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Socioeconomic inequalities in alcohol-related harm in adolescents: a prospective cohort study of 68,299 Danish 15–19-year-olds



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Summary

Background Evidence shows that similar levels of alcohol consumption lead to greater harm in adults with low socio-economic position (SEP) compared to high SEP. We investigated if SEP is associated with alcohol-related hospital contacts in adolescents, and whether differences in risk can be explained by differences in levels of alcohol consumption, drinking pattern, and substance use.

Methods This is a prospective cohort study of 68,299 participants aged 15–19 years old from the Danish National Youth Cohort 2014. SEP was operationalised as parent educational level, family income and perceived financial strain in the family. Data were linked to national registers and participants were followed up for five years from 2014 to 2019. Outcomes were hospital contacts due to alcohol. Multilevel Poisson regression was used to estimate incidence rates (IR) and incidence rate ratios (IRR).

Findings During 280,010 person years of follow-up, 872 participants had an alcohol-attributable hospital contact; intoxications ($n = 778$, 89%) were the most common diagnosis. Low as compared to high SEP was associated with higher IRR of alcohol-attributable hospital contacts for all three SEP measures. The adjusted IRR of harm was 1.73 (95% CI: 1.29–2.33) for elementary school as the highest parent education compared to longer parent education and 1.57 (95% CI: 1.30–1.89) for family financial strain compared to those without financial strain. Adjustment for weekly alcohol intake, drinking pattern and substance use did not substantially change results. Cubic spline analysis of the association between family income and alcohol-attributable hospital contacts revealed a dose–response relationship with decreasing risk of alcohol-related harm with higher income.

Interpretation Our findings suggested that alcohol-related harm is more common in socioeconomically disadvantaged adolescents despite similar levels of alcohol consumption, regardless of differences in drinking pattern or substance use. Future preventive strategies should prioritise young adolescents, including those who are most disadvantaged.

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Keywords: Alcohol-related harm; Alcohol-attributable hospital contact; Poisoning; Intoxication; Socioeconomic inequality; Alcohol harm paradox; Adolescents

Introduction

It is increasingly evident that alcohol-related harm is socially patterned.^{1,2} Yet, social inequality in alcohol-related harm among adolescents is poorly explored.

Inequalities in alcohol-related harm have mainly been investigated in adults, with little focus on adolescents. Alcohol consumption is a significant risk factor for adolescent health and accounts for substantial disability

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Research in context

Evidence before this study

We reviewed the literature in PubMed without language restrictions on September 7, 2022, using the search terms: (adolescents OR youth OR young adults) AND (alcohol) AND (socioeconomic inequality OR alcohol harm paradox). Additional literature was identified by “snowballing” of references from the identified literature. The current sparse literature points towards the presence of social inequalities in alcohol-related harm in adolescents, referred to as the alcohol harm paradox, just as in adults. Previous cross-sectional studies found a social gradient for the number of self-reported negative consequences experienced in connection to alcohol including accidents, physical fights, problems with relation to friends or family and regretted sex and drug use. However, longitudinal studies were notably absent.

Added value of this study

In this prospective cohort study, low parental socioeconomic position was associated with higher risk of alcohol-

attributable hospital contacts in 15–19-year-old adolescents. Lower family income was associated with higher risk in a dose-dependent relationship. The apparent social gradient was not explained by differences in alcohol intake, drinking patterns or other drugs (smoking, cannabis, and drug use). These results affirm that the alcohol harm paradox is already present in adolescence.

Implications of all the available evidence

The alcohol harm paradox—the finding that greater harm is experienced at similar levels of consumption among more socially disadvantaged populations—is seen in adolescents, as well as adults. This suggests that future preventive strategies to prevent alcohol-related harms should strengthen focus on young people and ensure inclusion of disadvantaged groups. More studies are needed to understand the potential mechanisms between social inequality and alcohol-related harm in young people.

in youth.^{3–6} Alcohol is associated with more than 200 acute and chronic conditions and diseases⁷ but since diseases such as liver cirrhosis and cancer take time to develop, adolescents are not at immediate risk of disease. In contrast, adolescents are at risk of harm caused by the acute effects of alcohol such as impaired motor skills and intoxications leading to accidents, injuries, violence and self-harm, as well as alcohol poisoning.^{8,9} Thus, the pattern of alcohol related health threats to young people differs from that of adults, and inequalities in alcohol-related harm have been poorly studied.

Studies in adults have consistently shown that individuals of lower socioeconomic position experience relatively more adverse consequences from alcohol such as alcohol-attributable hospital admissions and death compared to individuals with higher socioeconomic position despite similar or even lower alcohol intake.^{3–6} This phenomenon is called the alcohol harm paradox. Possible explanations include individual (e.g., genetics, differences in drinking patterns, accumulation of competing risk factors) and structural factors (e.g., alcohol policy, alcohol outlet density, social support, access to health care). Bias due to reverse causation and misclassification (if low socioeconomic position predicts underestimation of alcohol consumption) have also been suggested, although few results support this hypothesis.^{8–10}

We therefore set out to test if alcohol-attributable hospital contact is more widespread among adolescents from a lower socioeconomic background compared to those from higher socioeconomic backgrounds, after accounting for differences in consumption levels. Furthermore, we investigated if differences

in risk can be ascribed to differences in drinking patterns, smoking and other drug use. Finally, we investigated variations in associations between age groups.

