inattention may operate in interactions with other psychiatric diagnoses. This was however beyond the scope of the thesis. Fifth, previous studies have demonstrated that pharmacotherapy of ADHD symptoms reduce the risk for ADP (302, 303), and it is likely that a substantial proportion of the adolescents with ADHD diagnoses in our clinical sample have received such treatment, possibly contributing to an underestimation of the true associations between (untreated) ADHD and ADP. Hence, future investigations are needed on how dimensional ADHD-symptoms are associated with ADP, and how this association is influenced by the presence of co-occurring mental health problems.

In summary, ADHD-diagnoses may be important markers for illicit drug use during adolescence, but appear to have a very modest independent role in relation to

ADP. On the other side, dimensional childhood symptoms of hyperactivity/inattention demonstrated as robust risk factors for subsequent ADP (paper 2). It is however unclear whether this risk is mediated by conduct disorders (215), something which should be evaluated in future research with both categorical and dimensional measures of ADHD.

4.2.2.3.2 *Internalizing problems and adolescent ADP*

The results from this thesis highlight that internalizing disorders (depression and anxiety) were both markers of heightened risk for ADP, contrasting the findings from the study of childhood dimensional internalizing problems. However, depression-diagnoses was a more robust marker for ADP compared with anxiety.

Depression: Importantly, *depression* was among the psychiatric diagnoses with the most consistent positive associations with ADP in unadjusted models. Positive associations were revealed between depression and all measures of potential ADP, except high-level alcohol consumption, including increasing levels of indicators on APD. All these associations were also present after the adjustment for psychiatric comorbidity. However, after additional adjustment for SES, gender and age, depression were only positively associated with a positive CRAFFT-score.

These findings are aligned with previous studies reporting increased rates of ADP among adolescents with symptoms of depression (230, 304-306), while contradiction other previous findings. For example, it has previously been demonstrated that an anxiety disorder alone or depression alone did not predict co-occurring ADP, while

either having comorbid anxiety and depression, or having anxiety or depression and a comorbid conduct-related disorder, were both associated with co-occurring ADP (239). A previous study also reported that the co-occurrence of conduct disorders and depression is a strong predictor of ADP, while depression alone is a weak predictor (307).

The results from this thesis demonstrate that depression is an overall strong marker of risk for ADP, relatively independent of comorbid psychiatric diagnoses, while it may be significantly influenced by demographical factors. First, these findings provide some support for an internalizing pathway to adolescent ADP through depressive affect (1, 140). The widespread use of alcohol/drugs among depressed adolescents highlights self-medication as a likely driver or motive. Moreover, it should be noted that sociodemographic factors (SES, gender and age) consistently reduced that magnitude of the positive associations with ADP. This finding can be interpreted in light of a bioecological model in which the dynamic relationship across contexts are conceptualized as drivers for developmental processes. Potentially, depression may only be a risk factor for ADP within specific social or demographical contexts. However, the present thesis did not explicitly investigate such mechanisms, and it is therefore difficult to draw firm conclusions.

Finally, despite the negative longitudinal association between childhood dimensional internalizing problems and adolescent ADP, it is interesting to note that internalizing problems may serve as a risk factor of ADP for subgroups of individuals. Paper 3 lend some support to this hypothesis, as the internalizing diagnosis of depression was an important marker for adolescents at risk for ADP, while also being

independently associated with a positive CRAFFT-score. A possible explanation for the discrepancies between paper 2 and 3 in relation to emotional problems as predictor for ADP, is that a formal depression diagnosis during the adolescent years is likely to be a stronger indicator for clinically significant emotional problems than generalized internalizing problems during childhood. In support of this notion, individuals receiving specialist mental health services typically experience a considerable level of impairment (308, 309). Within the developmental psychological literature it is further noted that mental health problems that occur closer in time to the alcohol/drug use may have a stronger effect than more distant ones (310). Therefore, as depression-diagnoses were positively associated with ADP, this may imply that clinically impairing emotional problems are important in ‘risk’ processes towards ADP, whereas less impairing levels of emotional problems and/or more distant emotional problems have less predictive value. These findings add to the literature on the internalizing pathway toward development of ADP, suggesting that emotional problems – as observed among clinically depressed individuals – may increase the risk for adolescent ADP.

Anxiety: Previous literature is characterized by highly inconsistent findings on associations between *anxiety* and adolescent ADP, pointing to both negative (158-161) and positive associations (162-164). In the present thesis, anxiety was positively associated with illicit drug use during adolescence in unadjusted models. When comorbidity with other psychiatric diagnoses was accounted for, there was only detected one significant association with ADP, namely a *negative* association with frequent alcohol intoxication. When also accounting for the additional confounding

effects from demographic factors, no independent associations in neither negative nor positive direction were found between anxiety and any measure of ADP.

These findings demonstrate a complex relationship between anxiety disorders and ADP among adolescents. As a global measure, and after adjusting for relevant confounding variables, anxiety does not appear to be related to any increased risk for adolescent ADP. However, it has been suggested that different anxiety disorders (311, 312) and different anxiety typologies within a given disorder (313) yield different prediction of ADP. Previous literature have particularly pointed to social anxiety as a risk factor for ADP (291). Anxiety may also influence rates of ADP through interactions with other diagnoses, such as conduct disorders (239) or depression (239). Hence, the present thesis does not rule out that subtypes of anxiety maybe important factors for development of adolescent ADP; however, this possibility were not investigated in the present thesis.

The present thesis is constrained to the study of ADP during late adolescence (16 to 19 years of age). Although this is a highly influential period for experimentation with alcohol/drugs, it is also possible that anxiety disorders may be associated with ADP over a period of time that extend into adulthood. For example, previous publications have reported that a range of anxiety types during adolescence – including social phobia, panic disorders, generalized anxiety, and agoraphobia – are prospectively linked with ADP in adulthood (314, 315). Furthermore, in the transition from adolescence to adulthood reciprocal associations between anxiety disorders and ADP has been described (315). Nevertheless, it is interesting to note that anxiety diagnoses during adolescence were overall weak predictors for ADP.

In sum, the present thesis demonstrate that anxiety-diagnoses in general appear to play a very modest role in adolescent ADP. However, future research is needed to further disentangle the complex role of anxiety in the development of ADP in the transition to the early adult years.

4.2.2.3.3 Trauma-related disorders and ADP

A previous study by Forns and colleagues (122) identified trauma-related diagnoses as a separate psychopathological factor in addition to externalizing diagnoses, internalizing diagnoses, pervasive developmental disorders (including autism), and other psychiatric diagnoses. In accordance with this conceptualization, trauma-related disorders are discussed separately in the following section.

In the present thesis, adolescents with trauma-related disorders were the group with most consistent positive associations with both single measures of ADP and increasing levels of APD. Particularly, trauma-related disorders were positively associated with increasing levels of indicators on APD even in fully adjusted models, accounting for the influence of psychiatric comorbidity, SES, gender and age. These findings suggest that adolescents with trauma-related disorders are a high-risk group for adolescent ADP, and lend support to previous studies that have linked trauma-related disorders with ADP among adolescents (151-154). Additionally, particularly high rates of PTSD (approximately 20%) is reported among adolescents with SUDs (166), indicating that traumatic symptomatology is an important factor for adolescent ADP.

Trauma-related disorders had consistent and robust associations with alcohol-related problems, while associations with illicit drug use was no longer statistically significant after the adjustment from sociodemographical factors (SES, gender and age). Although the mechanisms behind this increased risk is difficult to interpret based on the present thesis, it has been suggested several pathways between trauma-related problems and ADP in previous literature (154). The self-medication hypothesis (see section 1.2.2) suggest that individuals may use alcohol/drugs to cope with emotional problems, for example related to traumatic stress (316). Operationally, this hypothesis has been suggested to imply that trauma-related symptoms play a mediating role between trauma exposure and ADP (154, 317), something which have been supported in several studies (144, 154). For example, a study by Haller and Chassin (154) demonstrated that adolescent PTSD symptoms was associated with early adult ADP, and this link was not accounted by preexisting trauma exposure nor family adversity. At the contrary, PTSD symptoms mediated the effect of pre-trauma family adversity on subsequent ADP. However, other mechanisms may also potentially be at work. For example, early ADP often involves chaotic and violent lifestyles, which could possibly increase the risk for trauma exposure (166).

In sum, the present thesis highlight that among adolescents receiving specialist mental health care services, individuals with trauma-related problems constitute a high-risk group for ADP. These findings is consistent with a notion that mental distress attributed to post-traumatic symptoms may serve as a context for self-medication through use of – most notably – alcohol. Importantly, the increased risk for ADP observed among adolescents with trauma-related disorders was not substantially

influenced by sociodemographical factors, such as SES, something which further highlight the specificity of trauma-related problems as a potential risk factor for ADP. This finding does however not rule out that third factors (such as disrupted families) may be important in the etiology of trauma-related disorders, and hence also for development of ADP among adolescents with trauma-related disorders. Previous studies have demonstrated that exposure to psychological trauma may be directly related to adverse psychosocial factors. For example, maltreatment and victimization is associated with both ADP (87, 88) and PTSD (318). Moreover, the findings in the present thesis which highlight trauma-related disorders as the psychiatric diagnoses with the most robust links to ADP, provide some external validity to the usefulness of distinguish trauma-related disorders from other psychopathological factors in the prediction of ADP.

4.2.2.3.4 Autism and ADP

The abovementioned study by Forns and colleagues (122) also identified pervasive developmental disorders, which predominantly include autism disorders, from other psychopathological factors. In accordance with this conceptualization, the results on the analyses of associations between autism and ADP are discussed separately in the following section.

Autism was the only psychiatric diagnosis in the present thesis which was convincingly negatively associated with ADP, supporting previous findings that link autism with reduced odds for ADP (240, 319). Specifically, autism had a negative

association with frequent alcohol intoxication, and this estimate was strengthened after adjusting for the confounding effects from psychiatric comorbidity, SES, gender and age. Although not statistically significant all the remaining associations between autism and ADP had also a negative direction. The findings in the present thesis of a particularly low risk for ADP among individuals with autism, highlight the usefulness of distinguish autism from other psychopathological factors (122) in the prediction of adolescent ADP.

A possible explanation for the negative associations between autism and adolescent ADP, may be related to the core symptoms of autism, which frequently include social withdrawal and avoidance from interaction with peers. These behavioral tendencies may also potentially prevent these individuals from exposure to settings with high rates of alcohol/drug use. In addition, it is likely that adolescents with autism receive a considerable degree of adult supervision, and support, something which also may contribute to a reduced risk for ADP during the adolescent years. However, a recent study indicated that individuals with autism are at increased risk for ADP later in the course of life, and particularly in the presence of a comorbid ADHD diagnosis (320). Nevertheless, the present thesis highlight that – during adolescence – autism is linked with a slightly lower risk for ADP compared with the general youth@hordaland population.

4.2.2.3.5 Eating disorders and ADP

Adolescents with *eating disorder diagnoses* had higher odds for frequent alcohol intoxication and a positive CRAFFT-score in the present thesis. After the adjustment for the confounding effects from psychiatric comorbidity, SES, gender and age, the only independent association was between eating disorders and frequent alcohol intoxication. These findings lend some support to previous studies which have linked eating disorders with specific patterns of alcohol use characterized by a loss of control, such as frequent intoxication (321) and binge drinking (322). The clinical feature of impulsivity among adolescents with eating disorders may be an important explaining factor for the co-occurring ADP (323), although other explanations may also be raised. Based on the present thesis, no specific explanations are given for the higher odds for frequent alcohol intoxication among these adolescents.

However, associations between eating disorders and ADP may be difficult to interpret in light of the dual pathway hypothesis, as impulsivity is a common feature among both adolescents with eating disorders and those with externalizing problems, whereas emotional problems is prominent among individuals with eating disorders as well as with individuals with internalizing problems. In addition, individuals with eating disorders are not a homogeneous group. On the other side, the eating disorders-diagnoses include both individuals with binge-eating tendencies (and possibly co-occurring binge-drinking) and individuals with anorexic behaviors (and likely restrictive consumption of alcohol) (52). As these potentially important differences within the eating disorders-group were not investigated in the present thesis, it is likely that the results are not generalizable to all sub-groups of adolescents with eating disorders. Future studies are therefore needed to explore how different typologies of

eating disorders are associated with ADP during adolescence. Also of note, it is likely that childhood symptoms of eating disorders are not satisfactorily identified in the SDQ-based measures of childhood externalizing/internalizing problems (paper 2), and future investigations are warranted on how dimensional symptoms of eating disorders during childhood are prospectively associated with adolescent ADP.

Despite these shortcomings, the present thesis highlights that adolescents with eating disorders had somewhat higher odds for ADP, specifically related to frequent alcohol intoxication, but not to broader measures of increasing levels of indicators on APD.

4.2.2.3.6 Adolescents in clinical sample without Axis 1 psychiatric diagnosis

Finally, adolescents that received specialist mental health care without receiving any Axis 1 psychiatric diagnosis had higher odds for high-level alcohol consumption and illicit drug use compared to the general population, even after adjusting for demographical factors. Additionally, these adolescents had slightly heightened odds for increasing levels of indicators on APD. A possible explanation for these findings may be highlighted in a shared vulnerability model, highlighting that these adolescents had one thing in common, namely that they were experiencing mental distress to such a degree that they were referred to the specialist mental health care services. However, lack of data on the psychiatric characteristics of this group makes it difficult to interpret these findings in detail. Further in-depth investigation is required for a better understanding of the heightened risk for ADP in this group.

4.3 Methodological and ethical considerations

4.3.1 Strengths

The thesis have some common strengths. First, they all applied data from the youth@hordaland sample, which consists of a well-defined population-based sample of adolescents in the age 16 to 19 years, which is sufficiently large to enable a detailed investigation of main effects between ADP, mental health problems, and school-related problems. The data from the youth@hordaland sample is also fairly recent, thus allowing for an updated view into the current status of the topics. Second, all papers applied several measures of alcohol- and drug use, including a validated measure of potential alcohol- and drug related problems, i.e. the CRAFFT instrument, along with measures of increasing levels of potential indicators for ADP. As previously highlighted, ADP may be conceptualized as either a categorical or a dimensional phenomenon. For research purposes it may be meaningful to use tools that give an indication of potential ADP rather than evidence of a formal diagnosis. The application of both single, categorical ADP-measures and a dimensional measure of ADP with gradually increasing severity, is that a larger variation of ADP is kept in the data analyses, potentially enabling a better understanding of ADP and its associated predictors and/or outcomes. Third, a range of relevant potential confounding variables were applied in the analyses of the associations of interest.

Additionally, each specific paper had its own strengths. In *paper 1* a unique linkage to the official school-registry was utilized, facilitating an investigation of objective

data on GPA and days and hours missed from school. As measures of potential confounding factors, validated instrument for the measurement of symptoms on anxiety, depression, hyperactivity/inattention and conduct problems were used. Applying data from the BCS sample, *paper 2* had the strength of a longitudinal design, therefore enabling an investigation of childhood mental health factors and their prospective associations with adolescent ADP. An additional strength of this paper was the utilization of repeated measures and multiple informants on the SDQ, providing a robust estimate for externalizing/internalizing symptoms which were present over time and across informants. *Paper 3* applied a unique linkage between a community-based sample of adolescents (youth@hordaland) and official registry data on specialist mental health care services (NPR). This combined data set facilitated an investigation of a broad set of formal psychiatric diagnoses, and their associations with ADP, which is rare in previous research (240). Moreover, paper 3 is possibly the first contribution in the scientific literature to compare a broad range of psychiatric diagnoses in terms of their associations with ADP during adolescence, while also addressing the role of psychiatric comorbidity.

4.3.2 Limitations

The papers comprising the present thesis had also some limitations in common. The target population is a cohort of Norwegian adolescents aged 16 to 19 years (born 1993 to 1995) from the youth@hordaland survey, and it should be noted that the prevalence rates of alcohol/drug use is fairly low in this group, compared with many other Western countries, and compared with previous historical cohorts. Therefore, the

results should be interpreted with caution, as they may not be fully generalizable to adolescent populations with different levels of alcohol/drug use. Furthermore, participant rate in the youth@hordaland survey were 53%, and the sample may therefore not be fully representative for the general population. Furthermore, the individuals of each of the three study samples were somewhat different from the full youth@hordaland survey (see section 2.3). Particularly, the samples included a low proportion of adolescents with self-reported low SES, who in previous studies are found to have higher levels of mental health problems (e.g. 267), while differences in ADP across levels of SES appear to be more limited (324). Differences between individuals in the study samples and the full youth@hordaland sample were overall in the small to medium range, but may nevertheless affect the generalizability of the findings. The use of self-reported measures on alcohol/drug use does not imply the presence of actual substance-related diagnoses, and the lack of clinical interviews in the collection of data on alcohol- and drug use adds as a limitation to this thesis. Finally, residual confounding may be an issue, due to third variables not included as confounding variables in the analyses, such as genetic predisposition, adverse life circumstances or events, peer relations, and family characteristics.

Each specific paper also had its own sets of limitations. *Paper 1* had a cross-sectional design, and it is therefore not possible to draw conclusion on causality between ADP and school-related outcomes based on the study. The mental health variables were solely based on self-report, something which may have led to a bias in the data due to misclassification of the control variables used in this study.

Furthermore, cumulative effects on school-related problems from ADP and mental health problems were not investigated, as this issue was beyond the scope of the paper.

Although *paper 2* had a longitudinal design, the findings of the study are not necessarily an expression of causality. A range of not-included third factors may affect both externalizing/internalizing problems and ADP during adolescence, and the study may therefore have overestimated the unique associations between externalizing/internalizing problems and ADP. Also, complex mechanisms may be at work as mediators (e.g. timing of puberty, drinking motives, peer involvement, parental supervision, and parental problem drinking) between childhood externalizing/internalizing problems and ADP (e.g. 138, 325, 326), something which was beyond the scope of the paper. Importantly, depression and conduct problems have previously been found to be the mental health symptoms strongest associated with ADP during adolescence (e.g. 29, 145, 327). However, the internalizing scale of the SDQ is a generalized measure of internalizing problems, and therefore does not separate between for example symptoms of anxiety and depression. Moreover, the measures of externalizing/internalizing problems were constructed solely on parent and teachers SDQ report. Although such measures have been supported in a review of psychometric studies (Stone et al., 2010), internalizing problems are likely to be more accurately reported by children themselves (Ederer, 2004), something which also may apply to externalizing problems (127). Hence, the inclusion of self-reported externalizing/internalizing symptoms would add more strength to the measures of childhood mental health problems in the present thesis. As no self-report data were available on SDQ symptoms at T1 due to the young age of the children, and as the

externalizing/internalizing variables were constructed based on two time points, the inclusion of self-reports at one time only would not work. However, the use of parent/teacher reports on T1/T2 and self-reports on T3 may contribute to avoiding mono-informant bias. In addition, selective drop out is a well-known problem in longitudinal research (271), and may not be fully ruled out in this study of the present thesis. The discrepancy in participation between T1 (n=7,007) and the study sample (n=2,438) is however not merely a result of dropout at each consecutive wave, but is also an administrative issue of the longitudinal survey design. Importantly, the BCS (comprising T1 and T2) had a different target population than the youth@hordaland (comprising T3). Therefore, it is not possible to calculate a strict attrition rate for the present study. We did however find some differences between the study sample and the full youth@hordaland sample, suggesting that the included individuals had somewhat higher SES than the non-included individuals. On the other side, effect sizes for differences between the study sample and the full youth@hordaland sample were for the most part non-significant on alcohol/drug use, and small on externalizing/internalizing problems. Hence, selective dropout is not likely to be an issue that seriously bias the findings of the study.

