

Mental health in adolescence as determinant of alcohol consumption trajectories in the Northern Swedish Cohort

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Abstract

Objectives The study aimed to analyze whether poor mental health in adolescence predicts heavy alcohol consumption over the long term.

Methods Alcohol consumption in the population cohort ($n = 1010$) was surveyed at the ages of 16, 18, 21, 30 and 42. Utilizing latent class growth analysis, six consumption trajectories ranging from ‘Late Onset Low’ to ‘Early Onset High’ were defined and analyzed with respect to internalization (depressiveness and anxiousness) and externalization (truancy and vandalism) at age 16.

Results Poor mental health predicted the Early Onset High trajectory (risk ratios in relation to the compliant trajectory 3.59 for anxiousness, 2.85 for depressiveness, 5.69 for truancy and 7.75 for externalized vandalism). Moreover, significant associations were found for the Early Onset Moderate and Early Onset Low trajectories.

Conclusions This is the first study to show an association between internalized mental health problems in adolescence and lifelong heavy drinking. The study also confirmed a strong association between externalized behavior and heavy drinking, indicating a need of preventive measures in this group. Nevertheless, the analyses demonstrated that most teenagers with mental health problems continue along a reasonable drinking trajectory.

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Introduction

Alcohol use ranks among major public health issues worldwide (Poznyak and Rekke 2014): the impact of the amount of alcohol intake on health and social harm, both acute and chronic, is mediated through the toxic effect of ethanol on the one hand, and the addictive potential on the other (Babor et al. 2010). This is why the development of alcohol consumption during the life course has attracted a lot of research interest for decades (Fillmore 1988; Johnstone et al. 1996). Evidently, heavy consumption is intertwined with the development of mental health through complex causal pathways. With respect to the methods of studying this complex, a step forward was taken around the turn of the millennium, when progress in statistics and

access to more powerful computers provided researchers with trajectory analysis packages. The study by Hill et al. (2000) seems to have been the first to apply trajectory analysis to alcohol consumption. They studied internalized and externalized mental health symptoms and delinquency of 880 schoolchildren at age 13, measured their binge drinking at six time points up to age 21 and named the obtained trajectory groups as ‘early highs’, ‘increasers’, ‘late onsetters’ and ‘non-bingers’. It turned out that delinquency and externalized symptoms predicted the ‘early high’ trajectory, while this was not the case for the internalized symptoms.

Trajectory analysis soon became an established method in research on the onset and development of drinking during adolescence and early adulthood (Maggs and Schulenberg 2004–2005) and the associated determinants and outcomes. Externalized disturbances, such as aggression, school problems and delinquency, have been most commonly regressed on the set of trajectories. In addition to Hill et al. (2000), Li et al. (2001) and Windle et al. (2005) have found support for the hypothesis that delinquency and antisocial behavior predict a high consumption trajectory, while Tucker et al. (2003) found that such a trajectory predicts delinquency at follow-up. In the study of a twin cohort (Wichers et al. 2013), even the genetic risk of externalized disorders was associated with the trajectory of high-level consumption up to middle age.

As far as internalized symptoms, such as anxiety and depression, have been included in the studies, the associations with drinking trajectories have turned out to be non-significant (Hill et al. 2000; Windle et al. 2005; Hicks et al. 2010). In line with these findings, internalized problems in childhood did not predict substance abuse in adulthood (Maggs et al. 2008; Miettunen et al. 2014), and depression at age 17 did not predict drug and alcohol dependence at ages 20 and 24 (Marmorstein et al. 2010).

The potential of trajectory analyses in assessing the importance of adolescence mental health to alcohol consumption is still under-utilized. In particular, research with internalized mental health is scarce, and replication of the zero findings in new settings is needed until they may be declared as universal. Moreover, as development of drinking during the teens and early adulthood seems to be quite heterogeneous (Li et al. 2001; Chassin et al. 2002), the relatively short-term trajectories of earlier studies raise questions about early mental health as a predictor of adulthood drinking trajectories. Extending the trajectories into middle age would open up a longer-term life course perspective—not only regarding differential development of alcohol consumption, but also regarding different health outcomes.