Methods

Study design

We undertook a prospective cohort study linking survey data from the Danish National Youth Cohort 2014 with national hospital register data during five years of follow up from 2014 to 2018.

The Danish National Youth Cohort

The Danish National Youth Cohort 2014 is a representative nationwide survey of 75,853 students attending high school and vocational school that aims to study health and health behaviour in young Danes, as previously reported in detail.¹¹ In brief, data collection took place from September to December 2014 at Danish high schools and vocational schools. All high schools in Denmark were invited to participate (n = 137), of which 87% of schools agreed (n = 119). Of these, 96% (n = 3214) of invited high school classes and 85% (n = 70,674) of invited students participated. Twelve selected vocational schools were invited, of which 10 (83%) schools and 69% (n = 5179) of invited students agreed to participate. Vocational schools were selected on the basis of size and geographical location to strengthen their regional representation. Generally, students were between 15 and 20 years old, but students aged 15–25 years were encouraged to participate. In 2014, there was no age limit for attending vocational school in Denmark which explains the relatively wide age range. We focused on 15–19-year-olds as we wanted

to study the influence of parent's socioeconomic position, rather than a person's own socioeconomic position. Consequently 3896 students outside this age were excluded. Further, 3590 students were excluded due to missing linkage to the Danish Civil Registration System and 68 students were excluded due to missing information on alcohol use. The final study population consisted of 68,299 high school and vocational school students.

Exposure

Socioeconomic position was operationalised by three different variables: parent educational level, family income and perceived financial strain in the family. The Danish Civil Registration System permits identification of student's parents and linkage to national registers on highest attained education (the Population's Education Register) and family income (the Income Statistics Register). Educational level was categorised into four groups, based on the parent who attained the highest educational level: elementary school (ten years mandatory education); short education covering upper secondary school (high school [three years] and vocational education [four years including works experience]); medium education covering higher education following upper secondary school (Academy Profession degree [two years], Bachelor's degree [three years], and Professional Bachelor's degree [three to four years]); and long education (Master's degree following bachelor's degree [two years] and PhD following Master's degree [three years]). For 33% of participants, maternal educational level was highest whereas both parents were equally educated in 44%. Family income, as derived from the Income Statistical Register, was operationalised into quintiles. As opposed to parent educational level and family income, financial strain was self-reported and based on the question "Have your parents had difficulties paying the bills within the last year?" (yes/no) from the Danish National Youth Cohort survey.

Outcomes

The Danish National Patient Register contains information on all contacts to public hospitals, including emergency departments and outpatient contacts.¹² Alcohol-attributable hospital contact was defined by admissions wholly attributable to alcohol. The following diagnostic codes were included: E24.4, E51.2, E52.9A, F10, G31.2, G62.1, G72.1, I42.6, I85.0, I85.9, K29.2, K70, K71.1B, K85.2, K86.0, R78.0, T50.0A, T51, Z72.1, JCA20, JCA22. We grouped certain diagnoses to ease interpretation and due to few observations. More detail on included diagnosis and grouping of codes is described in [Supplementary Table S1](#). In the Danish National Patient Register the primary clinical condition is registered as an action diagnosis (A-diagnosis), while any secondary diagnosis is registered as a B-diagnosis. If a hospital contact was registered with both an

A-diagnosis and a B-diagnosis representing one of the outcome measures, the A-diagnosis was prioritised.

Alcohol intake

Weekly alcohol intake was based on the survey question "how many alcoholic drinks do you normally drink (12 g alcohol) each day during a typical week?". For each day of the week (e.g., Monday, Tuesday), the participants indicated the number of drinks. A weekly average was then calculated among drinkers and categorised into the following groups: 0 drinks, <7 drinks, 7–13 drinks, 14–20 drinks, 21–27 drinks, and >27 drinks which was used to display the main effects of alcohol intake on alcohol-attributable hospital contacts.

Other covariates

Alcohol intake at parties was based on the following question: "how many drinks do you drink on average at parties or nights out?". Those who responded that they "never go to parties/out" were coded as zero and were not included in the count of party drinks. Smoking status was categorised into never, sometimes, and daily. Cannabis and drug use was based on whether the student had tried cannabis or any other drug such as amphetamine, ecstasy/MDMA, cocaine, mushrooms (yes/no). Other covariates included age (continuous), sex (male/female), school type (vocational school/Higher General Examination Programme/Higher Preparatory Examination Programme), and school year (first/second/third). Ethnicity was self-reported and based on which ethnicity participants identify themselves with. Participants who identified with more than one ethnic group were allowed to choose more than one. The question was "Which ethnicity do you identify yourself as? (Danish/Danish and other/other ethnicities than Danish).

Ethics

Participants gave informed consent before completing the Danish National Youth Cohort survey online. The study was approved by the Danish Data Protection Agency.