Although the measures of psychiatric diagnoses in *paper 3* preceded those of ADP, the paper did not have a stringent longitudinal design. It is therefore not possible to draw conclusions on the causality between psychiatric diagnoses and ADP based on the paper, since alcohol/drug use may have predated the mental health care contacts. A longer time period between the data collection of psychiatric diagnoses and subsequent ADP could enable a better understanding of the directionality of the findings.

However, more rigorous research designs might also be needed, for example in order to examine how mental health problems and alcohol/drug use interact over time. Due to a small number of participants in each type of psychiatric diagnoses it was not differentiated between subtypes of psychiatric diagnoses, something which could provide important nuances in associations with ADP. For example, different anxiety disorders may yield different predictions on ADP (311, 312), and eating disorders characterized by binge eating as opposed to anorectic behaviors may also potentially have different associations with ADP. Also, rates of psychiatric comorbidity varied across diagnostic categories, and were high among individuals with some diagnoses. The independent associations between these psychiatric diagnoses and ADP may therefore have been underestimated. In addition, potential interaction effects between different psychiatric diagnoses and ADP were not examined due to the relatively small number of adolescents within each diagnostic group. Also of note, an important limitation related to the generalizability of the findings from this study is that individuals with untreated mental health problems in the general youth@hordaland-population were not identified. Psychiatric diagnoses in the study was restricted to individuals that had received specialist mental health care services during the past four years. A range of factors may however potentially affect specialist mental health care use, such as functional impairment levels (308) and sociodemographic characteristics (328). Also, a former wave of the Bergen Child Study concluded that specialist mental health care use differed considerably across psychiatric diagnoses, in which children with emotional disorders were underrepresented in mental health care services (244).

Therefore, the findings on associations between psychiatric diagnoses and ADP should be interpreted with caution, particularly in relation to anxiety and depression disorders.

Finally, the bioecological model highlight that individual characteristics alone cannot explain how problem behaviors, such as ADP, develop during adolescence (280). On the contrary, multiple social contexts and the interdependencies among contexts should be considered in order to understand how individual characteristics result in heightened risk for ADP. The present thesis did not investigate interactions between psychiatric diagnoses and social factors, such as high-risk environments, which is proposed to further increase the risk for alcohol/drug use (128, 133, 134). This add as an important limitation to the thesis, and future studies should explore dynamic relations between psychiatric diagnoses and social contexts in the development of ADP.

4.4 Implications

4.4.1 For practice

A range of implications for practice may be inferred from the results of the present thesis. First, adolescents with indications on ADP should be specifically targeted in initiatives aiming at better school-functioning among adolescents. As highlighted in *paper 1*, adolescents with ADP had consistently higher risk for school-related problems, which could not be attributed to shared vulnerabilities due to mental health problems, SES, gender or age. These findings suggest that ADP should be regarded as an important factor for school-related functioning among adolescents. Of note, positive

associations with school-related problems were found for all single measures of ADP, highlighting the need for a focus at reducing the overall use of alcohol/drugs in the adolescent population. Furthermore, it was also observed that the highest risk for school-related problems were related to adolescents with the highest number of increasing levels of indicators on APD. Hence, the adolescents with the most pronounced symptoms of ADP, pose as a high-risk group for school-related problems, and it is important for teachers, parents and practitioners within school- and health services to make joint effort to ensure adolescents at risk proper support and treatment. Additionally, the development of interventions to reduce ADP among adolescents at risk for school-failure is needed, along with evaluations of their effectiveness.

Second, early and comprehensive efforts to support children with externalizing problems are important in order to reduce the future risk of adolescent alcohol and drug use. Adding to an already extensive evidence base that underscores the prominence of the externalizing pathway towards development of ADP, the results from *paper 2* in this thesis demonstrated that children with symptoms of externalizing problems were at risk for the development of adolescent ADP. Furthermore, the results demonstrated that children with internalizing problems as a group were at no heightened risk for adolescent ADP. At the contrary, after the adjustment from co-occurring externalizing problems, SES, gender and age, internalizing problems was consistently negatively associated with ADP. These findings should not be interpreted to reduce the importance of supportive interventions toward children with internalizing symptoms, but it should be noted that children with externalizing problems are at the highest need for early interventions specifically targeting development of adolescent

ADP. Importantly, these findings do not rule out that children with internalizing problems may be at heightened risk for ADP at a later stage in life; however, this topic was beyond the scope of the present thesis.

Third, specialist mental health practitioners should be aware of the high prevalence of ADP among adolescents receiving specialist mental health care services, and should also be informed as to which diagnoses are associated with higher risk in order to employ appropriately targeted preventive interventions. *Paper 3* of the present thesis demonstrated that adolescents receiving specialist mental health care services as a group had higher prevalence of ADP and were approximately twice as likely as adolescents in the general population to have tried illicit drugs or to have high number of indications of ADP. Specifically, conduct problems were strongly associated with higher odds of illicit drug use; eating disorders were associated with higher odds of frequent alcohol intoxication; depression were a strong marker for ADP across different measures; and adolescents with trauma-related disorders were an overall high-risk group for ADP independent of psychiatric comorbidity and demographical factors. A recent study provided evidence that individual trauma-focused psychological intervention delivered alongside interventions against ADP can reduce severity of PTSD symptoms and alcohol/drug use (329), and such interventions should be considered during specialist mental health care treatment of adolescents with co-occurring trauma disorders and ADP. In addition, the results from this thesis highlight the continued need for public health initiatives which aim to identify children and adolescents which have been exposed to psychological trauma, abuse and neglect, as this work may have implications for the prevention of both trauma-related disorders

and future ADP. Finally, it is likely that the high prevalence of ADP among adolescents with mental health problems reflect attempts from the youths to self-medicate or regulate their problems through the use of alcohol/drugs, and initiatives aiming at empowering adolescents to master their mental health problems in other ways are therefore encouraged. Several prevention programs and interventions for reduction of hazardous alcohol/drug use have recently been reviewed, including school-based programs (330, 331), family-based interventions (332), internet- and computer-based interventions (333), peer-led interventions (334), mentoring (335), media campaigns (336), and general positive youth developmental programs (337). These reviews provide useful information to be considered in prevention efforts. Similarly, psychological interventions for individuals with comorbid psychiatric diagnoses and ADP have also been reviewed (e.g. 318, 321, 322, and provide useful advice for mental health practitioners.

4.4.2 For research

The present thesis also suggests some directions for future research on the topic of ADP among adolescents. First, future studies should be encouraged to investigate to what extent poor grade achievement and high absence from school, serve as mediators between ADP and more long-term negative school-related outcomes, as very few studies have explored this possibility (338). As highlighted in *paper 1*, ADP was consistently associated with relatively short-term school-related problems, such as low school grades and high number of days and hours missed from school. Previous investigations have demonstrated that ADP is also associated with long-term

consequences such as lower high school graduation rates (188-191), lower post-secondary educational credentials (187), and higher drop-out rates from school (192-194). A better understanding of long-term school-related problems among adolescents with ADP, and the role of intermediate outcomes such as poor grades and low attendance in these associations, is needed. This knowledge could potentially be used to develop better informed treatment and prevention practices for adolescents at risk for school-failure.

Second, future studies should be encouraged to investigate the reciprocal or longitudinal associations between change in externalizing/internalizing problems and change in alcohol/drug use, as this would add important knowledge to the understanding of the role of mental health in development of ADP across the adolescent years. *Paper 2* demonstrated robust associations between externalizing problems and ADP, particularly when the influence of co-occurring internalizing problems was accounted for. Similarly, internalizing problems were more robustly negatively associated with ADP when co-occurring externalizing problems were adjusted for. These findings underscore the need to evaluate externalizing and internalizing problems in context of each other, in concert with recent recommendations (145, 219). However, the present study do not evaluate how changes in externalizing/internalizing problems interplay with changes in alcohol/drug use. In addition, it has been proposed that internalizing problems may increasingly turn from a protective factors towards a risk factor for ADP with increasing age (140, 145). Although there is some evidence that internalizing problems predict ADP from adolescence to adolescence (296), there is a need for more studies that investigate the

potentially changing role of internalizing problems on ADP from adolescence into the adult years.

Third, future studies should apply measures that differentiate between discrete aspects of childhood internalizing symptoms and their associations with future ADP. In *paper 2* of the present thesis, it was indicated that specific aspects of internalizing problems may be involved in ‘protective’ mechanisms toward adolescent ADP, while aspects potentially involved in ‘risk’ mechanism were not found. A better understanding of the internalizing pathway to ADP is generally an important area of future enquires, and novel approaches are needed in order to disentangle the complex role of internalizing problems in the development of ADP during the adolescent years and beyond.

Fourth, future studies are needed to replicate the findings of the present thesis with regard to which psychiatric diagnoses that posed adolescents at the highest risk for ADP, as few previous studies have explored a broad range of psychiatric diagnoses and their associations with ADP (240). As highlighted in *paper 3* adolescents receiving specialist mental health care services have higher rates of ADP, and these associations varied considerably across specific diagnoses. Also, future studies are required to further investigate how psychiatric comorbidity and demographical factors may interact with different psychiatric diagnoses in the prediction of ADP among adolescents. Further explorations into the developmental trajectories of common psychiatric diagnoses and ADP in the transition from adolescence to adulthood may also add to the scientific literature, as the present thesis was limited to investigating ADP during adolescence.

5. Conclusions

Adolescence is a time period where it is common to experiment with alcohol and illicit drugs, and many of the adolescents which display a risky alcohol and drug use will neither develop long-lasting ADP, mental health problems, nor school- or later work-related problems. However, the results from the present thesis demonstrate that ADP is an important factor in school-related functioning, that children with externalizing problems are at heightened risk for adolescent ADP, and that specific psychiatric diagnoses during adolescence – most notably trauma-related disorders – are associated with higher rates of ADP.

Source of data

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Alcohol and Illicit Drug Use Are Important Factors for School-Related Problems among Adolescents

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The aim of this study was to investigate the association between alcohol and drug use, and school-related problems measured by low grade point average (GPA) and high school attendance. We also examined potential confounding effects from mental health problems. Although the issue is not new within current literature, the present study has its strengths in a large number of participants and the utilization of registry-based data on school-related functioning. A cross-sectional design is employed in this study using data from a large population-based sample of adolescents, youth@hordaland, in a linkage to official school registry data, and the current study presents data from $N = 7,874$. The main independent variables were alcohol use and drug use, as well as potential alcohol- and drug-related problems. The dependent variables were registry-based school attendance and grades. All the alcohol- and drug measures included were consistently associated with low GPA (Odds ratios (OR) ranging 1.82–2.21, all $p < 0.001$) and high levels of missed days from school (ORs ranging 1.79–3.04, all $p < 0.001$) and high levels of hours missed from school (ORs ranging 2.17–3.44, all $p < 0.001$). Even after adjusting for gender, age, socioeconomic status and mental health problems all the associations between alcohol and illicit drug use and the school-related outcomes remained statistically significant. Increasing number of indications on alcohol/drug-related problems and increasing levels of alcohol consumption were associated with more negative school-related outcomes. The results suggest that alcohol- and drug use, and particularly alcohol/drug-related problems, are important factors for school-related problems independently of mental health problems.

Keywords: alcohol use, illicit drug use, alcohol and drug-related problems, school-related problems, grade point average (GPA), school attendance

INTRODUCTION

Adolescents using alcohol and illicit drugs are at risk for prolonged alcohol/drug-related problems (Ellickson et al., 2003), and co-occurrence with mental health problems are often observed among adolescents with alcohol/drug-related problems (Bukstein et al., 1989; Clark et al., 1997). Not least, both alcohol and illicit drug use during adolescence have been found to be associated with long-term negative school-related outcomes, such as lower high school graduation rates (Chatterji, 2006; Renna, 2007; Horwood et al., 2010; Kelly et al., 2015), lower post-secondary educational credentials

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(Staff et al., 2008), and higher drop-out rates from school (Van Ours and Williams, 2009; Leach and Butterworth, 2012; Brière et al., 2014).

More immediate consequences of alcohol and illicit drug use on school-related problems, such as poor grade achievement and high absence from school, are also highlighted in the scientific literature. Poor grade achievement has been found to be a potent predictor for dropout from school (Janosz et al., 1997), while lower attendance may be an indicator of disengagement from school and is associated with increased substance use (Chou et al., 2006; Henry and Thornberry, 2010). A study by Perini and Marti (2011) found that substance use had no direct effect on drop-out, but had an indirect impact through the intermediate outcomes of poor grades and high school-absence. In other words, short-term school-related problems appear to be important mediators between alcohol/drug use and long-term negative school-related outcomes. Hence, the investigation of how alcohol/drug-related problems are associated with poor grades and high school-absence may be an important step toward a better understanding of adolescents at risk for more long-term negative school-related outcomes.

Some previous studies report that alcohol and illicit drug use is associated with both poorer grades and lower school attendance. For example, adolescent alcohol and illicit drug use are demonstrated to be related to lower self-reported attendance rates (Roebuck et al., 2004; Chou et al., 2006; King et al., 2006; Henry and Thornberry, 2010; Hemphill et al., 2014) and lower self-reported grade achievement (Williams et al., 2003; DeSimone, 2010; Homel et al., 2014; Stiby et al., 2015), while other contributions report weak or non-significant associations between alcohol use and self-reported grades (Sabia, 2010; Brière et al., 2014) and registry-based grades (Balsa et al., 2011). In sum, the literature is not conclusive to whether alcohol and illicit drug use should be regarded as important factors for poor grade achievement and high school-absence or not.

A range of factors should be noted as potential limitations in the previous literature. First, the extent to which alcohol/drug use is associated with negative school-related outcomes may be influenced by the conceptualization of alcohol/drug use. Alcohol use is very prevalent among adolescents (e.g., Windle, 2003), while only a minority of the adolescent drinkers develop more adverse alcohol/drug-related problems (e.g., Olsson et al., 2016). Nevertheless, most previous studies have used single measures of alcohol or drug use—such as either binge drinking, high-level alcohol consumption, heavy drinking, or illicit drug use—and have not attempted to account for how combinations of potential problematic alcohol/drug-related behaviors relate to school-related problems. In our study we employ combined indicators of potential alcohol/drug-related problems, enabling us to evaluate how high-risk alcohol/drug use patterns are associated with poor grades and low school attendance.

Second, previous studies on associations between alcohol and illicit drug use and grade achievement and school attendance have with only a few exceptions (e.g., Hishinuma et al., 2006; Balsa et al., 2011) relied on self-reported measures of school functioning. A study by Balsa et al. (2011) demonstrated that self-reported grades among adolescents with a present alcohol

consumption are not only subject to bias, but also that the bias differs by gender. Specifically, boys are more likely to report deflated grades, while girls are more likely to report inflated grades. Therefore, studies employing registry-based information are needed in the investigation on how adolescent alcohol and illicit drug is associated with school functioning. In our study we utilize a linkage with registry-based data on school grades and attendance, which is rare in previous literature.

Third, it is noted that associations between alcohol and drug use and poor school performance may have significant interactions with socioeconomic status (SES), gender and mental health problems (Busch et al., 2014). In particular, mental health problems are demonstrated as influential factors in relation to both adolescent alcohol and illicit drug use (e.g., Chassin et al., 2013) and to negative school-related outcomes (e.g., Lee et al., 2009), and appears to be particularly important factors to take into account when exploring associations between alcohol and illicit drug use and school-related problems. However, very few studies have included mental health problems in the analyses of associations between alcohol and illicit drug use and grade achievement and school attendance (DeSimone, 2010; Stiby et al., 2015). The present study expands on this by including both internalizing symptoms such as anxiety and depression, along with externalizing symptoms such as inattention/hyperactivity and conduct problems as potential confounders. This enables us to investigate whether or not associations between alcohol and drug use and school grades and attendance are also present when mental health problems are accounted for, or if observed associations between alcohol/drug use and school functioning should merely be regarded as an expression of influences from internalizing and/or externalizing traits (e.g., Chassin et al., 2013).

Fourth, some previous studies have demonstrated that alcohol/drug use is associated with general reductions in grade achievement and school attendance (e.g., Roebuck et al., 2004; Balsa et al., 2011). However, the effect sizes are often small, and it may be difficult to interpret whether or not such reductions in school-related functioning should be regarded as indicators of school-related problems. In our study we address this “interpretation” issue, by investigating associations between alcohol/drug use and school-related problems, defined as low-levels of grade achievement and high-levels of school absence. In this respect, our study provides new knowledge with regard to how alcohol/drug use is associated with short-term school-related problems.

In sum, the present study contributes to the understanding of the association between adolescent alcohol- and illicit drug use and academic achievement in terms of grades and attendance rates. Utilizing a unique linkage between a large scale Norwegian population-based study among adolescents and official school-registry data on student's grades and attendance rates, we aimed to investigate the cross-sectional association between alcohol- and illicit drug use, and alcohol/drug-related problems, and negative school-related outcomes, including low GPA and high number of days and hours missed from class. Importantly, we use official registry based data on both grades and attendance rates, thereby obviating self-report bias in relation to the school-related

outcomes. Additionally, we employed a range of indicators for both alcohol and illicit drug use, along with potential alcohol and drug-related problems, thereby enabling us to investigate associations with school-related functioning across different patterns of alcohol and illicit drug use.

MATERIALS AND METHODS

Study Population

We employed data from the youth@hordaland study, which aimed at providing data on child and adolescent mental health, lifestyle, school performance and use of health services. All adolescents born between 1993 and 1995 living in Hordaland county in western Norway were invited to participate ($N = 19,430$), and of these 10,257 adolescents chose to participate, giving a participation rate of 53%. After deletion of participants not giving consent to use data from the school registry ($N = 682$), and those having missing information on either school registry data ($N = 1,190$) or alcohol- and illicit drug use ($N = 511$), the final number of participants was 7,874. 52% of the participants were girls, and the mean age in the sample was 17.4 (standard deviation 0.8).

Youth@hordaland is a cross-sectional population-based study carried out during early 2012, and data was collected from adolescents in upper secondary school. The adolescents received information per email and one school hour was used to complete the questionnaires at school. In addition, adolescents not going to school received the questionnaires by mail at their home address, and also mental health services and other institutions were contacted to let adolescents from these settings participate. The questionnaires used in the youth@hordaland study were web-based, and electronic informed consent was obtained from all participants. The study was approved by the Regional Committee for Medical and Health Research Ethics in Western Norway.

In order to provide access to medical care, easy accessible information on mental health services was made available for the adolescents who participated in the youth@hordaland study. Additionally, a direct phone number to the research staff was provided, by which they could call to receive more information. Also, personnel within school health services were informed about the survey, and therefore enabled to be present for the adolescents by the time they answered the questionnaire.