The present study draws on the Northern Swedish Cohort Study that has followed a population cohort from

age 16–42 by five questionnaire surveys with high participation rates. In terms of methodology, the aim is to conduct trajectory analyses that take into account the turning point from teenage to early adulthood, when average figures show a turn from increasing to stabilizing consumption. The trajectories are then related to baseline mental health, measured with internalized symptoms and externalized behavior. We hypothesize that these disorders are not only associated with early onset of drinking, but also predict high-level consumption in adulthood.

Methods

The Northern Swedish Cohort Study (Hammarström and Janlert 2012) was set up in 1981 with a questionnaire to all pupils ($n = 1,083$) who attended the last year of compulsory school (age 16) in all nine schools in a middle-sized municipality in Northern Sweden. The baseline survey took place in classrooms. Follow-up surveys were conducted in 1983 (age 18), 1987 (age 21), 1995 (age 30) and 2007 (age 42), and took place at classmate reunions or by post or by telephone. Response rates have been very high: at the 26-year follow-up in 2007 a total of 522 men and 488 women ($n = 1,010$, 94 % of those still alive) continued to participate. In 1983, 1987 and 1995, the numbers of respondents were, respectively, 997, 998 and 989. The study has been approved by the Regional Ethical Review Board in Umeå, Sweden.

Two composite measures of internalized symptoms at age 16, distinguishing depressiveness and anxiousness, were created on the basis of the symptom clusters defined in DSM-5 (American Psychiatric Association 2013). The items concerning (1) ‘sleeplessness’, (2) ‘poor appetite’, (3) ‘fatigue’, (4) ‘concentration difficulties’, (5) ‘felt down or sad’ and (6) ‘feeling downhearted about future’ were calculated into the depressiveness score. Internal consistency of the score was acceptable (Cronbach’s alpha 0.648; CFA $\chi^2(9) = 18.45$, $p = 0.030$, CFI = 0.99, RMSEA = 0.03). Anxiousness variable was based on the items concerning (1) ‘restlessness’, (2) ‘concentration difficulties’, (3) ‘worry’, (4) ‘palpitations’ and (5) ‘panic’ (Cronbach’s alpha 0.706; CFA $\chi^2(5) = 18.45$, $p = 0.002$, CFI = 0.99, RMSEA = 0.05). The scores were scaled from 0 (no symptoms) to 2 (intensive symptoms). Those belonging to the upper quartiles (split at 0.67 for depressiveness and 0.20 for anxiousness) were defined as suffering from depressiveness/anxiousness.

Externalized behavior at age 16 was measured with two indicators. Truancy was inquired by a question with the response options weekly, a few times monthly, once in a month, a few times in a semester and never. Distribution of the responses was 9, 10, 7, 34 and 39 %, respectively.

Truancy was dichotomized at never/a few times in a semester. The question about destroying property, with three response options was dichotomized at never (64 percent) versus once (19 percent) or several times (15 percent) into the vandalism variable.

In the questions of alcohol consumption, the respondents were asked to report the frequency of their drinking occasions (every or every second day, 1–2 times weekly, a couple of times monthly, more seldom, never) and average intake of beer (number of bottles), wine (number of glasses) and strong beverages (number of drinks) on each occasion. Basing on this data, the average intake in centiliters of absolute alcohol was calculated for each survey year.

The drinking trajectories were identified using the Flexmix package in R statistical software. Details of the trajectory analysis are described in the [Results](#).

Associations of mental health to the trajectory classes were studied with multinomial logistic regression analyses, adjusting for the gender and social class of the parents (a three class variable expressing if both, one or neither of the parents had a white collar occupation, basing on the reply to the questionnaire and the classification of Statistics Sweden). As an individual is not classified distinctively to one trajectory class, but is assigned to each class with a higher or a lower probability, the regression analyses were weighted with the posterior probability of belonging to the chosen (i.e., the most likely) trajectory class.