Statistical analysis

Descriptive statistics were conducted to illustrate the characteristics of participants. Analyses included frequencies, proportions for categorical variables and medians for continuous variables. Poisson regression was used to assess incidence rates and incidence rate ratios of first-time hospital contacts due to alcohol. Each person was followed from the date of participation in the baseline survey in 2014 to the occurrence of the outcome in question, emigration, death, or end of follow-up (approximately five years after baseline, being March 1, 2019). The individual risk time was incorporated in the Poisson analysis using an offset. Information on death and emigration was retrieved from the

Danish Civil Registration System Analysis was done both with and without excluding pre-existing events (n = 31). Since the results were not affected by excluding pre-existing events, these were not excluded in the final model. In the age-stratified analyses, participants moved from age group 15–17 to 18–19 years, as soon as they turned 18. Information on death and emigration was retrieved from The Danish Civil Registration System. Multilevel models were used to account for clustering of schools. To account for missing values, we used multiple imputation by chained equations.¹³ The model included alcohol-attributable hospital contacts as the outcome and weekly alcohol intake, sex, perceived ethnicity, school type, school year, cohabitation, parental educational level, and smoking status as predictors and covariates. Information on age, sex and school type was complete. The fraction of missing values for questionnaire variables (perceived ethnicity, cohabitation, smoking and alcohol intake) was low (1.6% at most). In cases where information on highest attained education was missing for either the mother (2.7%) or the father (6.3%), it was determined by the parent with available information. Educational level was missing for both parents in 1.2% and thus imputed. Following imputation, estimation was performed on each imputation separately and then combined using Rubin’s rules.¹⁴ Alcohol intake measured as drinks per week was

operationalised into categories as previously described. Family income was modelled continuously by cubic splines to illustrate the shape of the risk curve in more detail, allowing for non-linearity.^{15,16} Socioeconomic position measures were dichotomised into short (elementary school) and long education (short, medium, long), low (Q1-Q2) and high (Q3-Q5) family income and whether or not participants experienced financial strain in the family (yes/no). Finally, additive and multiplicative interaction tests were performed to reveal interactions between weekly alcohol intake and socioeconomic position on the risk of alcohol-attributable hospital contacts. STATA version 16 was used to perform all analyses.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. All authors confirm that they had full access to all the data in the study and accept responsibility for the decision to submit for publication.

Results

Participants’ characteristics are shown in Table 1. The median age was 17.8 years and 10.3% reported never drinking alcohol. The median alcohol intake among

	Male (40%) N = 27,491	Female (60%) N = 40,808	All N = 68,299
Age ^a	17.9 (15.2–19.9)	17.8 (15.0–19.9)	17.8 (15.0–19.9)
Ethnicity, n (%)			
Danish	24 481 (89.0)	37 181 (91.1)	61 662 (90.3)
Danish and other	951 (3.5)	943 (2.3)	1894 (2.8)
Other than Danish	2059 (7.5)	2684 (6.6)	4743 (6.9)
Cohabitation			
Mother and father	19 346 (70.4)	27 611 (67.6)	46 957 (68.8)
Mother or father	6659 (24.2)	10 804 (26.5)	17 463 (25.6)
Other	1486 (5.4)	2393 (5.9)	3879 (5.7)
Non-drinkers, n (%)	2826 (10.3)	4186 (10.3)	7012 (10.3)
Weekly alcohol intake among drinkers (number of drinks) ^a	11.7 (1.0–30.0)	8 (1.0–20.0)	10 (1.0–25.0)
Never go out or party, n (%)	1692 (6.2)	2721 (6.7)	4412 (6.5)
Alcohol intake at parties/night out among drinkers (number of drinks) ^a	12.0 (2.5–18.5)	8.5 (2.5–15.0)	12.0 (2.5–18.5)
Smoking status, n (%)			
Never	14 813 (53.9)	22 253 (54.5)	37 066 (54.3)
Sometimes	8712 (31.7)	14 225 (34.9)	22 937 (33.6)
Every day	3967 (14.4)	4330 (10.6)	8297 (12.2)
Ever tried cannabis, n (%)			
No	13 846 (50.4)	28 218 (69.2)	42 064 (61.6)
Yes	13 645 (49.6)	12 591 (30.8)	26 236 (38.4)
Ever tried other drugs than cannabis, n (%)			
No	25 112 (91.3)	39 635 (97.1)	64 747 (94.8)
Yes	2379 (8.7)	1173 (2.9)	552 (0.8)

^aMedian (10, 90 pct.).

Table 1: Characteristics of the Danish National Youth Cohort (N = 68,299).