A previous population-based study found that the geographical area from where the adolescents came, Hordaland county, to be regarded as representative of the general Norwegian population (Folkehelseinstituttet, 2010).

Exposure: Alcohol- and Illicit Drug Use

Self-reported measures of alcohol- and illicit drug use were our main independent variables.

Ever Tried Alcohol

Based on a single item “Have you ever tried alcohol?,” a dichotomous variable was constructed (Yes/No). $N = 6,159$ (78.3%) of the sample reported to having consumed alcohol.

Ever Tried Illicit Drugs

Another dichotomous variable was constructed based on a single item “Have you ever tried hash, marijuana or other narcotic substances?” (Yes/No). $N = 788$ (10.0%) of the sample reported to having tried illicit drugs.

High-Level Alcohol Consumption

Items measuring self-reported glasses of beer, cider, wine, spirits and illegally distilled spirits usually consumed during 14 days were added up. A total of $N = 4,503$ (61.2%) of the sample reported a present alcohol consumption. The high-level alcohol consumption variable was defined as the above 90th gender-specific percentile alcohol consumption among the adolescents with a present alcohol consumption, and a dichotomous variable was created for high-level alcohol consumption ($N = 453$). In addition, based on the continuous distribution of alcohol consumption in the sample an ordinal gender-specific variable of alcohol consumption was constructed, including seven levels from never used alcohol to consumption above 90th centile.

Frequent Alcohol Intoxication

Frequency of intoxication was measured based on the question: “Have you ever consumed so much alcohol that you were clearly intoxicated (drunk)?” The original item had five categories ranging from “No, never” to “Yes, more than 10 times.” Frequent intoxication was defined as drinking so much that one was clearly intoxicated more than 10 times (Skogen et al., 2014), and on this basis a dichotomous variable was created. $N = 1,588$ (20.2%) of the sample reported frequent intoxication.

Positive Crafft Score

Alcohol and drug-related problems were measured using the six-item, validated scale CRAFFT. This scale has been designed to identify possible alcohol- and drug related problems among adolescents, and has been demonstrated to have acceptable sensitivity and specificity at a cut-off of ≥ 2 (Dhalla et al., 2011). A dichotomous variable separating those above the cut-off of ≥ 2 on CRAFFT from those below the cut-off were calculated. $N = 1,664$ (21.2%) of the sample scored above the CRAFFT cut-off, and were operationalized to indicate potential alcohol- or illicit drug-related problems. In our sample the Cronbach's α of the CRAFFT scale was 0.67.

Any and Total Potential Alcohol/Drug-Related Problems

We constructed a dichotomous measure for any potential alcohol/drug-related problems, indicating whether or not an adolescent had a positive score for either having frequent alcohol intoxication, high-level alcohol consumption, a positive CRAFFT-score or having tried illicit drugs. $N = 2,710$ (34.4%) of the sample had any potential alcohol/drug-related problem. Similarly, we constructed an ordinal variable for total potential alcohol/drug-related problems, in which we summed up the number of positive scores on frequent alcohol intoxication, high-level alcohol consumption, a positive CRAFFT-score or having tried illicit drugs. A total of 5,164 (66.1%) had none, 1,439 (18.4%)

had one, 743 (9.5%) had two, 384 (4.9%) had three, and 84 (1.1%) had four of these potential alcohol/drug-related problems.

Outcome: Registry-Based Information about School Performance and Attendance

Academic grades were provided by official school registry in Hordaland County. In Norway, secondary schools use a scale running from 1 to 6, with 6 being the highest grade (outstanding competence), 2 being the lowest passing grade (low level of competence), and a 1 is a “fail” (no qualified competence). The grade point average (GPA) was calculated as the average of the student’s grades during their time at the school. Mean combined GPA in the sample was 3.85 (standard deviation 0.80). Based on the continuous distribution of GPA in the sample, we dichotomized GPA under/above the 10th gender-specific percentile, constructing a variable indicating low GPA for adolescents scoring below this threshold. 859 (10.9%) of the adolescents had a low GPA.

Official registry-based data on attendance rates were also provided by official registry data from the Hordaland County, and they included both days and school hours of absence for the last semester (6 months). The mean number of days missed in the sample was 4.02 (standard deviation 5.04), while the mean number of hours missed was 7.51 (standard deviation 11.10). Based on the continuous distribution in the sample of respectively days and hours missed from school, we constructed two variables indicating high number of days and high number of hours missed from school for adolescents which were dichotomized under/above the 90th gender-specific levels of respectively number of days and hours they did not attend school. 721 (9.2%) of the adolescents had a high number of days missed, and 767 (9.7%) had a high number of hours missed from school.

Included Co-variables

Demographic information and self-reported symptoms of depression, anxiety, inattention and hyperactivity (ADHD), and conduct problems were included and used as control variables in the main regression analyses.

Demographic Information

Age and gender were retrieved from registry data. In addition, socioeconomic status (SES) was collected by a self-reported item of perceived family economy as either (1) “about the same as others” (67%) (2) “better than others” (26%), or (3) “worse than others” (7%). Information on maternal and paternal educational attainment was collected by two self-report items separating the parental educational attainment variable into only primary school, high school, or more than 4 years of University or higher education. Both perceived family economy and parental educational attainment have been used as measures for SES in previous publications (e.g., Skogen et al., 2014) and have been found to be comparably associated with mental health problems (Bøe et al., 2012). The variables of perceived family economy, paternal educational attainment, and maternal educational attainment were all used as a measure of socioeconomic status (SES), and were included as control variables in the logistic regression models for the associations between alcohol and illicit

drug use, and potential alcohol/drug-related problems, and the school-related outcomes of interest.

Mental Health Problems

Symptoms of depression was assessed using the short version of the Mood and Feelings Questionnaire (SMFQ) (Thapar and McGuffin, 1998). The SMFQ consist of 13 items assessing depressive symptoms rated on a 3-point scale, ranging from “Not true,” “Sometimes true,” and “True.” A continuous measure of the SMFQ has recently been validated among Norwegian adolescents (Lundervold et al., 2013), and was used in the regression analyses in our study. In our sample the Cronbach’s α of the SMFQ was 0.88.

Symptoms of anxiety were correspondingly identified by employing the five-item inventory SCARED, which is a short form of the 41-item full version screening inventory for anxiety disorders (Birmaher et al., 1999). A continuous measure of the SCARED was used in our regression analyses. The Cronbach’s α of the short form of the SCARED instrument in our sample was 0.69.

Symptoms of inattention and hyperactivity were measured using an official Norwegian translation of the Adult ADHD Self-report Scale (ASRS) (Kessler et al., 2007). The ASRS instrument is an 18-item self-report scale, where 9 items construct the hyperactivity-impulsivity subscale and the 9 other items construct the inattention subscale. Responses are given on a 5-point scale ranging from “Never” to “Very often.” The Cronbach’s α of the ASRS in our sample was 0.89.

Symptoms of conduct problems were measured using the Youth Conduct Disorder (YCD) instrument, consisting of 8 items which are part of the Diagnostic Interview Schedule for Children Predictive Scales (DPS) (Lucas et al., 2001). The DPS scale has been shown to accurately determine adolescents who are at high probability of meeting diagnostic criteria for conduct disorder. The Cronbach’s α of the YCD in our sample was 0.79.

Statistical Analysis

The following statistical analyses were conducted: First, the sample was described according to age, gender, socioeconomic status, school-related functioning, and alcohol and drug use (Table 1). Second, odds ratios of the associations between alcohol/drug-related variables and the school-related variables were computed using logistic regression models (Table 2). More specifically, crude regression models were utilized, followed by adjustments for age, gender and SES, and finally adjusted for age, gender, SES, and mental health problems. Third, logistic regression analyses were conducted for the associations between ordinal number of indications on alcohol/drug-related problems and school-related outcomes, and also these associations were adjusted for the potential confounding by age, gender, SES and mental health problems. Fourth, crude and adjusted logistic regression models were conducted for associations between ordinal levels of alcohol consumption and the school-related outcomes. All analyses were performed using STATA V.14.0 (StataCorp., 2015).

TABLE 1 | Demographical and mental health-related characteristics in the adolescents of the sample ($n = 7,874$).

Demographics	Girls	Boys	p-value
Girls, %	52.3		<0.001
Age, mean (SD)	17.4(0.8)	17.4(0.8)	n.s.
Perceived family economy, %			<0.01
Below average	8.1	6.2	
Average	70.3	64.6	
Above average	21.6	29.3	
Mothers education, % ^a			n.s.
University/college	11.4	9.7	
High school	40.9	43.3	
Primary school	47.7	47.0	
Fathers education, % ^b			n.s.
University/college	11.5	10.8	
High school	46.3	48.1	
Primary school	42.3	41.1	
ALCOHOL AND ILLICIT DRUG USE			
Tried alcohol, %	81.1	75.2	<0.001
Tried illicit drugs, %	8.5	11.7	<0.001
CRAFFT-score ≥ 2 , %	22.9	19.4	<0.001
Frequent drinking to intoxication, %	20.0	20.3	n.s.
MENTAL HEALTH PROBLEMS^c			
Depression symptoms, mean (SD)	7.29(6.04)	4.08(4.87)	<0.001
Anxiety symptoms, mean (SD)	2.02(1.91)	0.93(1.51)	<0.001
ADHD symptoms, mean (SD)	28.32(10.07)	25.08(10.85)	<0.001
Conduct problems symptoms, mean (SD)	0.38(0.95)	0.71(1.48)	<0.001
SCHOOL-RELATED FUNCTIONING			
GPA, mean (SD)	3.95(0.78)	3.73(0.80)	<0.001
Days missed, mean (SD)	4.51(5.26)	3.49(4.72)	<0.001
Hours missed, mean (SD)	7.58(10.68)	7.44(11.55)	n.s.

CRAFFT: screening scale for identification of potential problematic alcohol and drug use among adolescents.

^a Only includes those who with valid response on mothers education ($n = 5,937$), excluding those having answered that they don't know ($n = 1,881$).

^b Only includes those who with valid response on fathers education ($n = 5,819$), excluding those having answered that they don't know ($n = 1,979$).

^c The measure for mental health problems includes depression (SMFQ), anxiety (SCARED), inattention/hyperactivity (ASRS), and conduct problems (YCD).

RESULTS

Demographical and Mental Health-Related Characteristics in the Sample

The adolescents which were excluded ($n = 2,383$) due to either non-consent for the usage of school registry data, or to missing information on either school registry data or alcohol- and illicit drug use, were found to deviate slightly from the adolescents of the final sample. They were more likely to be younger (mean difference -0.13 , $p < 0.001$), to have mothers with higher

educational attainment (mean difference 0.11 , $p < 0.01$) and fathers with higher educational attainment (mean difference 0.15 , $p < 0.001$), to have more symptoms of depression measured by SMFQ (mean difference 0.76 , $p < 0.001$), and to have more symptoms of inattention or hyperactivity measured by ASRS (mean difference 0.74 , $p < 0.01$). The adolescents who were excluded from the sample and which had valid responses on alcohol and illicit drug use, were found to be less likely to have tried alcohol than the adolescents in the included sample (73.1% compared to 78.3%, $p < 0.001$), but did not deviate on having tried illicit drugs or on the extent to which they had a positive CRAFFT score.

The final sample consisted of $N = 7,874$ participants. **Table 1** outlines the main demographical characteristics of the final sample, as well as the characteristics on alcohol and illicit drugs and school-related variables. The mean age of the sample was 17.4 years (standard deviation 0.83), and the sample included more girls (52.3%, $p < 0.001$). Regarding alcohol- and illicit drug use, a total of 78.3% of the sample had used alcohol, 10.0% had tried illicit drugs, 21.2% scored above the CRAFFT cut-off at ≥ 2 , indicating a problematic alcohol and drug use, and 20.2% of the sample reported to having been intoxicated by alcohol more than 10 times.

Some gender differences were found in the sample. Lower perceived family economy were more common among girls ($p < 0.01$). Girls had higher mean scores compared with boys on symptoms of depression (7.29 vs. 4.08, $p < 0.001$), anxiety (2.02 vs. 0.93, $p < 0.001$) and ADHD (28.32 vs. 25.08, $p < 0.001$), while boys had higher mean scores compared with girls on symptoms of conduct problems (0.71 vs. 0.38, $p < 0.001$). Girls were also more likely to have ever tried alcohol (81.1 vs. 75.2%, $p < 0.001$) and to have a positive CRAFFT score (22.9 vs. 19.4%, $p < 0.001$), while boys were more likely to have tried illicit drugs (11.7 vs. 8.5%, $p < 0.001$). Finally, girls had a higher mean GPA (3.95 vs. 3.74, $p < 0.001$) and a higher number of days missed from school (4.51 vs. 3.49, $p < 0.001$) compared to boys.

Alcohol- and Illicit Drug Use and School-Related Outcomes

Table 2 depicts the crude and adjusted associations between alcohol- and illicit drug use and the school-related outcomes of GPA, days missed from school, and hours missed from school. As detailed in this table, all the alcohol- and drug measures in the crude model were consistently associated (all $p < 0.001$) with low GPA (Odds ratios (OR) ranging 1.82–2.21) and high number of days missed (ORs ranging 1.79–3.04) and hours missed (ORs ranging 2.17–3.44).

When adjusting for age, gender, self-reported family SES and mental health problems the estimated associations were somewhat altered, but even in the fully adjusted model, all measures of alcohol- and illicit drug use still showed statistically significant associations with low GPA (Adjusted odds ratios (AOR) ranging from 1.48 to 2.04, all $p < 0.05$), and high number of days missed (AORs ranging 1.44–2.31, all $p < 0.01$) and high

TABLE 2 | Logistic regression analyses of associations between alcohol- and illicit drug use and negative school-related outcomes.

	Low GPA		High number of days missed from school		High number of hours missed from school	
	OR	95% CI	OR	95% CI	OR	95% CI
TRIED ALCOHOL (n = 6,159)						
Crude	1.98***	1.70, 2.31	2.20***	1.74, 2.78	2.99***	2.32, 3.84
Adjusted for age, gender and SES	2.12***	1.79, 2.50	1.85***	1.44, 2.36	2.59***	1.99, 3.36
+ adj for mental health problems ^a	1.83***	1.54, 2.18	1.60***	1.25, 2.06	2.09***	1.60, 2.73
TRIED ILLICIT DRUGS (n = 788)						
Crude	1.82***	1.36, 2.44	3.04***	2.51, 3.69	3.44***	2.86, 4.14
Adjusted for age, gender and SES	1.92***	1.42, 2.58	2.81***	2.29, 3.44	3.12***	2.57, 3.79
+ adj for mental health problems ^a	1.48*	1.09, 2.01	2.31***	1.87, 2.86	2.28***	1.86, 2.80
POSITIVE CRAFFT-SCORE (n = 1,664)						
Crude	2.04***	1.65, 2.52	2.41***	2.04, 2.83	2.41***	2.06, 2.83
Adjusted for age, gender and SES	2.05***	1.65, 2.54	2.13***	1.80, 2.52	2.21***	1.88, 2.60
+ adj for mental health problems ^a	1.60***	1.27, 2.00	1.70***	1.42, 2.04	1.53***	1.28, 1.83
FREQUENT ALC INTOXICATION^b (n = 1,588)						
Crude	2.14***	1.68, 2.72	1.79***	1.51, 2.14	2.17***	1.84, 2.56
Adjusted for age, gender and SES	2.31***	1.80, 2.96	1.63***	1.35, 1.96	2.05***	1.72, 2.44
+ adj for mental health problems ^a	2.04***	1.59, 2.63	1.44***	1.19, 1.74	1.70***	1.42, 2.04
HIGH ALCOHOL CONSUMPTION^c (n = 453)						
Crude	2.12***	1.42, 3.17	1.97***	1.51, 2.56	2.68***	2.11, 3.40
Adjusted for age, gender and SES	2.00**	1.33, 3.00	1.71***	1.29, 2.26	2.51***	1.96, 3.23
+ adj for mental health problems ^a	1.66*	1.10, 2.51	1.48**	1.11, 1.97	1.90***	1.46, 2.47
ANY ALCOHOL/DRUG PROBLEM (n = 2,710)						
Crude	2.21***	1.86, 2.63	2.49***	2.13, 2.90	2.82***	2.42, 3.28
Adjusted for age, gender and SES	2.30***	1.92, 2.76	2.17***	1.85, 2.56	2.60***	2.21, 3.04
+ adj for mental health problems ^a	1.90***	1.58, 2.30	1.85***	1.56, 2.19	1.98***	1.67, 2.35

N = 7,874 (girls n = 4,121, boys, n = 3,753).

^aThe measure for mental health problems includes depression (SMFQ), anxiety (SCARED), inattention/hyperactivity (ASRS), and conduct problems (YCD).

^bDrinking alcohol to intoxication more than 10 times.

^c ≥90th percentile gender-specific alcohol consumption (n = 453) among adolescents with a present alcohol consumption (n = 4,503).

Bold font denotes statistical significant mean differences at ***p < 0.001, **p < 0.01, *p < 0.05.

number of hours missed (AORs ranging from 1.53 to 2.28, all $p < 0.001$).

Ordinal Levels of Potential Alcohol/Drug-Related Problems and School-Related Outcomes

Table 3 outlines the associations between ordinal number of indications on alcohol/drug-related problems and school-related outcomes. For GPA the odds ratios ranged from 2.01 to 2.91 (all $p < 0.001$) in crude models, and from 1.78 to 2.35 in fully adjusted models (all $p < 0.01$). For days missed from school the odds ratios ranged from 2.08 to 4.69 in crude models and from 1.72 to 3.13 in fully adjusted models (all $p < 0.001$), while the odds ratios for hours missed from school ranged from 2.02 to 5.17 in crude models and from 1.62 to 2.93 in fully adjusted models (all $p < 0.001$). In both the crude and adjusted models there were statistically significant monotonous trends in the associations between increasing levels of potential alcohol/drug-related problems and increasingly adverse school-related outcomes (all $p < 0.001$), indicating that more indicators

of alcohol/drug-related problems were associated with more negative school-related outcomes.

Ordinal Levels of Alcohol Consumption and School-Related Outcomes

Table 4 depicts the crude associations between ordinal levels of alcohol consumption and the school-related outcomes of low GPA, high number of days missed from school, and high number of hours missed from school. As detailed in the table, increasing levels of alcohol consumption were associated with lower GPA and a higher number of days and hours missed from school, and for all the school-related outcomes of interest these monotonous trends were statistically significant in both the crude and fully adjusted models (all $p < 0.001$).

DISCUSSION

Main Findings

The aim of this study was to investigate the associations between alcohol and drug use, and alcohol/drug-related problems, and school-related problems measured by low GPA and high number

TABLE 3 | Logistic regression analyses of associations between ordinal levels of potential alcohol/drug-related problems and negative school-related outcomes.