Results

Trajectory analysis

Trajectory analysis, or ‘latent class growth analysis’ (Nagin 2005), aims to define distinctive groups that emerge from the data itself, instead of being based on predefined categories. The method classifies individuals into groups or categories so that, with respect to the development of the property of interest, those within a group are more similar than those in different groups (Yung and Wickrama 2008). It is a powerful and statistically well-justified method for disentangling the observed heterogeneity in longitudinal data (Maggs and Schulenberg 2004–2005).

The distribution of the alcohol consumption variable was very positively skewed, with several extreme or outlying observations, potentially disturbing the assumptions that underlie the latent class trajectory analysis. One way to proceed in this kind of situation is to first apply a transformation in an attempt to reduce the asymmetry in the distribution (see e.g., McLachlan and Peel 2000). The choice of transformation is an important step, since it may have an effect on the number of clusters identified in the

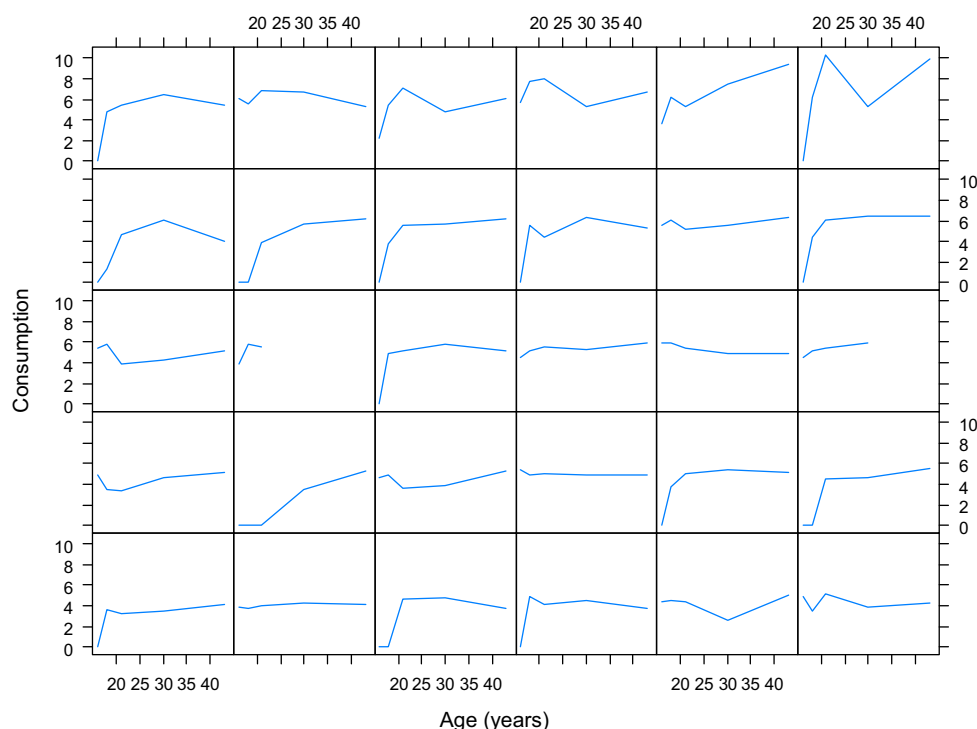
trajectory analysis. We chose to use log transformation; the choice was supported by the estimated parameter value of the Box-Cox transformation, which was close to zero ($=0.14$), indicating that distribution of the transformed data would be closer to the normal one.