	Never drink	Weekly alcohol intake ^a	Never go to parties/go out	Alcohol intake at parties/night out ^b
	N (%)	Median (95% CI)	N (%)	Median (95% CI)
Parents' education				
Elementary school	887 (29.2)	12.9 (12.3–13.5)	449 (14.8)	8.7 (8.4–8.9)
Short	2792 (11.5)	12.6 (12.4–12.5)	1770 (7.3)	9.9 (9.8–10.0)
Medium	2237 (8.5)	12.0 (11.8–12.1)	1543 (5.9)	9.8 (9.8–9.9)
Long	1096 (7.4)	11.2 (11.0–11.4)	650 (4.4)	9.2 (9.1–9.3)
Family income				
Q1 (lowest)	3234 (23.5)	12.2 (11.9–12.5)	1605 (11.6)	8.8 (8.7–8.9)
Q2	1332 (9.8)	12.4 (12.1–12.6)	932 (6.8)	10.0 (9.9–10.1)
Q3	935 (6.9)	12.0 (11.8–12.2)	718 (5.2)	10.0 (9.9–10.1)
Q4	848 (6.2)	11.9 (11.7–12.1)	617 (4.5)	9.8 (9.7–9.9)
Q5 (highest)	663 (4.9)	11.8 (11.6–12.0)	540 (4.0)	9.7 (9.6–9.8)
Financial strain				
Yes	1374 (12.7)	13.1 (12.8–13.4)	887 (8.2)	9.6 (9.5–9.7)
No	5638 (9.8)	11.9 (11.7–12.0)	3525 (6.1)	9.7 (9.6–9.7)

The Danish National Youth Cohort (N = 68,299). Financial strain was based on the following question: "Have your parents had difficulty paying their bills within the past year".
^aNumber of drinks among those who drink. ^bNumber of drinks in those who go to parties/out.

Table 2: Alcohol drinking habits according to socioeconomic position.

drinkers was 10 drinks per week. The median intake at parties/nights out was 12.0 drinks in males and 8.5 drinks in females (6.5% reported never going to parties or going out). Participants whose parents had low versus high socioeconomic position were more often never drinkers and less often went out partying (Table 2). However, in those who reported drinking alcohol, the weekly intake was generally higher in low compared to high socioeconomic groups. Alcohol intake at parties showed no clear socioeconomic gradient although the number of reported drinks was lowest among those in the most disadvantaged income group (Q1) and those whose parents' highest educational attainment was elementary school. Daily smoking and experience with drugs other than cannabis were more common among the low compared to high socioeconomic position groups (Supplementary Table S2).

During 280,010 person years of follow-up, 872 participants had an alcohol-attributable hospital contact. Intoxications (n = 778, 89%), harmful use (n = 60, 7%), and dependence (n = 13, 1.5%) were the most frequent diagnostic categories. Weekly alcohol intake was associated with adjusted incidence rates (IR) of alcohol-attributable hospital contacts in a dose-dependent manner (Fig. 1). Thus, each increase in alcohol intake per week was associated with higher risk. The adjusted IR per 1000 person years was 2.7 (95% CI: 2.3–3.0) for a weekly alcohol intake of less than 7 drinks/week and 5.7 (95% CI: 4.7–6.7) for a weekly alcohol intake of 28 or more drinks/week. Having parents with less education, lower family income, and who experienced financial strain was associated with higher incidence rate ratios (IRR) of alcohol-attributable hospital contacts (Table 3). For example, the IRR in adolescents whose parents'

highest attained education was elementary school was 1.73 (95% CI: 1.29–2.33) as compared to those having parents with higher levels of education. When looking at family income, any drop in income level was associated with higher IRR, indicating an inverse relationship between family income and risk of alcohol-attributable contacts. The subjective perception of financial problems in the family was also strongly associated with alcohol-attributable hospital contacts (IRR = 1.57, 95% CI: 1.30–1.89). Estimates changed little in models successively adjusting for dimensions of alcohol drinking behaviour and smoking, cannabis, and drug use. In strata of perceived ethnicity, results showed no difference in associations between socioeconomic position and alcohol-related hospital contacts (data not shown) and tests for interaction were not statistically significant. Similarly, there were no differences in associations in strata of sex (data not shown).

Associations between family income and IRR of alcohol-attributable hospital contacts were modelled by cubic splines which revealed an apparently lower risk with higher income after adjustment for age, sex, school type, school year, perceived ethnicity, and weekly alcohol intake (Fig. 2). The curve seemed to break halfway, meaning that the decline in IRR appeared steeper from 0th to 50th percentiles than for the remaining 51st to 100th percentile (Fig. 2).

As shown in Fig. 3, adjusted IRR was consistently higher among those with low socioeconomic position (black dots) compared to those with high socioeconomic position (white dots) when comparing groups with similar weekly alcohol intake. Consequently, adjusted IRR of alcohol-attributable hospital contacts was higher in groups of low socioeconomic position compared to