	Low GPA ^a		High number of days missed from school ^a		High number of hours missed from school ^a	
	OR	95% CI	OR	95% CI	OR	95% CI
No alc/drug problems (<i>n</i> = 5,164)	(Base)		(Base)		(Base)	
1 INDICATION OF ALC/DRUG PROBL (<i>n</i> = 1,439)						
Crude	2.01***	1.62, 2.49	2.08***	1.71, 2.53	2.02***	1.66, 2.47
Adjusted for age, gender and SES	2.03***	1.63, 2.53	1.90***	1.55, 2.33	1.92***	1.57, 2.35
+ adj for mental health problems ^b	1.78***	1.42, 2.23	1.72***	1.39, 2.12	1.63***	1.32, 2.01
2 INDICATIONS OF ALC/DRUG PROBL (<i>n</i> = 743)						
Crude	2.81***	2.02, 3.90	2.40***	1.89, 3.06	3.13***	2.50, 3.91
Adjusted for age, gender and SES	2.92***	2.08, 4.09	2.13***	1.66, 2.73	2.85***	2.26, 3.59
+ adj for mental health problems ^b	2.35***	1.66, 3.31	1.80***	1.39, 2.33	2.17***	1.70, 2.76
3–4 INDICATIONS OF ALC/DRUG PROBL (<i>n</i> = 468)						
Crude	2.91***	1.84, 4.60	4.69***	3.61, 6.11	5.17***	4.00, 6.69
Adjusted for age, gender and SES	2.98***	1.87, 4.74	3.95***	2.98, 5.22	4.36***	3.32, 5.71
+ adj for mental health problems ^b	2.17**	1.35, 3.48	3.13***	2.33, 4.22	2.93***	2.17, 3.91

N = 7,874 (girls *n* = 4,121, boys, *n* = 3,753).

^a*p*-value for trend in the association between potential alcohol/drug-related problems and school-related outcomes, all *p* < 0.001.

^bThe measure for mental health problems includes depression (SMFQ), anxiety (SCARED), inattention/hyperactivity (ASRS), and conduct problems (YCD).

Bold fonts denotes statistically significant associations: ****p* < 0.001, ***p* < 0.01.

TABLE 4 | Logistic regression analyses of associations between ordinal levels of alcohol consumption^a and negative school-related outcomes.

	Low GPA ^b		High number of days missed from school ^b		High number of hours missed from school ^b	
	OR	95% CI	OR	95% CI	OR	95% CI
CRUDE MODEL						
Never consumed alcohol	(Base)		(Base)		(Base)	
Non-consumption	1.42**	1.14, 1.76	1.61**	1.19, 2.19	1.74**	1.25, 2.42
0.1–19.9th percentile	1.21	0.96, 1.52	1.59**	1.14, 2.21	1.88***	1.32, 2.67
20–49.9th percentile	1.99***	1.59, 2.48	1.97***	1.49, 2.62	2.64***	1.97, 3.55
50–79.9th percentile	3.24***	2.50, 4.21	2.77***	2.12, 3.64	4.03***	3.04, 5.34
80–89.9th percentile	3.28***	2.15, 5.01	3.77***	2.70, 5.27	5.09***	3.61, 7.18
90–100th percentile	2.97***	2.01, 4.40	3.05***	2.17, 4.29	6.05***	4.37, 8.40
FULLY ADJUSTED^c						
Never consumed alcohol	(Base)		(Base)		(Base)	
Non-consumption	1.35**	1.08, 1.69	1.36	0.99, 1.88	1.49*	1.06, 2.10
0.1–19.9th percentile	1.34*	1.05, 1.72	1.30	0.91, 1.84	1.60*	1.12, 2.30
20–49.9th percentile	2.01***	1.58, 2.56	1.50**	1.11, 2.03	1.98***	1.45, 2.72
50–79.9th percentile	3.14***	2.37, 4.17	1.83***	1.36, 2.46	2.83***	2.09, 3.83
80–89.9th percentile	2.82***	1.82, 4.38	2.50***	1.74, 3.59	3.50***	2.43, 5.04
90–100th percentile	2.62***	1.75, 3.94	2.06***	1.42, 2.98	4.01***	2.81, 5.71

N = 7,874 (girls *n* = 4,121, boys, *n* = 3,753).

^aPresented alcohol level consumption percentiles are calculated among those adolescents who report to have an actual alcohol consumption.

^b*p*-value for trend in the association between alcohol variable and school-related variable: all *p* < 0.001.

^cAdjusted for the confounding of age, gender, SES and mental health problems.

Bold fonts denotes statistically significant associations: ****p* < 0.001, ***p* < 0.01, **p* < 0.05.

of days and hours missed from school. In short, all the alcohol- and drug measures included were consistently associated with low GPA and high number of days and hours missed from school. In this respect, our study supports several previous studies which have reported that adolescent alcohol- and illicit drug use are associated with lower academic achievement (e.g., Williams et al., 2003; DeSimone, 2010; Homel et al., 2014) and increased

absence from school (e.g., Roebuck et al., 2004; Hemphill et al., 2014), while it contradicts some recent studies which indicates that alcohol/drug use should not be regarded as particularly important factors for school-related functioning (Sabia, 2010; Balsa et al., 2011; Brière et al., 2014).

Few previous studies have investigated the extent to which the associations between alcohol- and illicit drug use/problems and

negative school-related outcomes may be confounded by mental health problems, along with SES, gender and age. Theoretically, this is a highly relevant issue, as the association between school-related adverse outcomes and adolescent alcohol and illicit drug use is likely to be complex and not necessarily causal in its nature (e.g., Busch et al., 2014; Stiby et al., 2015). It is suggested that the often observed association between alcohol and illicit drug use and school-related outcomes may be either direct (e.g., Latvala et al., 2014), that it may be a reverse association (e.g., Crosnoe, 2006; Brière et al., 2014), or that it may be caused by third factors which operate in ways that creates the observed association (e.g., Crosnoe, 2006). Importantly, as developmental models conceptualize alcohol and illicit drug use among adolescents as expressions of a broader tendency toward either internalizing problems or externalizing problems (e.g., Chassin et al., 2013), observed associations between alcohol and illicit drug use and school-related outcomes may therefore be hypothesized to merely be a marker of these broader tendencies.

In our study we adjusted the associations between alcohol- and illicit drug use/problems for the potential confounding from gender, age, socioeconomic factors and mental health problems, in accordance with recommendations from previous studies on this topic (e.g., Sabia, 2010; Balsa et al., 2011). We found that these confounders accounted for some, but not all of the association. In the fully adjusted models all associations between alcohol and illicit drug use/problems and the negative school-related outcomes were still statistically significant, although the size of the odds ratios were generally reduced, particularly when mental health problems were entered into the model. Therefore, our findings suggest that alcohol- and illicit drug use, and potential alcohol/drug-related problems, has a unique contribution to the association with negative school-related outcomes, which only in part may be attributed to the presence of mental health problems, and therefore to the broader tendencies to either internalizing or externalizing problems.

These findings extend the existing literature. A previous study by Sabia (2010) reported that after adjusting for psychological well-being and factors and individual changes in alcohol use, much of the association between alcohol use and grades disappeared. Similarly, Hemphill et al. (2014) reported that most of the association between alcohol use and subsequent grades and school attendance disappeared when adjusting for a range of individual, family, peer and school-related confounders. In our study the association between alcohol and illicit drug use and school-related outcomes consistently remained robust and statistically significant after adjusting for age, gender, socioeconomic status, and mental health.

We also wanted to explore how potential alcohol/drug-related problems contributed to the association between alcohol/drug use and negative school-related outcomes. The CRAFFT instrument is a widely used screening tool for potential alcohol/drug-related problems among adolescents, providing a broader perspective of adolescent alcohol and illicit drug use than self-reported frequency of alcohol and illicit drug use alone (Agle et al., 2015). CRAFFT has been found to correlate with other measures of substance use in adolescents, supporting its efficacy as a screening tool among adolescents (Pilowsky and Wu, 2013; Skogen et al., 2013; Oesterle et al., 2015). In the present

findings potential alcohol/drug-related problems as measured by the CRAFFT instrument were consistently associated with negative school-related function in terms of low GPA and high number of days and hours missed from school. The magnitude of the associations between alcohol/drug-related problems as indicated by a positive CRAFFT score and school-related problems was comparable to the magnitudes of the associations between the other included measures of alcohol/drug use and school-related problems. However, we also added supplementary measures for potential alcohol/drug-related problems, in terms of ordinal number of indicators on problematic alcohol and illicit drug use, and we found that higher number of indicators on potential alcohol/drug-related problems was associated with higher levels of school-related problems.

Similarly, the associations with negative school-related outcomes increased with ordinal increases of alcohol consumption levels. This tendency was found with regards to all the negative school-related measures. To our knowledge no previous studies have investigated how increasing levels of either potential alcohol/drug-related problems or alcohol consumption correspond to negative school-related outcomes, such as GPA or school attendance. A previous study reported a dose-response effect between cannabis use and results on standardized assessment test at age 16 (Stiby et al., 2015), while we have not found other studies reporting on how ordinal or continuous levels of alcohol- and illicit drug use/problems are associated with either school grades or school attendance rates. In short, our findings indicate that increasing levels of indicators of alcohol/drug-related problems and increasing levels of alcohol consumption are associated with increasing school-related problems, indicating that high-risk alcohol/drug use is strongly associated with school-related problems. We did not have available data to investigate if these patterns also applied to increasing levels of illicit drug use; something which should be addressed in future studies.

A final noteworthy finding in our study was that the association between alcohol use and negative school-related outcomes were not constricted to only a certain type of drinking pattern, and the magnitude on the association with the school-related problems only slightly varied across different measures of alcohol use. A previous study reported that binge drinking, but not alcohol use without bingeing, were associated with somewhat lower GPA (DeSimone, 2010). Although we did not have a variable which directly measured binge drinking, we found that both frequent alcohol intoxication and other measures of alcohol use were consistently associated with lower grade achievement, thereby contradicting the findings from DeSimone and colleges. Overall, our findings suggest that all types of alcohol and illicit drug use were associated with negative school-related outcomes, with comparable magnitudes between all measures of alcohol/drug use, and that increasing numbers of indicators for potential alcohol/drug-related problems was associated with more school-related problems.

Implications

Our study suggest that alcohol and illicit drug use should be regarded as important factors for school-related functioning among adolescents, and that alcohol and illicit drug use has

a unique contribution to negative school-related outcomes in terms of low GPA and high number of days and hours missed from school. Although positive associations were found for all included measures of alcohol/drug use, the most high-risk alcohol/drug use patterns had clearly the strongest associations with school-related problems. An important implication of this study is that alcohol/drug use, and particularly the most risky patterns of alcohol/drug use, should be targeted in initiatives aiming at better school-functioning among adolescents. Future studies should be encouraged to investigate to what extent short-term school problems, such as poor grades and high school-absence, serve as mediators between alcohol/drug use and more long-term negative school-related outcomes, as very few studies have explored this possibility (Perini and Marti, 2011).

Strengths and Limitations

The present study has several strengths. First, the sample consists of a well-defined population-based sample of adolescents in the age 16–19 years, which is sufficiently large to enable a detailed investigation of main effects between alcohol- and illicit drug use and school-related outcomes, along with sub-analyses of ordinal levels of alcohol consumption and potential alcohol/drug-related problems. Second, a unique linkage to the official school-registry was utilized, facilitating an investigation of objective data on GPA and days and hours missed from school. Third, the data from our study sample is recent, thus allowing for an updated view into the current status of alcohol- and drug use and its association with school-related outcomes. Fourth, the study used several measures of alcohol- and drug use, including a validated measure of potential alcohol- and drug related problems, i.e., the CRAFFT instrument, along with measures of increasing levels of potential indicators for alcohol/drug-related problems. Fifth, other standardized measures of symptoms on anxiety, depression as well as hyperactivity and inattention, were used in our study. Finally, we adjusted our analyses for a range of potential confounders on the association between alcohol and illicit drug use and school-related problems.

The present study has some limitations. First, the study has a cross-sectional design, and it is therefore not possible to draw conclusion on causality between alcohol and illicit drug use and school-related outcomes based on this study. Second, due to some adolescents not giving consent to use registry data, to missing data in the school-registry, and missing responses on the alcohol- and illicit drug variables, a total of 23% ($n = 2,383$) of the school-attending adolescents aged 16–19 were not included in our study. Our analyses revealed that this excluded group reported somewhat higher education among their parents, they were younger, and had more symptoms from depression and ADHD. Additionally, they were less likely to have tried alcohol. In sum, this may affect the generalizability of our findings among the school-attending adolescents. Third, the questionnaire which measured both the alcohol- and illicit drug use and the mental health variables, were solely based on self-report. This may have led to a bias in the data due to misclassification of the independent and control variables used in this study. The use of self-reported measures does not imply the presence of actual

psychiatric or substance-related diagnoses, and the lack of clinical interviews in the collection of data on mental health and alcohol- and drug use adds as a limitation to our study. Fourth, we did not include chronic illness as a confounding variable. We may not rule out that chronic illness may have played a confounding role on the association between alcohol/drug use and school-related problems, something which could be addressed in future studies. Fifth, we did not investigate cumulative effects from alcohol/drug use in combination with other potential risk factors such as mental health problems on school-related problems, as this issue is beyond the scope of the present paper. Finally, residual confounding may be an issue.

CONCLUSION

Adolescence is a time period where it is common to experiment with alcohol and illicit drugs, and many of the adolescents which display a risky alcohol and drug use will neither develop long-lasting substance problems nor school- or later work-related problems. However, the results from our study indicate that alcohol- and drug-related problems are important factors in school-related functioning. Importantly, alcohol- and illicit drug use, and potential alcohol/drug-related problems, were consistently associated school-related problems, even when no mental health problems are present, and the associations were particularly strong among adolescents with the most risky alcohol/drug use patterns. Our study highlight the need to keep adolescent's use of alcohol and illicit drugs as an important concern for prevention initiatives at all levels of the society surrounding the adolescents. In particular, efforts aiming to increase school-related functioning among adolescents should be aware of the important role of reducing levels of alcohol and illicit drug use (e.g., Engberg and Morral, 2006). Measures should be made to ensure a proper identification of adolescents at the highest risk for problematic alcohol- and illicit drug use, along with access to and utilization of health care services when needed; while initiatives aiming at reducing total levels of alcohol- and drug use among adolescents are also encouraged.

AUTHOR CONTRIBUTIONS

OH has carried out the literature review for the introduction and discussion sections, conducted the statistical analyses, and has written the manuscript. MH, JH, and JS has been involved in the preparation and conduction of the statistical analyses, and have reviewed and contributed to all parts of the written manuscript.

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Prospective associations between childhood externalising and internalising problems and adolescent alcohol and drug use: The Bergen Child Study

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Abstract

Aims: The literature on associations between internalising problems and subsequent alcohol/drug use and problems shows mixed results, and it is important to consider different aspects of internalising problems along with co-occurring externalising problems. **Methods:** In a longitudinal

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study ($n = 2438$) followed up when the subjects were 7–9, 11–13, and 16–19 years of age, we investigated associations between parent/teacher-reported externalising and internalising problems (Strengths and Difficulties Questionnaire, SDQ) and adolescent self-reported alcohol and illicit drug use and problems. Socioeconomic status (SES), gender, and age were included as potential confounding variables. We also adjusted for the potential confounding effects from externalising problems on the association between internalising problems and alcohol/drug use, and vice versa. **Results:** Externalising problems were positively associated with all measures of alcohol/drug use and problems (adjusted odds ratios [AORs] ranging from 1.24 to 1.40, all $p < .05$), while internalising problems were negatively associated with all measures of alcohol/drug use (AORs ranging 0.83 to 0.88, all $p < .05$). Full-scale SDQ externalising problems were somewhat stronger and more robust predictors of adolescent alcohol/drug-related problems compared with SDQ externalising subscales, while only full-scale SDQ internalising problems were negatively associated with alcohol/drug-related problems. All estimates were similar across genders. **Conclusions:** Childhood externalising problems are positively associated while internalising problems are negatively associated with alcohol/drug use and problems in late adolescence.

Keywords

adolescence, alcohol use, drug use, externalising problems, internalising problems, longitudinal

Adolescence can be characterised by an escalation of alcohol and illicit drug use (Chassin, Sher, Hussong, & Curran, 2013), and the use of alcohol/drugs during adolescence may serve as a potent risk factor for both prolonged alcohol- and drug-related problems (Fergusson, Boden, & Horwood, 2008) and mental health problems (Marmorstein, 2009). However, the nature of the association between mental health problems and alcohol and drug use is complex, leading to suggestions of different etiological pathways and mechanisms (e.g., Chassin et al., 2013; Schulenberg & Maggs, 2002).

A range of previous publications demonstrate that childhood externalising problems – in which symptoms of deviancy, conduct problems, and hyperactivity/inattention are prominent – are important precursors to alcohol/drug use during adolescence (e.g., Fergusson, Horwood, & Ridder, 2007; Heron et al., 2013; Miettunen et al., 2014). However, previous literature on associations between childhood internalising problems – in which symptoms of depression, anxiety, peer problems, and social withdrawal are important – and adolescent alcohol/drug use is marked by a lack of

consistent results. Some recent contributions have even pointed to a negative association between internalising problems and adolescent alcohol/drug use (Colder et al., 2013; Edwards et al., 2014; Scalco et al., 2014).

Previous findings highlight that a core feature in the externalising pathway towards substance use is behavioural disinhibition (Iacono, Malone, & McGue, 2008), whereas negative affect has been proposed as an important feature of internalising problems that may heighten the risk of hazardous alcohol/drug involvement (Hussong, Ennett, Cox, & Haroon, 2017; Hussong, Jones, Stein, Baucom, & Boeding, 2011). This is consistent with the broader self-medication hypothesis (e.g., Chassin et al., 2013; Khantzian, 1987), while internalising tendencies towards social withdrawal and fear of negative consequences are aspects suggested to decrease the risk of exposure to alcohol/drug use (Colder, Chassin, Lee, & Villalta, 2010; Hussong et al., 2011). Still, few empirical investigations have actually examined how specific internalising symptoms, such as peer/relationship problems and emotional problems, may affect alcohol/drug use, although these

internalising factors may be differentially associated with adolescent alcohol/drug-related behaviours.

Importantly, comorbidity rates between internalising and externalising symptoms are high in childhood and adolescence (Chan, Dennis, & Funk, 2008), and it is likely that such high rates of comorbidity may obscure the unique associations between internalising symptoms and alcohol/drug-related problems (Hussong et al., 2011). It is therefore recommended that developmental models of internalising symptoms and alcohol/drug use should also consider externalising symptoms (Colder et al., 2018; Hussong et al., 2017). Although the majority of previous studies do not attempt to control for externalising symptoms when associations between internalising problems and alcohol/drug use are investigated (Hussong et al., 2011), a growing body of research has emerged complying with the recommendation to control for co-occurring externalising symptoms (for a review, see Hussong et al., 2017). For example, a study by Colder and colleagues (2013) demonstrated that externalising problems in the absence of internalising problems yielded the strongest longitudinal association with both alcohol/drug use during early adolescence (12–16 years). For externalising problems in combination with internalising problems, a weak but statistically significant positive association with alcohol/drug use was found. Finally, internalising problems in the absence of externalising problems were associated with lower alcohol/drug use.