Next, we explored a random sample of 30 individual drinking profiles (Fig. 1) and found, as expected, that it is quite common for the consumption to increase from age 16 to age 21; while in adulthood, the changes tend to be less pronounced. In line with these illustrations, at age 18, there was still great variation in the consumption of the cohort, meaning that the consumption patterns not yet had been stabilized. The observations also are in line with earlier research, showing that the consumption tends to increase even after age 21 (Härkönen and Mäkelä 2010). Given the measuring times available in our data, modeling this kind of development by a simple linear trend or by second degree polynomial may not adequately depict the form of individual curves for the trajectory analysis. On the other hand, higher-order polynomial models may lead to over-fit and, therefore, provide quite unstable estimates. Our approach, therefore, was to apply the so-called ‘broken stick’ model with the ‘knot point’ at age 21 (Ruppert et al. 2005). This procedure provides a continuous curve by joining the linear trend model covering ages 16, 18 and 21 with the model covering ages 21, 30 and 42. It can be assumed to capture variation in the patterns of consumption development demonstrated in Fig. 1. Basically, it is a special form of the regression spline models that can be easily fitted using statistical software developed for linear models.

A normal mixture model with independent observations within a cluster was assumed, with different intercept terms for males and females and with normal distribution for log alcohol consumption (+1). Identification of the trajectories was started with the help of information criterion functions. We tested five numbers of clusters ($k = 4, 5, 6, 7$ and 8). Values of the corresponding Bayesian Information Criteria (BIC) were 18,863.07, 18,750.23, 18,666.94, 18,623.07 and 18,636.84. The minimum was obtained for $k = 7$, but the difference from $k = 6$ was minor. As also for $k = 7$ two of the clusters were relatively small (less than seven percent); whereas for $k = 6$ solution, only one cluster included less than ten percent of the cohort, we retained this model. This choice, moreover, provided a clear interpretation and therefore satisfied the ‘common sense criterion’. In addition, we investigated the histograms (so-called rootogram plots, not shown) of (square root of) the posterior probabilities that confirmed that the clusters are well separated.

Models for log-transformed alcohol consumption, separate for men and women at ages 16, 21 and 42, were plotted to visualize the development of drinking in the six clusters (Fig. 2). The classes of drinking trajectories were

Fig. 1 Drinking profiles (yearly consumption of absolute alcohol in centiliters, log-transformed scale) of a random sample of 30 individuals from age 16 to age 42. Northern Swedish Cohort 1981–2007



named, in the order of size, as ‘Ordinary’, ‘Early Onset Moderate’, ‘Early Onset High’, ‘Compliant’ (i.e., with legislative rules of the society), ‘Early Onset Low’ and ‘Late Onset Low’.

The largest trajectory class, more than a fourth of the participants, drank very little at age 16, had truly started drinking at age 18, and increased their consumption slightly throughout adulthood. Their drinking life course can be characterized as ‘Ordinary’, both with respect to size of the group and with respect to the social norms of drinking.

Almost as big was the trajectory class that was already drinking at the beginning of the follow-up and continued their consumption on a moderate level throughout the follow-up. This group broke the rule that it is not acceptable to drink at age 16, but in the adulthood this ‘Early Onset Moderate’ class in fact consumed somewhat less than the Ordinary trajectory class.

The analysis also revealed a trajectory that started and continued on a high level. This trajectory class, including 15 percent of the cohort, was labeled ‘Early Onset High’.

The fourth trajectory class was labeled ‘Compliant’ because they did not start drinking until after the age of 18 when it is legal to buy alcoholic beverages. Subsequently, their consumption resembled the pattern seen in the Ordinary class, albeit at a somewhat lower level. This class was chosen as the reference in the multinomial logistic regression analyses by mental health.

There was also a relatively small ‘Early Onset Low’ trajectory class that had started at age 16, showed a low peak at age 21 and decreased their drinking towards middle age.

Finally, a class of less than ten percent was labeled as ‘Late Onset Low’ consumers.

Assuming different intercept terms for men and women ‘forced’ the genders into the same trajectory groups and enabled gender comparison (Table 1). There were significant differences (Chi-square test: p value 0.010): men were over-represented on the Ordinary, the Early Onset High, and the Compliant trajectory classes.