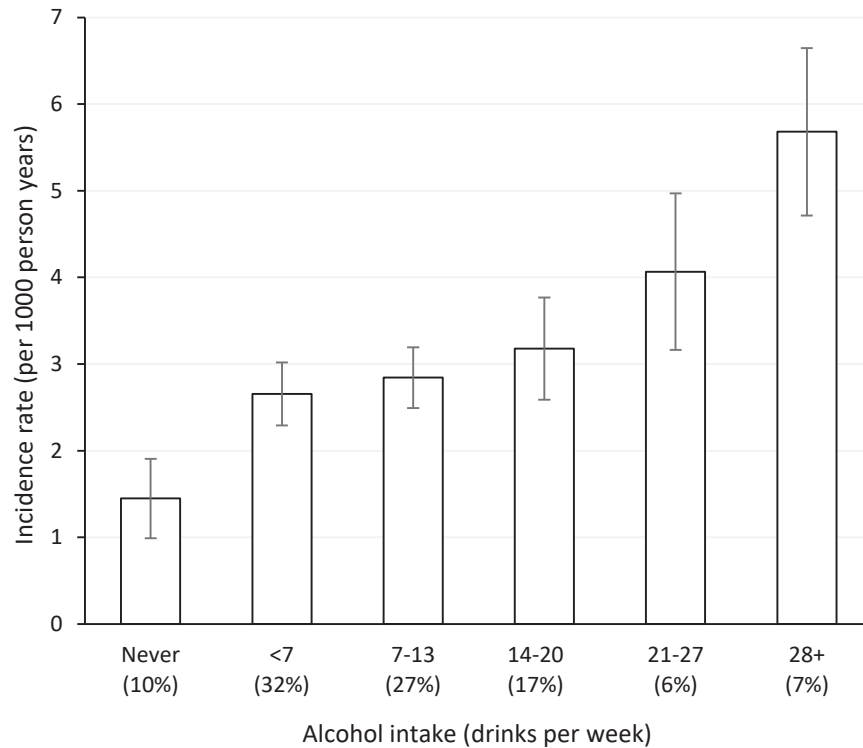


Fig. 1: Incidence rates per 1000 person years (95% CI) of alcohol-attributable hospital contacts by weekly alcohol intake. The Danish National Youth Cohort (N = 68,299). Adjusted for age, sex, school type, school year, ethnicity.

groups of high socioeconomic position, across the spectrum of alcohol intake. For instance, IRR of harm was 2.18 (95% CI: 1.35–3.53) as compared to 1.24 (95% CI: 1.05–1.50) in strata of shorter and longer education despite a uniform alcohol intake of 7–20 drinks per week. Estimates are listed in [Supplementary Table S3](#) along with tests for multiplicative and additive interactions. These tests were all insignificant apart from the additive interaction between family income and weekly alcohol intake.

Incidence rates (per 1000 person years) of alcohol-attributable hospital contacts among the youngest were comparable to the older age-group, ranging from 2.7–4.9 in 15–17-year-olds and 3.1–6.8 in 18–19-year-olds ([Fig. 4](#)). Overall, lower socioeconomic position was associated with higher risk of alcohol-attributable hospital contacts in both age groups and all three measures of socioeconomic position.

Discussion

We found that socioeconomic position was associated with alcohol-related harms in 15–19-year-old adolescents. The rate of alcohol-attributable hospital contacts was higher for similar levels of alcohol consumption in those with parents with low as compared to high socioeconomic position, even when taking into account

alcohol drinking behaviour, smoking, and experience with cannabis and other drugs. This finding was consistent over three measures of socioeconomic position (parent educational level, family income and perceived family financial strain). For family income, associations reflected a dose-dependent relationship; each increment of income was associated with lower risk, indicating that the socially skewed burden of alcohol-related harm was not limited to the most marginalised group. Results were similar in younger (15–17-year-olds) and older (18–19-year-olds) adolescents. These findings consistently show evidence of the alcohol harm paradox being present in adolescents, just as has been shown previously in adults.

Potential mechanisms behind the alcohol harm paradox have been suggested. The most well-researched hypothesis is that associated risk behaviours such as pattern of drinking, smoking, or concurrent drug use¹⁷ is causing the observed social inequality in alcohol-related harm, or simply put, that the results are confounded. However, there is little empirical evidence for this hypothesis in adults,^{3,18,19} which is also not supported by our findings, which provide no evidence that this mechanism explains any major part of the alcohol harm paradox. While our data showed that drinking habits as well as smoking and other drug use differed by socioeconomic background, taking such

	Events/Person years	Incidence rate ratios (95% CI)			
		Basic ^a	Basic ^a + weekly alcohol intake	Basic ^a + weekly alcohol intake + drinking pattern ^b	Basic ^a + weekly alcohol intake + smoking, cannabis, and other drugs than cannabis
Parents' education					
Elementary school	63/12,482	1.73 (1.29-2.33)	1.79 (1.33-2.41)	1.78 (1.32-2.40)	1.79 (1.32-2.42)
Short education	334/99,662	1.13 (0.94-1.36)	1.12 (0.92-1.33)	1.09 (0.91-1.31)	1.13 (0.94-1.36)
Medium education	307/107,361	1.00 (0.83-1.21)	0.99 (0.82-1.19)	0.97 (0.81-1.17)	1.00 (0.83-1.20)
Long education	167/60,499	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Family income					
Q1 (lowest)	209/56,404	1.46 (1.15-1.86)	1.54 (1.21-1.95)	1.53 (1.21-1.94)	1.52 (1.20-1.93)
Q2	201/55,970	1.36 (1.06-1.73)	1.36 (1.06-1.73)	1.34 (1.05-1.71)	1.36 (1.06-1.73)
Q3	165/55,922	1.13 (0.90-1.42)	1.13 (0.91-1.42)	1.12 (0.90-1.49)	1.14 (0.91-1.43)
Q4	155/55,925	1.09 (0.85-1.38)	1.09 (0.86-1.39)	1.08 (0.85-1.38)	1.10 (0.86-1.40)
Q5 (highest)	141/55,789	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Financial strain					
Yes	197/43,990	1.57 (1.30-1.89)	1.52 (1.26-1.83)	1.52 (1.26-1.84)	1.45 (1.20-1.75)
No	674/236,020	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Total	871/280,010				

Financial strain was based on the following question: "Have your parents had difficulty paying their bills within the past year". The Danish National Youth Cohort (N = 68,299). ^aAdjusted for age, sex, school type, school year, perceived ethnicity. ^bAlcohol intake at parties/nights out is a proxy for drinking pattern.