Our study uses the Strengths and Difficulties Questionnaire (SDQ) to investigate how childhood externalising and internalising problems precede alcohol/drug-related problems during late adolescence. We hypothesise that childhood externalising problems will have a robust positive association with adolescent alcohol/drug-related problems, and that childhood internalising problems are negatively associated with adolescent alcohol/drug-related problems, particularly after the adjustment of externalising problems. We also investigate how

subtypes of externalising and internalising problems are differentially associated with alcohol/drug-related problems. We expected that both SDQ subscales of externalising problems (conduct problems and inattention/hyperactivity) are positively associated with alcohol/drug-related problems, and that the SDQ internalising subscale of peer/relationship problems is more strongly negatively associated with alcohol/drug-related problems compared with the SDQ internalising subscale of emotional problems, due to the conceptual proximity between peer/relationship problems and social withdrawal processes. Our study adds to the knowledge base with data from a large, longitudinal sample of Norwegian children.

Methods

Participants

The sample comprised participants from the Bergen Child Study (BCS; for more information about the BCS and related publications, see uni.no/en/bergen-child-study), and the data stem from the first, second, and fourth waves of this study. The BCS is a longitudinal total population study of children in all public and private schools in the city of Bergen, Norway. The fourth wave of the BCS is nested within the youth@hordaland survey (Sivertsen, Harvey, Pallesen, & Hysing, 2017) covering the whole Hordaland county, in which Bergen is the largest city, as its target population. The BCS has been utilised in a range of previously published studies, and has also recently been used in a longitudinal design (Sivertsen et al., 2017).

The first wave of the BCS, conducted in autumn 2002, comprised a target population of 9430 primary-school children aged 7–9 years from the city of Bergen, and informed consent to participate was received from 7007 parents (74%) prior to inclusion in the study. The second wave was conducted four years later during spring 2006, and 5683 children aged 11–13 years participated (60% of the original target

population). Six years later in winter/spring 2012, when the adolescents were 16–19 years of age, the target population was expanded to include the whole county of Hordaland, and 10,253 (53%) of the 19,439 invited adolescents participated. The three waves used in our study are labelled T1, T2, and T3.

A total of 2438 adolescents had participated in T1, T2, and T3 with valid parent or teacher responses on the Strengths and Difficulties Questionnaire (SDQ) at both T1 and T2, and therefore comprised the final sample. The mean age of the total sample at T3 was 17.4 years (standard deviation 0.8), and 53.7% of the sample were girls.

The study was approved by the Regional Committee for Medical and Health Research Ethics in Western Norway.

Explanatory variables: Childhood mental health problems

The variable of mental health problems was defined by scores on the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997), which was completed separately by parents and teachers at T1 and T2. The SDQ is a screening questionnaire for children and adolescents aged 4–16 years, consisting of 25 items which describe positive and negative characteristics of children within five subscales: (1) emotional problems, (2) conduct problems, (3) hyperactivity/inattention problems, (4) peer/relationship problems, and (5) pro-social behaviour (not used in the current study). Each item is scored on a three-point scale – not true, somewhat true, and certainly true – with total subscale scores each ranging from 0 to 10.

The SDQ has been validated in several countries (Heiervang et al., 2007; Muris, Meesters, & van den Berg, 2003). A recent review found that the psychometric properties of the SDQ are strong, and recommended its use as a screening instrument (Stone, Otten, Engels, Vermulst, & Janssens, 2010). Importantly, the use of broader internalising and externalising scales from the SDQ is found to be acceptable in low-risk

samples (Goodman, Lamping, & Ploubidis, 2010), has a good fit with the included subscales (Van Roy, Veenstra, & Clench-Aas, 2008), and the scales are relatively “uncontaminated” by one another (Goodman & Scott, 1999). Additionally, the prosocial scale has low correlation with the other four subscales (Goodman, 2001; Van Roy et al., 2008), supporting its exclusion from our analyses.

Accordingly, an externalising problems scale was constructed by merging the subscales of conduct problems and hyperactivity/inattention problems, while an internalising problems scale was constructed by merging the subscales of emotional problems and peer/relationship problems. We were interested in externalising/internalising symptoms that were present over time and across informants, and therefore added together the responses from teachers and parents from T1 and T2, and summed the scales to single, continuous variables. Moderate correlations between parent and teacher reports were found for both the externalising problems scale ($R = 0.51$) and the internalising problems scale ($R = 0.47$), which were evaluated as acceptable. The Cronbach's α of the SDQ scales ranged from 0.81 to 0.85 in our sample.

Externalising problems. We constructed a single, continuous externalising problems variable including 2263 individuals (55.5% girls) and ranging from 0 to 57 ($M = 9.72$, $SD = 7.86$). For the purpose of secondary analyses, we also constructed a subscale for conduct problems ($M = 2.26$, $SD = 2.75$) and hyperactivity/inattention ($M = 7.47$, $SD = 5.91$).

Internalising problems. Similarly, we constructed a single, continuous internalising problems variable including 2266 individuals (55.4% girls) and ranging from 0 to 53 ($M = 6.02$, $SD = 6.58$). For the purpose of secondary analyses, we also constructed a subscale for emotional problems ($M = 3.23$, $SD = 3.86$) and peer/relationship problems ($M = 2.79$, $SD = 3.71$).

Outcome variables: Alcohol- and drug-related problems

Self-reported measures of alcohol and drug use at T3 were our main dependent variables.

Ever tried alcohol. We used a single item “Have you ever tried alcohol?” (Yes/No) to determine whether individuals had ever tried alcohol, and the majority ($n = 1854$, 78.5%) of the sample confirmed having tried alcohol.

Ever tried illicit drugs. Similarly, we used another single item “Have you ever tried hash, marijuana, or other narcotic substances?” (Yes/No) to determine whether individuals had ever tried illicit drugs, and 291 (12.3%) participants confirmed that they had tried illicit drugs.

High-level alcohol consumption. We added up items measuring self-reported amounts of beer, cider, wine, spirits, and illegally distilled spirits usually consumed during 14 days, and each type of beverage was weighted according to its alcohol percentage. To accurately calculate alcohol consumption levels, we used data from the full sample ($n = 10,253$), and 5471 (53.3%) individuals reported any usual alcohol consumption. High-level alcohol consumption was defined as above the 80th gender-specific percentile alcohol consumption among the adolescents with any usual alcohol consumption. Based on this, a dichotomous variable was created. Within the final sample ($n = 2438$), 255 individuals reported high-level alcohol consumption, which constituted 11.4% of the sample and 18.5% of those with any usual alcohol consumption.

Frequent drinking to intoxication. Frequency of alcohol intoxication was measured by asking: “Have you ever consumed so much alcohol that you were clearly intoxicated (drunk)?” The original item had five response categories ranging from “No, never” to “Yes, more than 10 times”. Frequent intoxication was defined as drinking so much that one had been clearly intoxicated more than 10 times (Skogen et al.,

2014), and on this basis a dichotomous variable was created. Of the participants, 439 (18.0%) reported frequent intoxication.

A positive CRAFFT score. Alcohol- and drug-related problems were measured using the six-item, validated CRAFFT scale. This scale has been designed to identify possible alcohol- and drug-related problems among adolescents, and has been demonstrated to have acceptable sensitivity and specificity at a cutoff of ≥ 2 (Dhalla, Zumbo, & Poole, 2011), also in the target population of our study (Skogen, Bøe, Knudsen, & Hysing, 2013). The CRAFFT scale has been found to correlate with other measures of alcohol/drug use in adolescents, supporting its efficacy as a screening tool among adolescents (Oesterle, Hitschfeld, Lineberry, & Schneekloth, 2015; Skogen et al., 2013). A dichotomous variable was calculated separating those above the cutoff of ≥ 2 on CRAFFT from those below the cutoff. We identified 499 (21.2%) participants who scored above the CRAFFT cutoff, indicating potential alcohol- and drug-related problems. In our sample the Kuder–Richardson’s reliability score of the CRAFFT scale was 0.67.

Total alcohol and drug use indicators. Finally, we constructed an ordinal variable for total alcohol- and drug-use indicators, summing up the number of positive scores on frequent alcohol intoxication, high-level alcohol consumption, a positive CRAFFT score, and having tried illicit drugs (Heradstveit, Skogen, Hetland, & Hysing, 2017). A total of 1435 respondents (64.5%) had none, 423 (19.0%) had one, 207 (9.3%) had two, 129 (5.8%) had three, and 30 (1.4%) had four of these potential alcohol/drug-related problems. In our sample, the Cronbach’s alpha for this ordinal scale of total alcohol/drug use indicators was 0.63.

Included covariates

Age and gender for all participants were retrieved through personal identity numbers in

the Norwegian National Population Registry. In addition, we measured self-reported perceived economic well-being by an item where participants rated their family's economic situation either as (1) "Equal to others" (66.0%), (2) "Better than others" (28.8%), or (3) "Poorer than others" (5.2%). We also collected information on maternal and paternal educational attainment at T3 by two self-report items differentiating between primary school only, high school, or higher education. Perceived family economy, and maternal and paternal educational attainment were used as measures for socioeconomic status, and were entered separately into the regression analyses.

Statistical analysis

Data preparation. The distributions on the scales for externalising and internalising problems, and their subscales, were all skewed (skewness > 1, ranging from 1.55 to 2.48 as would be expected in a community sample) (Woerner, Becker, & Rothenberger, 2004). We transformed these scales using a log transform (Rønning, Handegaard, Sourander, & Mørch, 2004), which improved the normality of the data (skewness < 1, ranging from -0.32 to 0.35). All analyses are reported on log-transformed SDQ data.

Descriptive statistics and regression analyses. We conducted the following statistical analyses: First, the sample was described by demographics, alcohol/drug use, and externalising/internalising problems, and was compared with the non-responders of the full BCS/youth@hordaland sample. Second, we computed odds ratios for associations between externalising/internalising problems and alcohol/drug use using logistic regression models. More specifically, unadjusted regression models were utilised, followed by adjustments for SES, gender, and age, and were adjusted for SES, gender, age, and externalising/internalising problems. Finally, unadjusted and adjusted ordinal logistic regression analyses were

conducted for (a) the associations between externalising/internalising problems and ordinal number of indications on alcohol/drug-related problems, and (b) the associations between subscales of externalising/internalising problems and ordinal number of indications on alcohol/drug-related problems. All analyses were performed using STATA V.14.0 (Stata-Corp, 2015).

Results

The final sample consisted of $n = 2438$ participants. Table 1 outlines the demographics of the subjects in the total included sample, as well as alcohol and illicit drug use. There were some differences between the included versus the not-included individuals, related to gender, socioeconomic status, alcohol/drug use, and externalising/internalising problems. However, effect sizes were overall small to moderate (Cohens d 's ranging from 0 to 0.35). Of note, these differences were small for externalising/internalising problems (d 's ranging from 0.18 to 0.20) and non-existent or very small for alcohol/drug use (d 's ranging from 0 to 0.09).

As outlined in Table 2, externalising problems were positively associated with illicit drug use, a positive CRAFFT score, and frequent alcohol intoxication (odds ratios [ORs] ranging from 1.17 to 1.29, all $p < .01$) in unadjusted analyses. After adjusting for SES, gender, age, and internalising problems, externalising problems were positively associated with all measures of alcohol/drug use ($AORs$ ranging from 1.24 to 1.40, all $p < .05$). Internalising problems were negatively associated with having ever used alcohol and frequent alcohol intoxication (ORs ranging from 0.89 to 0.90, all $p < .05$) in unadjusted analyses. After adjusting for SES, gender, age, and externalising problems, internalising problems were negatively associated with all measures of alcohol/drug use ($AORs$ ranging from 0.83 to 0.88, all $p < .05$).

Table 3 outlines associations between externalising/internalising problems and ordinal levels of indicators for alcohol/drug use during

Table 1. Demographics, alcohol and drug use, and mental health problems during adolescence in the full youth@hordaland sample ($n = 10,253$)^a.

Demographics	Study sample ($n = 2438$)	Non-included sample ^b ($n = 7815$)	Cohen's d	p -value ^c
Girls, %	55.3	51.8	.069	.003
Age at completion, mean	17.4	17.4	.020	.399
Perceived economic well-being, %			.043	.066
Poorer than others	4.4	8.0		
Equal to others	66.6	67.5		
Better than others	29.0	24.5		
Mother's education, %			-.285	< .001
University/college	60.0	44.6		
High school	32.2	44.3		
Primary school	7.8	11.2		
Father's education, %			-.345	< .001
University/college	56.3	38.2		
High school	36.3	50.0		
Primary school	7.4	11.8		
Alcohol and illicit drug use				
Tried alcohol, %	78.5	76.9	-.038	.104
Tried illicit drugs, %	12.3	9.6	-.089	< .001
CRAFFT score ≥ 2 , %	21.2	21.3	.003	.908
Frequent drinking to intoxication, %	18.0	19.1	.029	.216
High-level alcohol consumption, %	11.4	12.3	.003	.298
Mental health problems ^d				
Externalising problems, mean (SD)	4.99 (2.98)	5.55 (3.05)	.183	< .001
Internalising problems, mean (SD)	4.31 (3.12)	4.98 (3.36)	.204	< .001

Note. SD = standard deviation; CRAFFT = screening tool for identification of problematic alcohol and drug use among adolescents.

^aAll the demographic and alcohol and drug use variables listed are measured at T3. ^bIndividuals participating in the youth@hordaland study (T3) but excluded from the study sample due to not having valid Strengths and Difficulties Questionnaire (SDQ) responses at T1 and T2. ^c p -value for difference between the study sample and the sample of non-included individuals. ^dIncludes youth self-reported SDQ scores at T3.

adolescence. Using likelihood-ratio tests of proportionality of odds across response categories, we found only non-significant differences between externalising/internalising problems and each ordinal level of indicators for alcohol/drug use in the unadjusted models (p -values ranging from 0.08 to 0.73), indicating that the proportional odds assumption underlying the ordinal logistic regression models was met (Liao, 1994, p. 41). We found positive associations between externalising problems and increasing levels of indicators for alcohol/drug use in both unadjusted models ($OR = 1.21$, $p < .001$) and after adjustment for SES, gender, age, and internalising problems ($AOR = 1.38$,

$p < .001$). We found negative associations between internalising problems and increasing levels of indicators for alcohol/drug use after adjusting for SES, gender, age, and externalising problems ($AOR = 0.84$, $p = .001$).

In secondary analyses, associations between externalising/internalising problems and ordinal levels of indicators for alcohol/drug use were analysed stratified by gender. However, no substantial gender differences were found: the same patterns of associations were evident across genders, with a similar magnitude of associations (not shown).

Table 4 sketches associations between subscales of externalising problems (conduct

Table 2. Logistic regression analyses for associations between childhood externalising/internalising problems and adolescent alcohol/drug use ($n = 2438$).

	Ever used alcohol OR (95% CI)	Ever used drugs OR (95% CI)	A positive CRAFFT score OR (95% CI)	Frequent alcohol intoxication OR (95% CI)	High-level alcohol consumption OR (95% CI)
EXT problems					
Unadjusted	1.02 (0.93, 1.12)	1.29 (1.15, 1.45)***	1.17 (1.07, 1.28)**	1.24 (1.13, 1.37)***	1.12 (0.99, 1.25)
Adj for SES, gender, age	1.16 (1.03, 1.30)*	1.32 (1.15, 1.52)***	1.29 (1.15, 1.45)***	1.32 (1.17, 1.49)***	1.18 (1.02, 1.37)*
+ Adj for INT problems	1.24 (1.08, 1.42)***	1.36 (1.16, 1.60)***	1.32 (1.16, 1.51)***	1.40 (1.22, 1.62)***	1.27 (1.07, 1.50)*
INT problems					
Unadjusted	0.89 (0.81, 0.96)**	1.00 (0.90, 1.11)	0.96 (0.88, 1.05)	0.90 (0.82, 0.99)*	0.91 (0.82, 1.02)
Adj for SES, gender, age	0.92 (0.82, 1.02)	0.96 (0.85, 1.09)	0.97 (0.87, 1.08)	0.92 (0.82, 1.02)	0.88 (0.77, 1.01)
+ Adj for EXT problems	0.86 (0.76, 0.97)*	0.88 (0.77, 1.00)*	0.87 (0.79, 0.99)*	0.83 (0.74, 0.94)**	0.83 (0.72, 0.96)*

Note. OR = odds ratio; CI = confidence interval; EXT problems = externalising problems; INT problems = internalising problems; SES = socioeconomic status; CRAFFT = screening tool for identification of problematic alcohol and drug use among adolescents.

Bold font denotes statistically significant associations.

* $p \leq .05$. ** $p < .01$. *** $p < .001$.

problems, hyperactivity) and internalising problems (emotional problems and peer problems) and ordinal levels of indicators for alcohol/drug use during adolescence. The proportional odds assumption underlying the ordinal logistic regression models was also met for these analyses (p -values ranging from .25 to .86). Both externalising subscales were for the most part positively associated with increasing levels of indicators on alcohol/drug use even in fully adjusted models ($AORs$ ranging from 1.19 to 1.23, all $p < .05$). Neither of the internalising subscales were significantly associated with increasing levels of alcohol/drug-related problems (p -values ranging from .15 to .67).

Discussion

Our study suggests that childhood externalising problems are positively associated, and that internalising problems are negatively associated, with adolescent alcohol/drug use and problems. These estimates were exacerbated when associations between internalising problems and alcohol/drug use were adjusted for co-occurring externalising problems, and vice versa. There was no evidence for substantial gender differences in these associations.

These findings correspond with those of a growing body of literature that is conceptualising involvement with alcohol/drug use within a broader context of antisocial or deviant behaviour (Chassin et al., 2013; Zucker, Heitzeg, & Nigg, 2011). Our results also extend the existing knowledge base of studies which have indicated that childhood internalising problems are negatively associated with alcohol/drug use in early adolescence (Colder et al., 2013; Edwards et al., 2014) to also apply to later stages of adolescence. This supports a recent contribution by Colder and colleges (2018). Also of note, both the full SDQ externalising problems scales and the subscales of conduct problems and hyperactivity/inattention were positively associated with alcohol/drug-related problems. However, the associations were somewhat stronger and more consistent in relation to the

Table 3. Ordinal logistic regression analyses between childhood externalising/internalising problems and increasing levels of alcohol and drug use indicators among adolescents ($n = 2438$).

	Increasing levels of indicators on alcohol and drug use	
	OR/AOR (95% CI)	p-value
Externalising problems		
<i>Unadjusted</i>	1.21 (1.12, 1.31)	< .001
<i>Adjusted for SES, gender, age</i>	1.29 (1.17, 1.42)	< .001
<i>Adjusted for SES, gender, age, INT problems</i>	1.38 (1.23, 1.54)	< .001
Internalising problems		
<i>Unadjusted</i>	0.93 (0.87, 1.00)	.057
<i>Adjusted for SES, gender, age</i>	0.93 (0.85, 1.02)	.112
<i>Adjusted for SES, gender, age, EXT problems</i>	0.84 (0.77, 0.93)	.001

Note. OR = odds ratio; AOR = adjusted odds ratio; CI = confidence interval; EXT problems = externalising problems; INT problems = internalising problems; SES = socioeconomic status. Bold font denotes statistically significant associations.

full externalising scale, possibly indicating that overall externalising behavioural tendencies are more potent predictors of subsequent alcohol/drug-related problems, compared with high symptoms on either conduct problems or hyperactivity/inattention alone.