Associations of baseline mental health with the trajectories

Descriptive percentages in Table 2 show the lowest prevalence of the internalized symptoms as well as the externalized behavior for those on the Compliant drinking trajectory with one exception: vandalism was the least common in the Late Onset Low trajectory class. As a rule, the figures for Early Onset High trajectory class were the highest.

Largely similar risk ratio patterns were obtained for both internalized symptoms. The risks of the Late Onset Low and the Ordinary trajectory classes were slightly increased (range of RRRs from 1.04 to 1.97), whereas the risks of all types of Early Onset trajectory classes were significant.

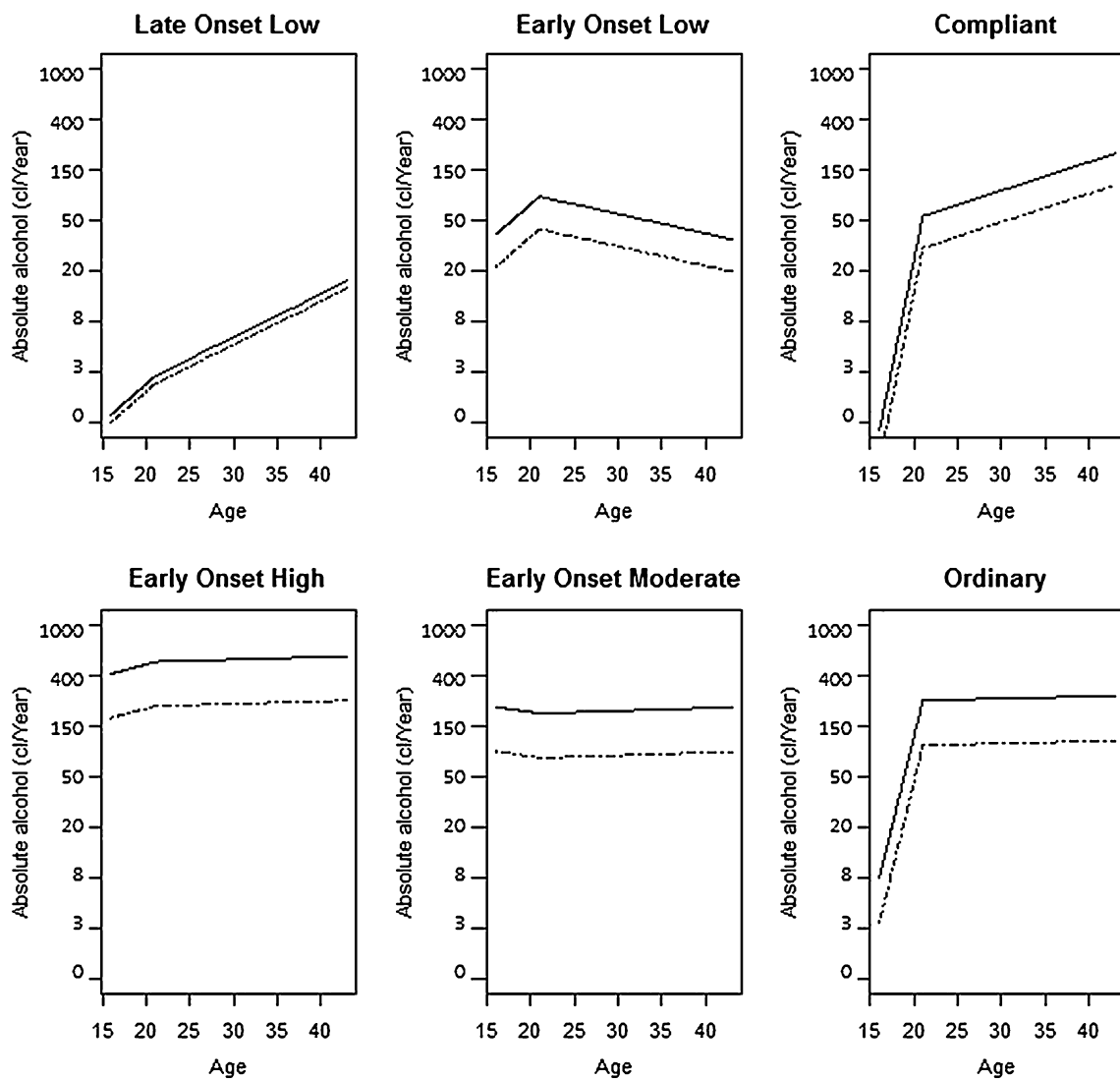


Fig. 2 Illustrations of the development of drinking from age 16 to age 42 in men (*dashed lines*) and in women (*dotted lines*) assigned to the classes produced by the ‘broken stick’ trajectory analysis with the knot point at age 21. Northern Swedish Cohort 1981–2007

Table 1 Sample of the study according to the trajectory of alcohol consumption from age 16 to age 42

Trajectory class	<i>n</i>	Percent	Percent men
Ordinary	283	28.3	53.4
Early onset moderate	259	25.9	47.1
Early onset high	151	15.1	55.6
Compliant	129	12.9	64.3
Early onset low	101	10.1	43.6
Late onset low	78	7.8	44.9
Total	1,001	100	51.8

Northern Swedish Cohort 1981–2007

Anxiousness stood out as incurring high risk of the Early Onset High trajectory (RRR 3.59).

Externalized behavior predicted very strongly the Early Onset High trajectory class (RRR for truancy 5.69 and for vandalism 7.75). It also predicted other Early Onset classes, the RRRs tending to be higher than in the case of

internalized symptoms. ‘Compliant’ drinking trajectory does not indicate the highest compliancy with respect to vandalism, as evidenced by the significantly low RRR (0.16) of the Late Onset Low trajectory class.