Table 3: Number of events per person years and incidence rate ratios (95% CI) of alcohol-attributable hospital contact according to socioeconomic position.

variables into account in the statistical model left the results virtually unchanged. Differential vulnerability²⁰ is suggested as an alternative mechanism, meaning that adolescents with different socioeconomic position

have a different sensitivity towards the harmful effect of alcohol, rendering them at higher risk at a given level of intake. Our analysis supports this hypothesis although we are unable to explore the nature of these

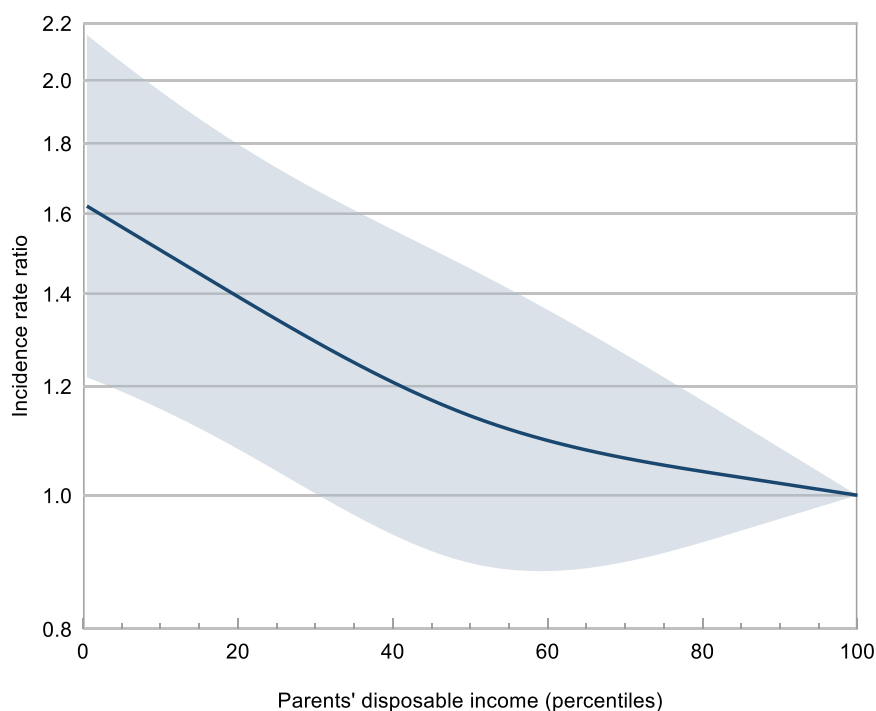


Fig. 2: Incidence rate ratio (95% CI) of alcohol-attributable hospital contracts by family income. The Danish National Youth Cohort (N = 68,299). Adjusted for age, sex, school type, school year, ethnicity, and weekly alcohol intake.

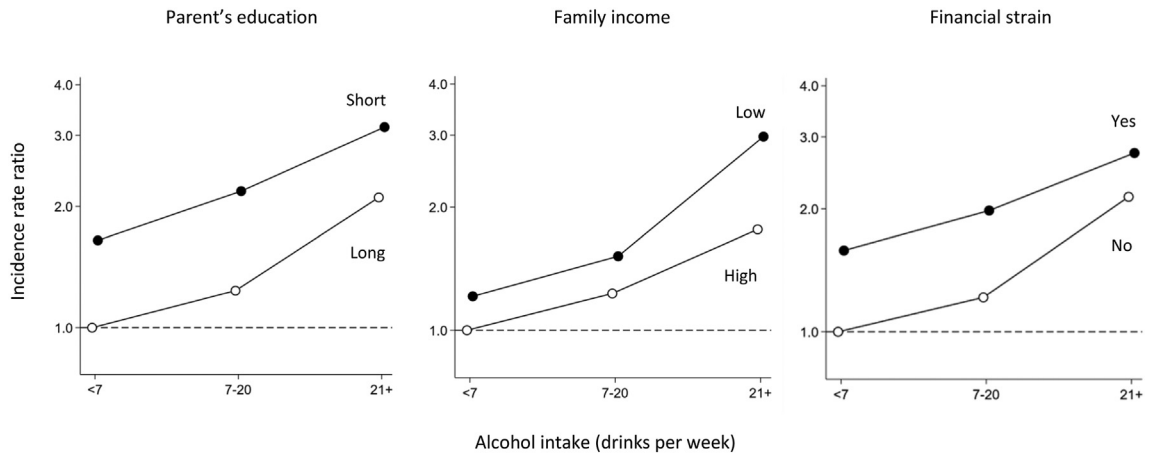


Fig. 3: Incidence rate ratios of alcohol-attributable hospital contacts by weekly alcohol intake and socioeconomic position. The Danish National Youth Cohort (N = 68,299). Adjusted for age, sex, school type, school year, ethnicity. Short education: elementary school. Long education: short, medium and long education. Low income: Q1-Q2. High income: Q3-Q5. Financial strain was based on the following question: "Have your parents had difficulty paying their bills within the past year".