Only the full SDQ internalising problems scale was negatively associated with alcohol/drug-related problems in our study, and only in the fully adjusted model, following the adjustment for SES, gender, age, and co-occurring externalising problems. This finding lends support to recent studies suggesting that internalising problems may protect against alcohol/drug use during adolescence (Colder et al., 2010; Hussong et al., 2011). It has been suggested that internalising problems may contribute to less alcohol/drug use due to avoidance and social withdrawal strategies, and hence potentially less exposure to situations or peer groups with high risk for alcohol/drug use (Hussong et al., 2017). Therefore, we hypothesised that peer/relationship problems were more strongly negatively associated with alcohol/drug-related problems, compared with emotional problems, but our study did not confirm this hypothesis. A possible explanation is that the influence of peer/relationship problems on

alcohol/drug-related behaviours is exacerbated by emotional problems, and hence that overall internalising behavioural tendencies are more influential than peer/relationship problems alone. However, more studies are needed to clarify the complex mechanisms that link childhood internalising problems with fewer alcohol/drug-related problems during adolescence.

Although we did not find evidence that internalising problems may also be involved in “risk processes” or heighten the risk of alcohol/drug-related problems (e.g., McCarty et al., 2012; Wittchen et al., 2007), we cannot rule out this possibility. As Hussong and colleagues (2011) note in their article describing a developmental psychopathology framework for the internalising pathway to alcohol-use disorders, that a range of factors may affect the extent to which internalising problems increase the future risk of alcohol/drug use or not, such as coping expectancies and motives for alcohol/drug use, initiation of alcohol/drug use with the goal of self-medication effects, and an escalation of alcohol/drug use to the point of addiction (Hussong et al., 2011). Furthermore, it is hypothesised that the self-medication hypothesis on development of alcohol/drug-related problems becomes more relevant later in life

Table 4. Ordinal logistic regression analyses between subscales of externalising/internalising problems and increasing levels of alcohol and drug use indicators among adolescents ($n = 2438$).

	Increasing levels of indicators on alcohol and drug use	
	OR/AOR (95% CI)	p-value
Subscales of externalising problems		
Conduct problems		
Unadjusted	1.16 (1.05, 1.28)	< .001
Adjusted for SES, gender, age	1.19 (1.05, 1.34)	< .010
Adj for SES, gender, age, hyperactivity	1.10 (0.96, 1.25)	.168
Adj for SES, gender, age, hyperactivity, INT problems	1.19 (1.03, 1.38)	< .05
Hyperactivity/inattention		
Unadjusted	1.18 (1.10, 1.28)	< .001
Adjusted for SES, gender, age	1.24 (1.13, 1.37)	< .001
Adj for SES, gender, age, conduct problems	1.18 (1.04, 1.35)	< .010
Adj for SES, gender, age, conduct problems, INT problems	1.23 (1.07, 1.41)	< .010
Subscales of internalising problems		
Emotional problems		
Unadjusted	0.94 (0.86, 1.02)	.156
Adjusted for SES, gender, age	0.96 (0.86, 1.07)	.448
Adj for SES, gender, age, peer problems	0.97 (0.85, 1.11)	.671
Adj for SES, gender, age, peer problems, EXT problems	0.91 (0.79, 1.04)	.162
Peer/relationship problems		
Unadjusted	0.94 (0.85, 1.03)	.205
Adjusted for SES, gender, age	0.92 (0.82, 1.04)	.183
Adj for SES, gender, age, emotional problems	0.95 (0.83, 1.09)	.494
Adj for SES, gender, age, emotional problems, EXT problems	0.90 (0.78, 1.04)	.153

Note. OR = odds ratio; AOR = adjusted odds ratio; CI = confidence interval; EXT problems = externalising problems; INT problems = internalising problems; SES = socioeconomic status. Bold font denotes statistically significant associations.

(Virtanen et al., 2015), and therefore that internalising problems hypothetically tends to become positively associated with alcohol/drug-related problems with increasing age (Colder et al., 2013, 2018). While a study by Colder and colleagues could not confirm this hypothesis in the transition from early to late adolescence (Colder et al., 2018), a recent study by Virtanen and colleagues (2015), which followed adolescents into the adult years, clearly indicated that internalising problems predicted alcohol problems. There is a need for more studies that further investigate the potentially changing role of internalising problems on alcohol/drug-related problems from adolescence into the adult years.

Strengths and limitations

Our study has several strengths. The sample consists of a well-defined population-based sample of children followed into adolescence, which is sufficiently large to enable a detailed investigation of longitudinal associations between childhood mental health problems and adolescent alcohol/drug use. An additional strength is the utilisation of repeated measures and multiple informants on the SDQ, providing a robust estimate for externalising/internalising symptoms.

The study has some limitations. First, although we employed a prospective design for the study with a temporal order of data

collection, the findings of the study are not necessarily an expression of causality. The findings can also be explained, for example, by third factors (such as genetic predisposition, adverse life circumstances, and family characteristics), which may act as risk factors for both externalising/internalising problems and alcohol/drug use during adolescence. Additionally, we had available measures of alcohol/drug use only at T3, therefore failing to control for prior substance use. Second, complex mechanisms may be at work as mediators (e.g., timing of puberty, peer involvement, parental supervision, and parental problem drinking) between childhood externalising/internalising problems and subsequent alcohol/drug use (e.g., Dickson, Laursen, Stattin, & Kerr, 2015; Finan, Schulz, Gordon, & Ohannessian, 2015). This is beyond the scope of our study. Third, the information on alcohol/drug use was based on self-reports, while the information on childhood mental health problems was based on parent and teacher reports. The lack of clinical interviews thus adds as a further limitation to our study. However, whereas clinical diagnoses of either mental health or alcohol/drug-related problems are typically categorised as dichotomous measures, previous studies have also gained support for dimensional conceptualisations of common mental health problems (e.g., Andrews et al., 2007) and alcohol/drug-related problems (Beseler & Hasin, 2010; Krueger et al., 2004) that are not necessarily above a formal, clinical cutoff. Our study thus highlights how parent/teacher-reported externalising/internalising symptoms across a spectrum of severity are associated with self-reported alcohol/drug use. Future studies that also apply diagnostic levels of respectively externalising/internalising problems and alcohol/drug-related problems should therefore be encouraged. Fourth, although it might be preferable to have more detailed information on illicit drug use, only lifetime use was available in the youth@hordaland-survey. Illicit drug use is also particularly infrequent among Norwegian adolescents compared with other European countries (Kraus et al., 2016), and the inclusion of frequent illicit drug use could therefore be too strict a measure in the context of this study. Fifth, depression and conduct problems have previously been found to be the mental health symptoms most strongly associated with alcohol/drug use during adolescence (e.g., Armstrong & Costello, 2002; Hussong et al., 2017). In addition, associations with alcohol/drug-related problems tend to vary across subtypes of anxiety problems (Fröjd, Ranta, Kaltiala-Heino, & Marttunen, 2011; Ohannessian, 2014). However, the internalising measures of the SDQ, including its subscales, are generalised measures of internalising problems, which therefore do not separate between, for example, symptoms of anxiety and depression, and between subtypes of anxiety. Therefore, our findings may not be generalisable to all manifestations of internalising symptomatology. Sixth, only parent and teacher reports on SDQ were available at T1. Although teacher and parent versions of the SDQ have gained support in a review of psychometric studies (Stone et al., 2010), it should be noted that internalising problems are likely to be reported more accurately by children themselves (Ederer, 2004). The inclusion of self-reported externalising/internalising symptoms would add more strength to the measures of childhood internalising problems. However, there is no self-report data available on SDQ symptoms at T1 due to the young age of the children. Our externalising/internalising variables are constructed based on two time points, and thus including self-reports at one time only would not work. In addition, the use of parent/teacher reports on T1/T2 and self-reports on T3 may contribute to avoiding mono-informant bias. Finally, selective drop out is a well-known problem in longitudinal research (Wolke et al., 2009), and may not be fully ruled out in our study. However, the discrepancy between T1 ($n = 7007$) and the study sample ($n = 2438$) is not merely a result of dropout at each consecutive wave, but is also an administrative issue of the longitudinal survey design. More specifically, the BCS (comprising T1 and T2)

had a different target population than the youth@hordaland (comprising T3). Therefore, it is not possible to calculate a strict attrition rate for the present study. We did, however, find some differences between the study sample and the full youth@hordaland sample, suggesting that the included individuals had somewhat higher SES than the non-included individuals. While this was the case, effect sizes for differences between the study sample and the full youth@hordaland sample were for the most part non-significant on alcohol/drug use, and were small on externalising/internalising problems. Hence, selective dropout is not likely to be an issue that would seriously bias our findings.

Conclusion

An important contribution from our study is that childhood externalising problems are positively associated while internalising problems are negatively associated with alcohol/drug use and problems in late adolescence. Associations with alcohol/drug-related problems were similar across both genders, and were most consistent and robust when associations between externalising problems and alcohol/drug-related problems were accounted for co-occurring internalising problems, and vice versa.

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III

Which psychiatric diagnoses are associated with adolescent alcohol/drug-related problems? A Norwegian population-based survey linked with national patient registry data

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Abstract

Objectives To examine alcohol/drug-related problems across psychiatric diagnoses, and to what extent associations between each psychiatric diagnosis and alcohol/drug-related problems were independent from the potential confounding effects from psychiatric comorbidity, socioeconomic status, sex and age.

Design A large population-based and cross-sectional study among Norwegian adolescents, the youth@hordaland conducted in 2012, were linked with national registry-based data on specialist mental health care use during the four years prior to the survey (2008 to 2011).

Study population Individuals aged 16 to 19 years who participated in the youth@hordaland survey and consented to the linkage with patient registry data (n=9,408). Among these, 853 (9%) had received specialist mental health care and comprised the clinical sample, while the rest (n=8,555) comprised the comparison group.

Main outcome measures Several measures of indicators for alcohol/drug-related problems, including frequent alcohol intoxication, high-level alcohol consumption, a positive CRAFFT-score, and lifetime illicit drug use.

Results: Adolescents receiving specialist mental health care (n=853) reported more frequently alcohol/drug use and problems compared to adolescents not receiving these services (Cohens d's ranging from 0.09 to 0.29, all $p \leq 0.01$). Anxiety, depression, conduct disorders, eating disorders, ADHD, and trauma-related disorders were all associated with problematic alcohol/drug use, with odds ratios (ORs) ranging from 1.60 to 4.76 (95% CI [1.13, 8.70]) in unadjusted models. Trauma-related disorders, depression and conduct disorders were positively associated with higher numbers of indicators for alcohol/drug-related problems (ORs ranging from 1.92 to 3.20, 95% CI [1.43, 6.23]); however, only trauma-related disorders

remained positively associated in the fully adjusted model (adjusted odds ratio 2.53, 95% CI [1.34, 4.79]).

Conclusions: Alcohol/drug use and problems were slightly more common among adolescents who received specialist mental health care during the past four years compared with the general adolescent population, and adolescents with trauma-related disorders had particularly high odds for alcohol/drug-related problems.

Strengths and limitations of this study

- The youth@hordaland survey is a well-established, large population-based survey among adolescents that allows analysis of alcohol/drug-related problems and the associations of interest.
- The linkage between population-based data on alcohol/drug use and registry-based data on psychiatric diagnoses independently determined by professional mental health practitioners are very rare in the scientific literature.
- This study is to our knowledge the first to compare a broad range of psychiatric diagnoses in terms of their associations with alcohol/drug-related problems during adolescence, while also addressing the role of psychiatric comorbidity.
- Although the measures of psychiatric diagnoses preceded those of alcohol/drug use, the study does not have a stringent longitudinal design, and it is not possible to draw conclusions on the causality between psychiatric diagnoses and alcohol/drug, since some substance use may have predated the mental health care contacts.

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Introduction

Mental health problems are prevalent among children and adolescents, with one in five fulfilling criteria for a mental disorder [1-4]. Furthermore, approximately 25% of adolescents with a psychiatric diagnosis have at least one additional psychiatric diagnosis [5], indicating that psychiatric comorbidity is common. Mental disorders are particularly frequent among adolescents with alcohol/drug-related problems, and it is estimated that 37–80% of adolescents with alcohol/drug-related problems have at least one psychiatric disorder [e.g. 6, 7, 8]. Similarly, among adolescents within a psychiatric inpatient setting, one third of the adolescents fulfilled criteria for a substance use disorder (SUD) [9].

Previous studies have demonstrated positive associations with adolescent alcohol/drug-related problems for a range of psychiatric disorders, including anxiety [10, 11], attention-deficit/hyperactivity disorder (ADHD) [12, 13], eating disorders [14, 15], post-traumatic stress disorder (PTSD) [16, 17], conduct disorders [18], depression [17, 19, 20], and psychotic disorders [21, 22]. The majority of previous literature has however focused on selected associations between single psychiatric diagnoses or symptoms and alcohol/drug-related behaviors, and few studies have investigated the full range of common mental disorders. Furthermore, it is important to consider psychiatric comorbidity in order to clarify whether specificity of risk is indicative of potentially unique psychological mechanisms, or whether “general mental distress” is primarily driving an increased vulnerability. Nevertheless, the inclusion of control for psychiatric comorbidity is rare in previous studies.

A recent Norwegian study reported that illicit drug use was four times higher among adolescents receiving psychiatric services compared to the general population, and that depression was the diagnosis associated with the highest frequencies of alcohol and drug use and autism with the lowest [23]; however, participation in the clinical group was low and

psychiatric comorbidity was not investigated. Similarly, a study by Wu and colleagues [24] investigated comorbidity between a range of psychiatric diagnoses and substance use disorders (SUDs); however, their analyses focused primarily on sex, ethnicity, and inpatient versus outpatient attenders, and there were no comparisons between diagnostic groups. A study by Boys and colleagues [25] also collected information on a broad range of psychiatric diagnoses in relation to alcohol/drug-related problems but small numbers did not allow differentiation between separate disorders. Therefore, there are still considerable knowledge gaps in relation to which psychiatric disorders that are associated with the highest risk for alcohol/drug use and problems among adolescents.

In the present study, we aimed to examine the prevalence of alcohol/drug use and problems among adolescents receiving specialist mental health care compared with a general population of adolescents, and compared between psychiatric diagnostic groups, accounting for potential confounding from other comorbid psychiatric diagnoses, as well as sex, age and socioeconomic status (SES). The study contributes to the scientific field with knowledge on which psychiatric disorders that are associated with the highest risk for alcohol/drug use and problems among adolescents.

Methods

Study population

We employed data from the youth@hordaland-survey, which includes information on child and adolescent mental health, lifestyle, school performance and use of health services. Of all 19,430 adolescents born between 1993 and 1995 living in Hordaland County in Western Norway, 10,253 (53%) agreed to participate. The youth@hordaland-survey is a cross-sectional population-based study carried out during early 2012, when the adolescents ranged

from 16 to 19 years of age, and data were collected from adolescents in upper secondary school. Participants received information by email and one school hour was used to complete the questionnaires. In addition, adolescents not going to school received the questionnaires by mail at their home address, and mental health services and other institutions were contacted to let adolescents from these settings participate. The questionnaires used in the youth@hordaland-survey were web-based.

The youth@hordaland-survey was linked to data from the National Patient Registry (NPR) through the participants' personal identification number. The NPR is the official national registry in Norway on specialist mental health care services, and includes information on specialist mental health care use and Axis 1 psychiatric diagnoses from January 2008 to December 2011, at a time when the adolescents ranged from 12 to 18 years of age, and before youth@hordaland participation. A total of 845 (8.2%) of the adolescents did not provide consent for merging the data from the youth@hordaland-survey with other registries, and were excluded from the analyses. The final sample therefore included 9,408 participants, of whom 853 (9.1%) had at least one registration in NPR.

The study was approved by the Regional Committee for Medical and Health Research Ethics (REC) in Western Norway. In accordance with the regulations from the REC and Norwegian health authorities, adolescents aged 16 years and older can make decisions regarding their own health (including participation in research), and thus gave consent themselves to participate in the current study. Parents/guardians have the right to be informed, and in the current study, all parents/guardians received written information about the study in advance.

Patient involvement

Patient were not involved in the planning of the present study.

Measures and instruments

Explanatory variables: Mental health disorders

The adolescents who had received specialist mental health care (n=853) were assigned to the following diagnostic categories: anxiety (n=132), depression (n=172), conduct disorders (n=32), attention-deficit/hyperactivity disorder (ADHD, n=154), autism spectrum disorders (n=46), eating disorders (n=40), trauma-related disorders (n=66), psychotic disorders (n=10), other diagnoses (n=84), and no Axis 1 psychiatric diagnosis (n=329). In addition, 133 adolescents had psychiatric diagnoses from more than one of the specified diagnostic categories, and were correspondingly assigned to multiple diagnostic categories. Due to the small group size, psychotic disorders were excluded from the diagnosis-specific analyses, while the “other diagnoses” group also was excluded due to considerable conceptual heterogeneity. However, both these diagnostic categories were included as confounders when adjusting for psychiatric comorbidity. Appendix I details the operationalization of the diagnostic categories.

In addition, self-reported mental health problems were measured in order to examine differences between individuals that consented (n=9,408) to the linkage between the youth@hordaland-survey and the NPR, and those that did not consent to this linkage (n=845). Specifically, the short version of the Mood and Feelings Questionnaire (SMFQ) [26] was used to measure symptoms of depression; the SCARED inventory [27] was used for anxiety symptoms; the Adult ADHD Self-report Scale (ASRS) [28] for symptoms of hyperactivity/inattention; and the Youth Conduct Disorder (YCD) instrument [29] for symptoms of conduct disorders.

Outcome variables: Alcohol/drug use and problems

Based on a single item, 'Have you ever tried alcohol?' (Yes/No), a variable for having ever used alcohol was constructed, and based on a single item, 'Have you ever tried hash, marijuana or other narcotic substances?' (Yes/No), a variable for having ever used illicit drugs was constructed. Frequent drinking to intoxication was measured based on the question: 'Have you ever consumed so much alcohol that you were clearly intoxicated (drunk)?' The original item had five categories ranging from 'No, never' to 'Yes, more than 10 times'. Frequent intoxication was defined as drinking so much that one was clearly intoxicated more than 10 times, and on this basis, a dichotomous variable was created. We added up five items that measured how many glasses of i) beer, ii) cider, iii) wine, iv) spirits and v) illegally distilled spirits the adolescents usually consumed during a time period of 14 days. A total of 5,058 adolescents reported any usual alcohol consumption. The high-level alcohol consumption variable was defined as the above 90th sex-specific percentile alcohol consumption among the adolescents with any usual alcohol consumption, and a dichotomous variable was created for high-level alcohol consumption. Alcohol and drug-related problems were measured using the six-item, validated scale CRAFFT. This scale has been designed to identify possible alcohol-and drug related problems among adolescents, and has been demonstrated to have acceptable sensitivity and specificity at a cut-off of ≥ 2 [30]. A previous publication based on the youth@hordaland-sample investigated the factor structure and concurrent validity of CRAFFT and demonstrated a good fit with a single latent construct of alcohol/drug-related problems [31]. A dichotomous variable separating those above the cut-off of ≥ 2 on CRAFFT from those below the cut-off were calculated. In our sample the omega internal consistency coefficient [32] of the CRAFFT scale was 0.88. Finally, an ordinal variable for total potential alcohol/drug-related problems was constructed (ranging from 0 to 4), in which we summed up the number of positive scores on frequent alcohol intoxication, high-level alcohol consumption, a positive CRAFFT-score, and having tried illicit drugs.