Finally, we checked gender differences in the associations of the symptoms with the trajectory classes. *p* values

Table 2 Mental health at age 16 and drinking trajectory until age 42 of the Northern Swedish Cohort ($n = 1,001$)

	Drinking trajectory					
	Compliant	Late onset low	Ordinary	Early onset low	Early onset moderate	Early onset high
Internalized symptoms						
Anxiousness						
Within trajectory prevalence (%)	16	24	28	33	36	40
OR (95 % CI)	Ref	1.54 (0.72–3.32)	1.97 (1.08–3.60)	2.43 (1.21–4.88)	2.84 (1.56–5.15)	3.59 (1.89–6.82)
Depressiveness						
Within trajectory prevalence (%)	13	17	20	30	30	33
OR (95 % CI)	Ref	1.07 (0.45–2.50)	1.41 (0.74–2.72)	2.37 (1.14–4.93)	2.46 (1.31–4.64)	2.86 (1.45–5.66)
Externalized behavior						
Truancy						
Within trajectory prevalence (%)	24	30	52	71	74	89
OR (95 % CI)	Ref	0.92 (0.50–1.69)	2.30 (1.44–3.66)	2.24 (1.25–4.00)	3.83 (2.35–6.24)	5.69 (3.15–10.3)
Vandalism						
Within trajectory prevalence (%)	23	4	28	41	45	60
OR (95 % CI)	Ref	0.16 (0.04–0.55)	1.43 (0.82–2.49)	3.92 (1.99–7.72)	4.24 (2.42–7.44)	7.75 (4.14–14.5)

Relative risk ratios with 95 % confidence intervals (CI) of those reporting the symptom for assuming the trajectory with the Compliant trajectory as the reference. Multinomial logistic regression adjusted for gender and parental social class

Statistically significant risk ratios are in bold

for the interactions showed the differences to be non-significant. Among women, however, the association with the early onset classes tended to be stronger; for instance, the frequency of depressiveness in the Compliant trajectory class was 14 % in women and 12 % in men, while in the Early Onset High class the figures were 42 and 25 %, respectively.