vulnerabilities within the current data. We observed that perceived financial strain in the family was associated with alcohol-related harm. This measure of socioeconomic position is different from family income and parent educational level as it is a subjective assessment. In accordance with the Psycho-social Model, social inequality causes psychological distress²¹ and children and adolescents experiencing distress in the form of adverse childhood experiences have been shown to be more likely to engage in adolescent risk behaviours.²² One suggested pathway for economic hardship includes disruption of supportive parenting behaviours as described in the family stress model.²³ One can speculate that stress in the family is likely to compromise parental monitoring and support, and may explain why a larger proportion of adolescents with parents with low socioeconomic position end up in hospital with an alcohol-related diagnosis as compared with those whose parents have high socioeconomic position. Health seeking behaviour may also differ by socioeconomic position and for indications such as alcohol poisoning where the treatment is first and foremost surveillance and symptom treatment. It might be that children of high socioeconomic position receive greater care from their parents while those who are less affluent must rely on seeking formal health care through the freely available health system in Denmark.

Although the alcohol harm paradox is well-established in adults, only a handful of studies have focussed on socioeconomic inequalities in alcohol-attributable consequences in youth.^{24–27} Current literature is heterogeneous in terms of socioeconomic measures and outcome variables. In a Swedish cross-sectional study, Thor et al. found that the social gradient among 4448 young people aged 17–18 years

old was stronger for self-reported alcohol-related problems than for harmful drinking.²⁸ In a previous study, also using data from the Danish National Youth Cohort 2014, we found a social gradient in various self-reported outcomes such as having been in a fight, experienced problems with parents or friends, having had sex or done drugs which were regretted afterwards and attributable to drinking.²⁷ These results persisted after adjustment for binge drinking, in keeping with the current findings, which stemmed from the same cohort in a longitudinal design. Studies using a more ecological study design have also been performed. For instance, Rhew et al. found more alcohol-related harms in 18–23-year-olds living in poor neighbourhoods which was also not fully explained by differences in alcohol intake.

This study has several strengths. First, the Danish National Youth Cohort study is a large, longitudinal study in which the inclusion of students from vocational schools enhances its representativeness and relevance for a study of socioeconomic position. Secondly, the use of linked data from alcohol-attributable hospital contacts reduces the risk of misclassification and ensures complete follow-up; the Danish National Patient Register¹² is complete and contains information on all contacts to public hospitals, including emergency departments and outpatient contacts. Information from the Danish Civil Registration System²⁹ includes information on all persons with permanent residence in Denmark and Greenland and is updated continuously. Thirdly, socioeconomic position was operationalised using three independent measures, each one capturing different aspects of socioeconomic position: parent education represents an indicator of parent knowledge, family income represents an indicator of financial and material

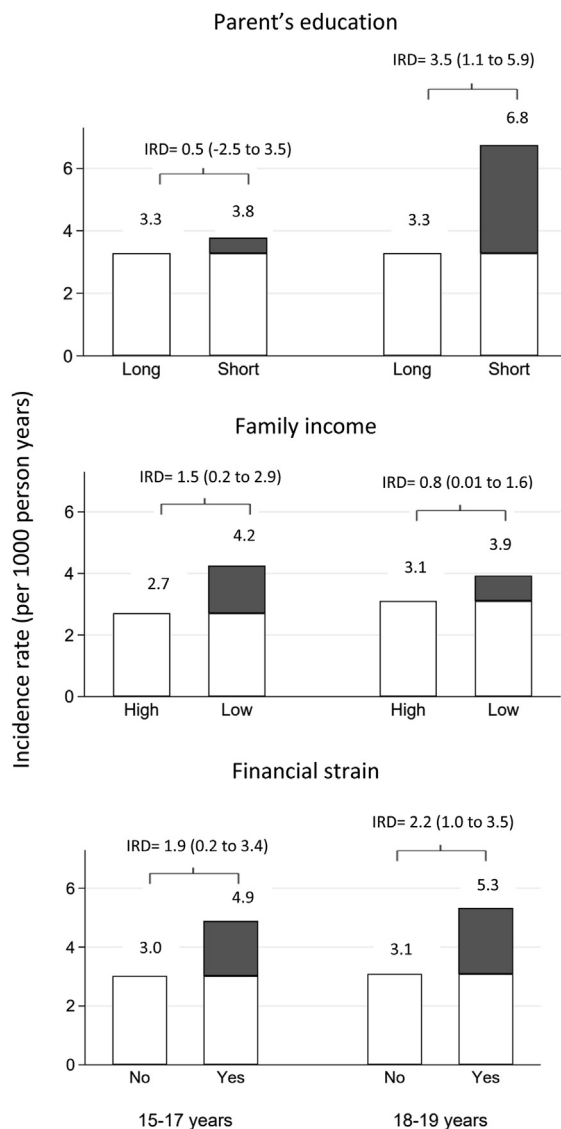


Fig. 4: Incidence rates per 1000 person years of alcohol-attributable hospital contacts by age group and socioeconomic position. The Danish National Youth Cohort (N = 68,299). Adjusted for sex, school type, school year, ethnicity, weekly alcohol intake. Coloured bars display differences in IR between socioeconomic groups within the same age group. Incidence rate differences (IRDs) and 95% CI are shown. Short education: elementary school. Long education: short, medium and long education. Low income: Q1-Q2. High income: Q3-Q5. Financial strain was based on the following question: "Have your parents had difficulty paying their bills within the past year".