Included co-variables

Age and sex were retrieved from the Norwegian Population Registry, and were available for all participants in the youth@hordaland-sample. In addition, self-reported family financial circumstances was collected as either (1) ‘about the same as others’ (2) ‘better than others’, or (3) ‘worse than others’. Self-reported information on maternal and paternal educational attainment was divided into primary school, high school, or more than four years of university or higher education. The variables of self-reported family financial circumstances, paternal educational attainment, and maternal educational attainment were used as a compound measure for socioeconomic status (SES) [33].

Statistical analyses

All analyses were performed using STATA V.14.0 [34], with the exception that the omega internal consistency coefficient for the CRAFFT questionnaire was calculated in R [35]. First, differences in terms of alcohol/drug use, self-reported symptoms of mental health problems, and sociodemographic variables were examined across individuals who gave their consent to the linkage between the youth@hordaland-survey and the NPR, and those who refused to consent to this linkage (Table 1). Second, the sample was described according to age, sex, SES, and alcohol and drug use among adolescents that had received specialist mental health care services compared to the adolescents that had not receiving these services during the past four years (Table 2). Third, psychiatric comorbidity rates within each diagnostic category were described, and all investigated psychiatric diagnoses were analyzed in terms of Spearman’s Rank correlations with other psychiatric diagnoses (Table 3). Fourth, logistic regression models were employed to calculate associations between psychiatric diagnoses received within specialist mental health care and alcohol/drug use and problems, and we also adjusted the analyses from the potential confounding effects from age, sex, SES, and

comorbid psychiatric diagnoses (Table 4). Finally, ordered logistic regression models were employed to calculate crude and adjusted odds ratios for the associations between psychiatric diagnoses and increasing number of indicators for potential alcohol/drug-related problems; however, restricted to associations that met the underlying proportional odds assumption for the ordered logistic regression model (Table 5).

Results

For the most part, adolescents that consented to the linkage between the youth@hordaland-survey and the NPR and which therefore constituted the final study sample (n=9,408), were similar to those that refused to consent (n=845) and which therefore were excluded (Table 1). However, the individuals that refused consent had somewhat higher frequencies of high-level alcohol consumption (8.5 % versus 5.9 %, $d=0.11$, $p<0.01$), higher mean symptom levels of self-reported conduct problems (0.68 versus 0.54, $d=0.11$, $p<0.01$), and were somewhat older (17.6 versus 17.4, $p<0.001$).

In the study sample (n=9,408), a total of 9.1% (n=853) of the adolescents had received services from Norwegian specialist health care during the past four years (2008 to 2011). As outlined in Table 2, adolescents that had received specialist mental health care services were more likely to be female (58.5% versus 52.3%, $p=0.001$), and to have a low SES ($d=0.17$, $p<0.001$). In addition, adolescents that had received specialist mental health care services had higher frequencies of most alcohol/drug use and problems (d 's ranging from 0.09 to 0.29, all $p<0.05$) compared with adolescents that had not received specialist mental health care services. The only exception was on the measure for having ever used alcohol, which were non-significant ($p=0.571$).

(Insert table 1 around here)

Frequencies of comorbidity with other psychiatric diagnoses were examined for each of the included psychiatric diagnoses. Among adolescents who had received a psychiatric diagnosis from a specialist mental health care clinic (n=524), a total of 133 (25.4%) had at least one comorbid psychiatric diagnosis from another diagnostic category (data not shown).

Specifically, the prevalence of psychiatric comorbidity were 59.1% (n=78) for anxiety, 62.2% (n=107) for depression, 62.5% (n=20) for conduct disorders, 42.9% (n=66) for ADHD, 60.1% (n=28) for autism, 52.5% (n=21) for eating disorders, 28.8% (n=19) for trauma-related disorders, 70.0% (n=7) for psychotic disorders, and 11.8% (n=39) for “other psychiatric diagnoses”. Table 3 presents the correlation coefficients between the psychiatric diagnoses. Anxiety and depression had the strongest correlation ($r_s=.246$, $p<0.001$), while all other correlations were either non-significant or had a very small magnitude, spanning from $r_s=.069$ to $r_s=.108$.

(Insert table 3 around here)

In unadjusted models (Table 4), anxiety was associated with illicit drug use (OR=1.99, 95% CI [1.26, 3.14], $p<0.01$); depression was associated with frequent alcohol intoxication, a positive CRAFFT score and illicit drug use (ORs ranging from 1.60 to 2.57, 95% CI [1.13, 3.72], $p<0.01$); conduct disorders were associated with a positive CRAFFT score and illicit drug use (ORs ranging from 2.49 to 4.67, 95% CI [1.20, 10.08], $p<0.05$); ADHD was associated with illicit drug use (OR=1.83, 95% CI [1.17, 2.85], $p<0.01$); eating disorders were associated with frequent alcohol intoxication and a positive CRAFFT score (ORs ranging from 2.01 to 2.09, 95% CI [1.05, 4.06], $p<0.05$); trauma-related disorders were associated with all alcohol/drug measures (ORs ranging from 1.89 to 4.76, 95% CI [1.12, 8.70], $p<0.05$); and the “no diagnosis received” group was associated with a positive CRAFFT score and illicit drug use (ORs ranging from 1.51 to 1.74, 95% CI [1.18, 2.37], $p<0.01$). Additionally,

autism was negatively associated with frequent alcohol intoxication (OR=0.30, 95% CI [0.09, 0.97], $p<0.05$).

In fully adjusted models, adjusting for the potential confounding effects from psychiatric comorbidity, SES, sex and age, neither anxiety nor ADHD were significantly associated with any measures of alcohol/drug use. Depression was associated only with a positive CRAFFT score (AOR=1.60, 95% CI [1.03, 2.51], $p<0.05$); conduct disorders were associated only with illicit drug use (AOR=4.03, 95% CI [1.31, 12.39], $p<0.01$); eating disorders were associated only with frequent alcohol intoxication (AOR=2.25, 95% CI [1.02, 4.95], $p<0.05$); and trauma-related disorders were associated with high-level alcohol consumption, frequent alcohol intoxication and a positive CRAFFT-score (AORs ranging from 2.14 to 4.70, 95% CI [1.07, 10.30], $p<0.05$). In addition, autism was negatively associated with frequent alcohol intoxication (AOR=0.22, 95% CI [0.05, 0.98], $p<0.05$), and the “no diagnosis received” group was associated with high-level alcohol intoxication and illicit drug use (AORs ranging from 1.74 to 1.86), 95% CI [1.04, 2.92], $p<0.05$) after adjustment for SES, sex and age.

(Insert table 4 around here)

Using likelihood-ratio tests of proportionality of odds across response categories, we found only non-significant differences between all the psychiatric diagnoses listed in Table 5 and each ordinal level of indicators for alcohol/drug-related problems in the crude models (p -values ranging from 0.27 to 0.93), indicating that the proportional odds assumption underlying the ordered logistic regression models were met [36, p.41]. Autism diagnoses were excluded from this analysis as the proportional odds assumption was not met for this diagnosis. In unadjusted models employing ordered logistic regression analyses we found positive associations with increasing levels of indicators for alcohol/drug-related problems and depression (OR=1.92, 95% CI [1.43, 2.59], $p<0.001$), conduct disorders (OR=3.20, 95% CI [1.65, 6.23], $p<0.01$), trauma-related disorders (OR=2.82, 95% CI [1.75, 4.56], $p<0.001$),

and the “no diagnosis received” group (OR=1.46, 95% CI [1.16, 1.84], $p<0.01$). Depression, conduct disorders and trauma-related disorders remained positively associated with increasing levels of indicators for alcohol/drug-related problems after adjustment for psychiatric comorbidity (AORs ranging from 1.57 to 2.92, 95% CI [1.08, 5.47], $p<0.05$). However, in fully adjusted models, accounting for the confounding effects from psychiatric comorbidity, SES, sex and age, we found only a positive association with increasing levels of indicators for alcohol/drug-related problems for trauma-related disorders (AOR=2.53, 95% CI [1.34, 4.79], $p<0.01$). Additionally the “no diagnosis received” group had a positive association after adjustment for SES, sex and age (AOR=1.50, 95% CI [1.11, 2.02], $p<0.01$).

(Insert table 5 around here)

Discussion

The present study is to our knowledge the first to compare a broad range of psychiatric diagnoses in terms of their associations with alcohol/drug use and problems during adolescence, while also addressing the role of psychiatric comorbidity. Frequencies of alcohol/drug use and problems were higher among adolescents who had received specialist mental health care services compared to adolescents who had not received such services during the past four years; however the magnitude of these differences were overall small. Furthermore, the investigated psychiatric diagnoses varied widely in the extent to which they were associated with potential alcohol/drug-related problems, particularly when the influence of other comorbid psychiatric disorders and demographic variables was accounted for.

Depression and alcohol/drug-related problems. In unadjusted models, depression was among the psychiatric diagnoses with the most consistent positive associations with alcohol/drug use and problems. Specifically, we found positive associations between depression and all

measures of alcohol/drug use and problems except high-level alcohol consumption. These associations remained significant after adjustment for psychiatric comorbidity. However, the only independent association between depression and alcohol/drug use, after the additional adjustment for sociodemographic factors, was in relation to a positive CRAFFT-score. Our findings suggest that depression is an overall good marker of risk for hazardous alcohol/drug use, but associations between depression and alcohol/drug use appeared to be influenced by sociodemographic factors.

These findings correspond with previous studies that report positive associations between depression and self-reported adolescent alcohol-related problems [37] and general alcohol/drug use [38, 39]. However, previous studies have also reported positive associations between depression and binge drinking [40] and alcohol intoxication [39] among adolescents. In the present study, depression was associated with frequent alcohol intoxication in unadjusted analyses and after adjustment from psychiatric comorbidity, while after the additional adjustment from sociodemographic factors, this association was non-significant. It has also been reported that the co-occurrence of conduct disorders and depression is a strong predictor of substance use, while depression alone is a weak predictor [38]. The present study adds to the existing knowledge base by suggesting that the association between depression and alcohol/drug-related problems appears to be explained only to a modest extent by comorbid psychiatric diagnoses, while it may be significantly influenced by sociodemographic factors.

Anxiety and alcohol/drug-related problems. We found that anxiety was positively associated with illicit drug use in unadjusted models. However, when comorbidity with other psychiatric diagnoses was accounted for, we found only a negative association with frequent alcohol intoxication, but this association was no longer significant after the additional adjustment from SES, sex and age. In sum, the present study lends little support to an independent

association between anxiety and alcohol/drug use or problems among adolescents, and adjustment from psychiatric comorbidity tended to reduce the positive direction of the associations between anxiety and alcohol/drug use.

Of note, the previous literature is characterized by highly inconsistent findings, pointing to both negative [41-44] and positive associations between anxiety and adolescent alcohol/drug use [10, 45, 46]. Some studies have suggested that different anxiety disorders [47, 48] and different anxiety typologies within a given disorder [49] yield different prediction of alcohol/drug-related problems, and anxiety may also have a role on adolescent alcohol/drug use through interactions with other diagnoses [50]. The present study further highlight the complexity of associations between anxiety and adolescent alcohol/drug use.

Autism and alcohol/drug-related problems. In the present study, autism was negatively associated with frequent alcohol intoxication independent of other disorders. A limited number of previous studies have to our knowledge explored associations between autism and alcohol/drug use among adolescents [23, 51], all suggesting a low alcohol/drug use in this group. The present study add to these findings by indicating that adolescents with autism may have lower odds for frequent alcohol intoxication compared with the general adolescent population.

Eating disorders and alcohol/drug-related problems. Our findings suggest that eating disorders were positively associated with frequent alcohol intoxication and a positive CRAFFT-score. However, the only independent association was between eating disorders and frequent alcohol intoxication. This finding supports previous studies linking eating disorders with specific patterns of alcohol use characterized by a loss of control, such as frequent intoxication [52] and binge drinking [53].

ADHD and alcohol/drug-related problems. Previous studies have linked both childhood ADHD symptoms [54] and ADHD symptoms during adolescence [55] with adolescent alcohol/drug use. However, several researchers have highlighted that most studies have not controlled for associated psychopathology [54-56], therefore leaving doubt on the independence of this association. Our findings were that ADHD was associated with illicit drug use alone. We found no independent associations between ADHD and any measures of alcohol/drug use or problems, suggesting that the association between ADHD and illicit drug use was explained by comorbidity with other psychiatric diagnoses.

These findings correspond well with a study by August and colleagues [55], which demonstrated that adolescent ADHD was positively associated with illicit drug use only for individuals with a comorbid externalizing disorder, primarily oppositional defiant disorder. A recent literature review similarly indicated that ADHD does not increase the risk of illicit drug use beyond the effect of conduct-related disorders [57].

Conduct disorders and alcohol/drug-related problems. A range of previous studies have pointed to positive associations between externalizing problems and alcohol/drug use [e.g. 20, 58, 59], while studies exploring the independence of these associations with respect to comorbidity are more limited. In the present study, we found that conduct disorders were associated with illicit drug use, a positive CRAFFT score, and increasing levels of indicators for alcohol/drug-related problems in unadjusted models, while the only independent association between conduct problems and adolescent alcohol/drug use was in relation to illicit drug use.

Trauma-related disorders and alcohol/drug-related problems. Adolescents with trauma-related disorders had the highest odds of alcohol/drug-related problems among all adolescents that had received specialist mental health care during the past four years. In both unadjusted

models and after the adjustment for psychiatric comorbidity, trauma-related disorders were positively associated with all included measures of alcohol/drug use and problems. Additionally, it was the only diagnostic group that was independently associated with increasing levels of potential alcohol/drug-related problems. These findings support previous studies which found positive associations between trauma-related disorders and alcohol/drug use and problems among adolescents [16, 60], while also adding that adolescents with trauma-related disorders constitute the group with the highest odds for alcohol/drug use and problems in a clinical sample. The mechanisms behind associations between trauma-related problems and alcohol/drug-related problems are complex. A longitudinal, community-based study by Haller and Chassin [16] found that PTSD symptoms increased the risk for later alcohol/drug-related problems among adolescents, and the authors concluded strong support for a self-medication hypothesis. However, other mechanisms may also potentially be at work. For example, early alcohol/drug-related problems often involves chaotic and violent lifestyles, which could possibly increase the risk for trauma exposure [61].

Adolescents receiving specialist mental health without being assigned any Axis 1 psychiatric diagnosis. Adolescents that received specialist mental health care without receiving any Axis 1 psychiatric diagnosis were found to have higher odds for high-level alcohol consumption and illicit drug use compared to the general population, even after adjusting for sociodemographic factors. Additionally, these adolescents had slightly heightened odds for potential alcohol/drug-related problems. Lack of data on the psychiatric characteristics of this group makes it difficult to interpret these findings, and further in-depth investigation is required for a better understanding of the heightened risk.

Strengths and limitations

The study described here has several strengths. First, the sample consists of a well-defined population-based sample of adolescents aged 16 to 19 years, and was sufficiently large to enable a detailed investigation of the associations of interest. Second, a unique linkage with official registry data on specialist mental health care services was utilized, facilitating an investigation of formal psychiatric diagnoses independently determined according to the ICD-10 by professional mental health practitioners, potentially superior to self-reported measures. Third, we investigated alcohol/drug use across a broad range of diagnostic groups, which is rare in previous research [23], and enabled us to evaluate the relative likelihood for alcohol/drug-problems across several psychiatric diagnoses. Finally, due to the relatively large sample and comprehensive information about psychiatric diagnoses, we were able to adjust our analyses for psychiatric comorbidity, SES, sex and age.

There are some limitations that require consideration when drawing inferences. First, although the measures of psychiatric diagnoses preceded those of alcohol/drug use, the study does not have a stringent longitudinal design, and it is not possible to draw conclusions on the causality between psychiatric diagnoses and alcohol/drug use in this study, since some substance use may have predated the mental health care contacts. A longer period between the data collection of psychiatric diagnoses and subsequent alcohol/drug use, as well as records of the history of alcohol/drug use, could establish a better understanding of the directionality of our findings. However, more rigorous research designs might also be needed, for example in order to examine how mental health problems and alcohol/drug use interact over time.

Second, the response rate in the population-based sample was 53% and included a relatively low proportion of adolescents with self-reported low SES, who in previous studies are found to have higher levels of mental health problems [e.g. 62]. Official Norwegian statistics indicate that in 2012, 92% of all adolescents in Norway aged 16 to 18 years of age attended high school, compared with 98% in the youth@hordaland-sample [63]. The sample may

therefore not have been fully representative of adolescents with psychiatric diagnoses due to selective participation. However, a previous publication from the Bergen Child Study indicated that although non-participation in the survey affected the estimated frequency of mental health problems, it did not affect patterns of associations between sociodemographic characteristics and mental health problems [64]. Nevertheless, our findings on associations between the broad range of psychiatric diagnoses and alcohol/drug use require replication within more comprehensively ascertained clinical samples. Third, we did not differentiate between subtypes of psychiatric diagnoses. Fourth, psychiatric comorbidity was significantly higher within some of the diagnostic categories, particularly anxiety, depression and conduct disorders. We may therefore have underestimated the independent associations between these psychiatric diagnoses and alcohol/drug use. Fifth, alcohol/drug use was measured by self-report, and does not imply the presence of diagnosable substance use disorders. This adds as a limitation to the study. Moreover, the legal drinking age in Norway is 18 years, and the sample of the present study spanned from 16 to 19 years of age, something that may naturally affect prevalence rates for alcohol/drug use. Although this issue is not explicitly elaborated in the present study, age is included as a potential confounding variable in all analyses. Sixth, although adolescents that refused to consent to the linkage between the youth@hordaland-survey and the NPR, were overall similar to those that consented to this linkage, they reported somewhat higher frequency of high-level alcohol consumption, self-reported conduct problems, and higher age. Hence, this limitation may affect the generalizability of our findings. Seventh, the present study included many sets of analyses of associations. Multiple testing might therefore be an issue to consider when interpreting the results. However, the analyses of associations between psychiatric diagnoses and total number of indicators for alcohol/drug-related problems are less likely to be affected by multiple testing, and should therefore be regarded as our most robust estimate. Finally, an important limitation related to

the generalizability of the findings from the present study is that individuals with untreated mental health problems in the general youth@hordaland-population were not identified. Psychiatric diagnoses in the present study was restricted to individuals that had received specialist mental health care services during the past four years. A range of factors may potentially affect specialist mental health care use, such as functional impairment levels [65] and sociodemographic characteristics [66]. Also, a former wave of the Bergen Child Study concluded that specialist mental health care use differed considerably across psychiatric diagnoses, in which children with emotional disorders were underrepresented in mental health care services [67]. Therefore, our findings on associations between psychiatric diagnoses and alcohol/drug use should be interpreted with caution, particularly in relation to anxiety and depression disorders.

Conclusions

Alcohol/drug-related problems were slightly more common among adolescents who received specialist mental health care during the past four years compared with the general adolescent population. All investigated psychiatric diagnoses – except autism – were associated with some measure of hazardous alcohol/drug use, and adolescents with trauma-related disorders had particularly high odds for alcohol/drug-related problems.