Discussion

This follow-up study analyzed the relations of different mental symptoms in adolescence with drinking trajectories from age 16 up to middle age. The population cohort was classified into six trajectories, ranging from ‘Early Onset High’ to ‘Late Onset Low’. Externalized behavior was more common among those who would later follow a trajectory of high consumption. We also found support for the importance of internalized symptoms as predictors of such trajectories.

Earlier studies with shorter-term trajectories have consistently found that teenage externalized disorders predict trajectories of heavy alcohol consumption (Hill et al. 2000; Colder et al. 2002; Tucker et al. 2003; Windle et al. 2005; Hicks et al. 2010). According to the study by Wichers et al. (2013), this is the case also with longer-term trajectories. Overall, the present findings are in line with previous results. On closer inspection, all ‘Early Onsetters’ stand out with higher symptom figures; this indicates that drinking could also be counted as one of the externalized symptoms

in adolescence. Diverging drinking trajectories of the ‘Early Onsetters’ suggest that for a considerable group of teenagers these symptoms are transient.

Compared with the externalized mental health problems, the predictive importance of internalized mental health problems for the development of alcohol consumption has been studied less often, and the associations with drinking trajectories have turned out to be non-significant (Hill et al. 2000; Windle et al. 2005; Hicks et al. 2010). The present study suggests that there may be a positive association. One explanation may lie in different drinking cultures: the three referred studies come from US. Moreover, they have used different ways to assess internalization [teacher ratings of anxiousness and social withdrawal at age 10–12 in Hill et al. (2000), a 20-item scale for depression at age 16 in Windle et al. (2005) and teacher ratings of ‘internalizing distress’ composed of depression, anxiety and stress reaction in 17-year-old boys in Hicks et al. (2010)]. Age may explain the difference with respect to Hill et al. (2000) and gender the difference with respect to Hicks et al. (2010), as also in our study the association tended to be stronger among women. Finally, differing from previous studies, our sample was contacted at universal compulsory school, which means that it included the whole age group in the population living in the geographic area.

The variables constructed in the Northern Swedish Cohort study are particular, but nevertheless cover the main symptoms of depressiveness and anxiousness as conceptualized in DSM-5. As also their internal consistencies

were acceptable and their validity was ascertained by confirmatory factor analysis, it is unlikely that our non-conformist finding could be due to a biased measurement method. The result was also quite insensitive as regards the point of dichotomisation: the associations pointed to same direction, albeit with wider confidence intervals, when using upper deciles as the cut-off point. Notably, the symptoms predict all 'early onset' trajectories. This could mean that in the teenage years, alcohol is used to alleviate anxiety and depressiveness, but this 'treatment' usually does not develop into adulthood alcohol use disorder. Alternative or additional explanations could be an underlying third factor such as difficulties in school or existential uncertainties ('Sturm und Drang'). Finally, we cannot rule out the possibility of reverse causality: onset of drinking in adolescence may harm mental health. A limitation of our study was that the follow-up did not start earlier, ideally before the adolescence, when children have not started drinking.

As to the trajectories, there are some noteworthy findings. The 'early onsetters' mostly continued along the trajectory of moderate consumption, but about three out of ten (15 % of the total cohort) went on to a trajectory of high-level consumption; while in two out of ten, the adulthood consumption settled down as low. Among those who did not drink at sixteen, the onset until age eighteen was so common that this trajectory (28 % of the total cohort) was characterized as 'ordinary', while it was relatively uncommon to start 'compliantly', or only in legal adult age. The analysis did not identify a trajectory of lifelong abstinence, but placed those (8 women and 7 men) reporting zero consumption in all surveys in the Late Onset Low trajectory class.