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Table 1. Frequencies of alcohol/drug use, mental health problems and sociodemographic characteristics in adolescents excluded from the study sample (n=845), compared with adolescents in the study sample (n=9,408)

	Youth@hordaland-sample (n=10,253)			
	<i>Study sample:</i> Consented to linkage with NPR (n=9,408)	<i>Excluded individuals:</i> Refused consent to linkage with NPR (n=845)	Cohens d	p-value
Alcohol/drug use				
Ever tried alcohol, n (%)	6,948 (77.2)	573 (77.6)	.01	.803
Ever tried drugs, n (%)	917 (10.2)	82 (11.1)	.03	.436
CRAFFT \geq 2, n (%)	1,901 (21.2)	161 (21.9)	.02	.636
Frequent alcohol intoxication, n (%)	1,766 (18.8)	168 (19.9)	.03	.429
High-level alcohol consumption, n (%) ¹	495 (5.9)	56 (8.5)	.11	.008
Mental health problems				
Anxiety (SCARED), mean (95% CI)	1.51 (1.47, 1.55)	1.55 (1.42, 1.69)	.02	.522
Depression (SMFQ), mean (95% CI)	5.88 (5.76, 6.00)	6.30 (5.85, 6.76)	.07	.058
Hyperactivity/inattention (ASRS), mean (95% CI)	26.90 (26.68, 27.12)	27.25 (26.39, 28.11)	.03	.396
Conduct problems (YCD), mean (95% CI)	0.54 (0.52, 0.57)	0.68 (0.57, 0.79)	.11	.004
Sociodemographic variables				
Girls, n (%)	4,974 (52.9)	425 (50.3)	.05	.151
Age, mean (95% CI)	17.4 (17.4, 17.4)	17.6 (17.6, 17.7)	.26	<.001
Poor family economy, n (%) ²	650 (7.1)	57 (7.2)	.00	.953
Low maternal education, n (%) ³	718 (10.1)	71 (12.8)	.09	.050
Low paternal education, n (%) ⁴	743 (10.7)	55 (10.1)	.02	.649

1 Includes individuals above 90th percentile sex-specific alcohol consumption levels in the full youth@hordaland sample (n=10,253)

2 Includes individuals reporting family economy as "worse than others"

3 Includes individuals reporting maternal education as restricted to only primary school

4 Includes individuals reporting paternal education as restricted to only primary school

Table 2. Alcohol/drug use and sociodemographic characteristics of the study sample (n=9,408) stratified by those who had received specialist mental health care and those who had not received such services

Demographics	Study sample (n=9,408)		Cohens d	p-value
	Received specialist mental health care services ¹ (n=853)	Did not receive specialist mental health care services (n=8,555)		
Girls, n (%)	499 (58.5)	4,475 (52.3)	.124	.001
Age, mean (SD) ²	17.4 (0.8)	17.4 (0.8)	.047	.189
Family financial circumstances, n (%)			.173	<.001
Below average	115 (13.9)	535 (6.4)		-
Average	531 (64.4)	5,623 (67.6)		-
Above average	179 (21.7)	2,165 (26.0)		-
Mothers education, % ³			.159	<.001
University/college	258 (43.8)	3,174 (48.9)		-
High school	242 (41.1)	2,687 (41.4)		-
Primary school	89 (15.1)	629 (9.7)		-
Fathers education, % ⁴			.174	<.001
University/college	190 (35.9)	2,770 (43.4)		-
High school	264 (49.8)	2,953 (46.2)		-
Primary school	76 (14.3)	667 (10.4)		-
Alcohol and illicit drug use	Received specialist mental health care services ¹ (n=853)	Did not receive specialist mental health care services (n=8,555)	Cohens d	p-value
Ever used alcohol, n (%)	636 (78.0)	6,312 (77.2)	-.021	.571
Frequent drinking to intoxication ⁵ , n (%)	188 (22.0)	1,578 (18.5)	-.092	.010
High-level alcohol consumption, n (%)	65 (8.7)	442 (5.8)	-.122	.001
CRAFFT-score ≥ 2 , n (%)	233 (28.7)	1,668 (20.4)	-.202	<.001
Tried illicit drugs, n (%)	148 (18.2)	769 (9.4)	-.292	<.001
Combined alcohol/drug problems			-.269	<.001
No indicators for alcohol/drug problems, n (%)	419 (56.3)	5,002 (65.4)		-
1 indicator for alcohol/drug problem, n (%)	136 (18.3)	1,454 (19.0)		-
2 indicators for alcohol/drug problems, n (%)	103 (13.8)	738 (9.6)		-
3 indicators for alcohol/drug problems, n (%)	70 (9.4)	375 (4.9)		-
4 indicators for alcohol/drug problems, n (%)	16 (2.2)	83 (1.1)		-

CRAFFT: screening scale for identification of potential problematic alcohol and drug use among adolescents

¹Received specialist mental health care services during the four years (2008-2011) prior to the youth@hordaland-survey (2012)

²Age at the time that the youth@hordaland-survey was collected

³Only includes those who with valid response on mother's education (n=7,079), excluding those having answered that they don't know (n=2,187).

⁴Only includes those who with valid response on father's education (n=6,920), excluding those having answered that they don't know (n=2,325).

⁵Above 90th percentile alcohol consumption among those adolescents with a present alcohol consumption (n=5,058)

Table 3. Correlation matrix between psychiatric diagnoses (n=853)

	ANX	DEP	COND	ADHD	AUT	EAT	TRA	PSY
ANX (n=132)	-							
DEP (n=172)	.246***	-						
COND (n=32)	.001	-.038	-					
ADHD (n=154)	-.091**	-.038	.100*	-				
AUT (n=46)	-.059	-.004	.008	.090**	-			
EAT (n=40)	-.049	.096**	-.044	-.090**	-.028	-		
TRA (n=66)	-.051	-.047	.012	-.102**	-.069*	-.043	-	
PSY (n=10)	.074*	.108**	-.022	-.023	-.026	-.024	-.032	-
OTH (n=329)	-.022	-.098**	.018	.019	.078*	.020	-.052	-.036

ANX=anxiety disorders; DEP=depression/mood disorders; COND=conduct disorders; ADHD=attention deficit/hyperactivity disorder; AUT=autism spectrum disorders; EAT=eating disorders; TRA=trauma-related disorders; PSY=psychotic disorders; OTH=other psychiatric diagnoses.

Bold fonts signify statistically significant associations. *p<0.05. **p<0.01. ***p<0.001

Table 4. Logistic regression analyses between psychiatric diagnoses given during contact with specialist mental health care services and potential alcohol/drug-related problems among adolescents (n=9,408)¹

	High-level alcohol consumption OR (95%CI)	Frequent alcohol intoxication OR (95%CI)	CRAFFT-score ≥ 2 OR (95%CI)	Illicit drug use OR (95%CI)
Anxiety (n=132)				
Crude model	1.16 (0.56, 2.39)	0.68 (0.41, 1.12)	1.22 (0.81, 1.83)	1.99 (1.26, 3.14)**
Adj for comorbidity ²	0.85 (0.40, 1.81)	0.53 (0.31, 0.89)*	0.90 (0.58, 1.38)	1.21 (0.74, 1.98)
+Adj for SES+sex+age	1.21 (0.49, 2.98)	0.64 (0.34, 1.23)	0.86 (0.49, 1.52)	1.24 (0.65, 2.39)
Depression (n=172)				
Crude model	1.50 (0.86, 2.62)	1.60 (1.13, 2.25)**	2.05 (1.48, 2.82)***	2.57 (1.77, 3.72)***
Adj for comorbidity ²	1.13 (0.62, 2.08)	1.49 (1.02, 2.17)*	1.77 (1.25, 2.52)**	1.78 (1.17, 2.69)**
+Adj for SES+sex+age	0.86 (0.39, 1.93)	1.15 (0.70, 1.88)	1.60 (1.03, 2.51)*	1.40 (0.81, 2.43)
Conduct disorders (n=32)				
Crude model	1.88 (0.57, 6.25)	1.97 (0.93, 4.17)	2.49 (1.20, 5.18)*	4.67 (2.16, 10.08)***
Adj for comorbidity ²	1.18 (0.34, 4.09)	1.58 (0.73, 3.43)	1.71 (0.80, 3.65)	2.30 (1.04, 5.13)*
+Adj for SES+sex+age	0.80 (0.10, 6.45)	1.60 (0.48, 5.36)	1.76 (0.58, 5.32)	4.03 (1.31, 12.39)**
ADHD (n=154)				
Crude model	0.88 (0.41, 1.89)	1.33 (0.91, 1.93)	1.09 (0.73, 1.63)	1.83 (1.17, 2.85)**
Adj for comorbidity ²	0.67 (0.30, 1.48)	1.23 (0.83, 1.81)	0.89 (0.59, 1.35)	1.29 (0.81, 2.06)
+Adj for SES+sex+age	0.79 (0.28, 2.23)	1.16 (0.67, 2.01)	1.00 (0.59, 1.71)	1.42 (0.77, 2.61)
Autism disorders (n=46)				
Crude model	0.84 (0.20, 3.51)	0.30 (0.09, 0.97)*	0.49 (0.19, 1.24)	0.43 (0.10, 1.77)
Adj for comorbidity ²	0.61 (0.14, 2.58)	0.24 (0.08, 0.79)*	0.36 (0.14, 0.92)*	0.24 (0.06, 1.03)
+Adj for SES+sex+age	0.60 (0.08, 4.59)	0.22 (0.05, 0.98)*	0.37 (0.11, 1.25)	0.15 (0.02, 1.17)
Eating disorders (n=40)				
Crude model	1.38 (0.42, 4.51)	2.09 (1.08, 4.06)*	2.01 (1.05, 3.86)*	1.26 (0.49, 3.22)
Adj for comorbidity ²	1.07 (0.32, 3.54)	1.90 (0.97, 3.72)	1.64 (0.85, 3.19)	0.80 (0.31, 2.08)
+Adj for SES+sex+age	0.83 (0.19, 3.62)	2.25 (1.02, 4.95)*	1.40 (0.65, 3.02)	0.91 (0.31, 2.72)
Trauma disorders (n=66)				
Crude model	4.76 (2.60, 8.70)***	1.89 (1.12, 3.21)*	2.73 (1.66, 4.51)***	2.49 (1.37, 4.52)**
Adj for comorbidity ²	4.60 (2.50, 8.48)***	1.81 (1.06, 3.06)*	2.52 (1.53, 4.17)***	2.04 (1.11, 3.74)*
+Adj for SES+sex+age	4.70 (2.14, 10.30)***	2.14 (1.07, 4.26)*	2.42 (1.27, 4.62)**	1.97 (0.90, 4.31)
No diagnosis received (n=329)³				
Crude model	1.31 (0.84, 2.04)	1.13 (0.86, 1.49)	1.51 (1.18, 1.94)**	1.74 (1.28, 2.37)***
Adj for SES+sex+age	1.74 (1.04, 2.92)*	1.13 (0.78, 1.64)	1.37 (0.98, 1.90)	1.86 (1.24, 2.80)**

CRAFFT: screening scale for identification of potential problematic alcohol and drug use among adolescents

¹Analyses for psychotic disorders (n=11) and other psychiatric diagnoses (n=84) are not shown in the table.

²For each diagnostic category, psychiatric diagnoses from any other category are included as confounding comorbid diagnoses.

³Fully adjusted model for 'no diagnosis received' group does not include adjustment for psychiatric comorbidity.

Bold fonts signify statistically significant associations. *p<0.05. **p<0.01. ***p<0.001.

Table 5. Ordered logistic regression analyses between psychiatric diagnoses given during contact with specialist mental health care services and increasing levels of indicators for alcohol and drug-related problems among adolescents (n=9,408)¹

	Unadjusted model	Adjusted for psychiatric comorbidity ²	Adj psychiatric comorbidity ² + SES, sex and age
	OR (95%CI)	AOR (95%CI)	AOR (95%CI)
Anxiety (n=132)	1.09 (0.76, 1.58)	0.77 (0.52, 1.13)	0.81 (0.49, 1.34)
Depression (n=172)	1.92 (1.43, 2.59)***	1.57 (1.13, 2.17)**	1.28 (0.84, 1.94)
Conduct disorders (n=32)	3.20 (1.65, 6.23)**	2.15 (1.08, 4.28)*	2.28 (0.85, 6.14)
ADHD (n=154)	1.36 (0.97, 1.91)	1.13 (0.80, 1.62)	1.31 (0.83, 2.08)
Eating disorders (n=40)	1.84 (1.00, 3.40)	1.46 (0.79, 2.73)	1.44 (0.71, 2.93)
Trauma disorders (n=66)	2.82 (1.75, 4.56)***	2.92 (1.56, 5.47)**	2.53 (1.34, 4.79)**
No diagnosis received (n=329) ³	1.46 (1.16, 1.84)**	n/a	1.50 (1.11, 2.02)**

¹Analyses for psychotic disorders (n=11) and other psychiatric diagnoses (n=84) are not conducted. Autism diagnoses (n=46) were also excluded as the proportional odds assumption was not met.

²For each diagnostic category, psychiatric diagnoses from any other category are included as confounding comorbid diagnoses.

³Fully adjusted model for 'no diagnosis received' group does not include adjustment for psychiatric comorbidity as they had no comorbid psychiatric diagnoses.

Bold fonts signify statistically significant associations. *p<0.05. **p<0.01. ***p<0.001.

Contributors OH has carried out the literature review for the introduction and discussion sections, conducted the statistical analyses, and has written the manuscript. OH, MH and JCS have been involved in the preparation and conduction of the statistical analyses, while all authors (OH, MH, JCS, JH, RS) have reviewed the project and participated in manuscript writing.

Competing interests None.

Data sharing statement Due to legal restrictions from the owner of the data set for the patient registry, no additional data sharing is available.

Appendix

Full range of ICD-10 psychiatric diagnoses (F and R codes) in the clinical sample, and the psychiatric diagnostic categories employed in the study

Diagnostic category	ICD-10 code	ICD-10 diagnosis
ADHD	F900	Hyperkinetic disorders
	F901	Disturbance of activity and attention
	F908	Other hyperkinetic disorders
	F909	Attention-deficit hyperactivity disorder, unspecified type
Conduct disorders	F910	Conduct disorder confined to family context
	F911	Unsocialized conduct disorder
	F913	Oppositional defiant disorder
	F918	Other conduct disorders
	F919	Conduct disorder, unspecified
	F920	Depressive conduct disorder
	F928	Other mixed disorders of conduct and emotions
	F929	Mixed disorder of conduct and emotions, unspecified
Anxiety disorders	F401	Social phobias
	F402	Specific (isolated) phobias
	F408	Other phobic anxiety disorders
	F410	Panic disorder [episodic paroxysmal anxiety]
	F411	Generalized anxiety disorder
	F412	Mixed anxiety and depressive disorder

F413	Other mixed anxiety disorders
F418	Other specified anxiety disorders
F419	Anxiety disorder, unspecified
F420	Predominantly obsessional thoughts or ruminations
F421	Predominantly compulsive acts [obsessional rituals]
F422	Mixed obsessional thoughts and acts
F429	Obsessive-compulsive disorder, unspecified
F452	Hypochondriacal disorders
F930	Separation anxiety disorder of childhood
F931	Phobic anxiety disorder of childhood
F932	Social anxiety disorder of childhood
F940	Elective mutism
F932	Social anxiety disorder of childhood
F940	Elective mutism

Depression / mood disorders	F310	Bipolar affective disorder, current episode hypomanic
	F311	Bipolar affective disorder, current episode manic without psychotic symptoms
	F313	Bipolar affective disorder, current episode mild or moderate depression
	F316	Bipolar affective disorder, current episode mixed
	F317	Bipolar affective disorder, currently in remission
	F319	Bipolar affective disorder, unspecified
	F320	Mild depressive episode
	F3200	Mild depressive episode
	F321	Moderate depressive episode

	F322	Severe depressive episode without psychotic symptoms
	F328	Other depressive episodes
	F329	Depressive episode, unspecified
	F331	Recurrent depressive disorder, current episode moderate
	F332	Recurrent depressive disorder, current episode severe without psychotic symptoms
	F333	Recurrent depressive disorder, current episode severe with psychotic symptoms
	F338	Other recurrent depressive disorders
	F349	Persistent mood [affective] disorder, unspecified
	F381	Other recurrent mood [affective] disorders
	F412	Mixed anxiety and depressive disorder
	<hr/>	
Trauma-related disorders	F430	Acute stress reaction
	F431	Post-traumatic stress disorder
	F4320	Adjustment disorder, unspecified
	F4321	Adjustment disorder with depressed mood
	F4322	Adjustment disorder with anxiety
	F4323	Adjustment disorder with mixed anxiety and depressed mood
	F4325	Adjustment disorder with mixed disturbance of emotions and conduct
	F438	Other reactions to severe stress
	F439	Reaction to severe stress, unspecified
		<hr/>
Psychotic disorders	F2090	Schizophrenia, unspecified
	F21	Schizotypal disorder
	F231	Acute polymorphic psychotic disorder with symptoms of schizophrenia

	F239	Acute and transient psychotic disorder, unspecified
	F2390	Acute and transient psychotic disorder, unspecified
	F29	Unspecified nonorganic psychosis
	F333	Recurrent depressive disorder, current episode severe with psychotic symptoms
Autistic disorders	F840	Childhood autism
	F841	Atypical autism
	F845	Asperger syndrome
	F849	Pervasive developmental disorder, unspecified
Eating disorders	F500	Anorexia nervosa
	F501	Atypical anorexia nervosa
	F502	Bulimia nervosa
	F503	Atypical bulimia nervosa
	F509	Eating disorder, unspecified
Other psychiatric diagnoses	F449	Dissociative [conversion] disorder, unspecified
	F454	Persistent somatoform pain disorder
	F489	Neurotic disorder, unspecified
	F510	Nonorganic insomnia
	F512	Nonorganic disorder of the sleep-wake schedule
	F54	Psychological and behavioral factors associated with disorders or diseases classified elsewhere
	F601	Schizoid personality disorder
	F633	Trichotillomania
	F640	Transsexualism
	F659	Disorder of sexual preference, unspecified

F933	Sibling rivalry disorder
F938	Other childhood emotional disorders
F939	Childhood emotional disorder, unspecified
F941	Reactive attachment disorder of childhood
F942	Disinhibited attachment disorder of childhood
F951	Chronic motor or vocal tic disorder
F952	Combined vocal and multiple motor tic disorder [de la Tourette]
F980	Nonorganic enuresis
F981	Nonorganic encopresis
F988	Other specified behavioral and emotional disorders with onset usually occurring in childhood and adolescence
F989	Unspecified behavioral and emotional disorders with onset usually occurring in childhood and adolescence
R418	Other symptoms and signs involving cognitive functions and awareness
R452	Unhappiness
R454	Irritability and anger
R457	State of emotional shock and stress, unspecified
R458	Other symptoms and signs involving emotional state
R466	Undue concern and preoccupation with stressful events

Non- diagnosis	1000	No proven diagnosis on Axis I
	1999	Not sufficient information to code on Axis I
	-	No F- or R-codes on Axis I



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