There are two earlier drinking trajectory analyses that serve as reference for the present study regarding the age range. A study from Finland (Berg et al. 2013) found exactly the same share of Early Onsetters as we did. The figure was somewhat higher (56 %) in the study from the US (Wichers and al 2013) but it included only men and excluded the never drinkers. In the Finnish study, the measure ('heavy drinking' vs. not) was too different to allow comparison of the trajectories. In the US study, intake was measured in drinks per month, and the six trajectories obtained are similar in shape to the trajectories of men obtained in our study: there are three early onset trajectories of varying consumption level, as well as three trajectories of initial zero level. Regarding the size of the subgroups, the most common trajectory in the US study, including 24 % of the participants, resembles the Compliant rather than the Ordinary group in our study. On the other hand, the proportion of respondents in the Early Onset High trajectory was 15 % in both studies.

Strengths and limitations

Studies of drinking trajectories have almost always started their follow-up in the late teens and utilized institutional settings, e.g., compulsory schools or colleges in the recruitment of participants. This facilitates high response rates at baseline and in short-term follow-ups, but the after-school surveys face the problem of non-participation: in particular, the non-response-related to heavy drinking and to poor mental health. In the present study, the practically total participation at baseline and in the follow-up surveys is a definite strength. Through intensive efforts, we reached even the severely marginalized individuals with advanced alcohol use disorders.

Compared to earlier drinking trajectory studies, our sample is large rather than small, and the cohort is representative of the whole country in many respects (Hammarström and Janlert 2012). Still, findings from one Swedish town can only be generalized with caution. Corresponding trajectories probably exist all over the Western cultures, but their prevalence may vary, as well as strength of the associations with mental symptoms in adolescence.

In contrast to binge drinking or corresponding variables used in most of the earlier trajectory analyses, we measured the intake of absolute alcohol by an established questionnaire. From the perspective of a longer-term life course, the relevance of such a measure is obvious, as the binge drinking prevalent in adolescence and early adulthood is supplemented and partly substituted by more or less regular drinking of smaller amounts towards middle age (Casswell et al. 2002). Detailed assessment of the trajectories as regards their harmfulness or the norms for heavy drinking falls out of the scope of the present study.

This follow-up study started at the point in the life course when half (51 %) of the cohort members had started to drink, and it is possible that some symptoms were due to the pre-baseline drinking trajectory. We may, however, assume that the extent of the intake has mostly been small and the duration short, and argue that the measurements at age 16 are valid indicators of the drinking-independent mental health in adolescence. Still, it is possible that the complex of drinking and mental symptoms may be related to underlying third factors, such as bereavement, difficulties with peers, girlfriends/boyfriends and studies, for example. Indeed, both early drinking and the mental health problems studied here could be part of a generally poor mental health indicative of negative exposures in childhood and/or genetic susceptibility.

Conclusions and policy implications

Maggs and Schulenberg (2004–2005) advocate for trajectory analysis as a method for breaking down the average, or

'normative', development by age into a taxonomy that helps to deepen the understanding of the causes and consequences of drinking. Agreeing with them, we analyzed in the present study the importance of mental health in adolescence for various drinking trajectories extended up to the age of 42. Compared to analyses of the average course of consumption, the taxonomy obtained, together with subsequent regression analyses, makes it clear that those with mental health problems are not predetermined to be problem drinkers; there are good chances for them to continue along reasonable drinking trajectories as well. The findings increase our understanding of the early background of adult drinking patterns and could help to focus the alcohol policy by defining target groups for intervention measures among youth. The strong association of externalized behavior with drinking gives reason to recall the importance of targeted prevention in this group, but more importantly, this study gives reason to emphasize that alcohol should not be overlooked in the case of the teenagers with the less arresting internalized problems of mental health.

What remain to be studied are drinking trajectories during late middle age and senior age, and how they might be related to mental health, ranging from the emergence of toxic organ effects to declined psychosocial well-being. In addition, studies of interventions or natural experiments should be used to obtain better evidence regarding the possible causal relationship between mental health and later alcohol problems. For instance, enforcement of the age limits may result in more moderate alcohol use during the life course, as evidenced by the Compliant trajectory class.

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