resources and perceived family financial strain represents the subjective experience of financial hardship. These measures provide a more nuanced definition of socioeconomic position than many studies and allowed us to explore possible differences between the measures.³⁰

There are also limitations. Alcohol intake was assessed at only one time point by self-report, yet it is known that drinking patterns, like other behaviours, change over time in adolescents. The weekly alcohol intake at baseline may thus not be in accordance with the weekly alcohol intake when the injury occurred. The fact that rates of alcohol-attributable hospital contacts were not null in the self-reported never drinker category most likely reflects this. Furthermore, validity of self-reported alcohol use, as well as sensitive information such as drug use and smoking may differ with socioeconomic position, potentially leading to bias.³¹ However, the validity of self-reported alcohol intake is enhanced by the results showing incidence rates of hospital contacts wholly attributable to alcohol increased in a dose-dependent relationship. A possible limitation is the accuracy of the outcome in our study. While it is arguably a considerable strength that the outcome relied on diagnoses from the Danish National Patient Register¹² obtained independently from the study baseline (i.e. the questionnaire in the Danish National Youth Cohort), it is unknown if there is bias in the way health personnel register alcohol diagnoses by socioeconomic position and differences in referral and treatment may reflect socioeconomic position. However, healthcare services are free of charge in Denmark which may reduce such potential differences. Another consequence of using diagnostic codes is that pre-hospital contacts were not considered. The actual burden of harm may thus be underestimated as only a minority of alcohol-related harm requires hospital care.

Our results support that adolescents from low socioeconomic position experience disproportionately more alcohol-related harm compared to adolescents from high socioeconomic position, and that these differences are not fully explained by differences in drinking patterns or other risk factors. Test for effect modification was not statistically significant for all measures of socioeconomic position but we found that low as compared to high socioeconomic position was consistently associated with higher risk of harm independent of alcohol intake, consistent with the alcohol harm paradox. This may indicate that these differences are rooted in inequity. Still, the alcohol harm paradox in adolescents lacks widespread empirical testing. Future research should seek to replicate this work as well as identify possible causal mechanisms driving these inequalities. In adults, risk behaviour is the most well-studied factor; other explanatory factors have been insufficiently tested.^{17,18,32} Compared to adults, who are exposed to chronic diseases in relation to alcohol-attributable harm, young people are more prone to experience acute harm reflected by the high proportion of poisonings in this study (89%). This study only assessed hospital contacts wholly attributable to alcohol, however adolescents are at risk of a number of other negative consequences in relation to alcohol including intentional and

unintentional injuries which are leading causes of death and disability in young people worldwide.³³ Consequently, another set of drivers may be in play which calls for a specific focus on the adolescent population. It is striking that incidence rates in the younger (15–17 years old) and older (18–19 years old) age groups were comparable. Furthermore, the predominant cause of hospital contact was intoxications (89%), with similar incidence rates among the younger (15–17-years-olds) and older group (18–19-years-olds). This, alongside the fact that median weekly alcohol intake (10 drinks per week) and alcohol intake at parties (12 drinks per week) were nearly the same, points to a widespread alcohol culture of binge drinking, which is especially concerning given the extent of brain development during adolescence. Alcohol use in adolescents, especially binge drinking, causes alterations in brain tissue in neuroimaging studies and is associated with impaired learning and increased impulsivity among other affected cognitive functions.^{34,35}

These novel insights point towards the need for preventive strategies to reduce alcohol-related harm in adolescents. Beyond universally reducing access to alcohol, these findings suggest that focus is particularly indicated for disadvantaged groups and younger adolescents. Effective structural initiatives against adolescent drinking include lifting the minimum legal drinking age, using taxation to drive higher costs of alcoholic beverages and restricting advertising of alcoholic products.¹ Denmark is among the few countries in Europe where the minimum legal age for buying beer and wine in stores is 16 years. As studies show that young and especially disadvantaged adolescents are sensitive to minimum legal age legislations and higher prices,^{1,36} lifting the minimum age to buy alcohol, and ensuring implementation of that policy, would be an important first step. In Europe, Danish adolescents rank high in terms of alcohol consumption, with a greater proportion of them engaging in lifetime use (92%), recent use within the past 30 days (74%), and getting intoxicated (40%) compared to the European average (79%, 47%, and 13%).³⁷ As a result, it is likely that Denmark carries a heavier burden of alcohol-related harm compared to countries where youth consume less alcohol. In summary, this is the first prospective cohort study of 15–19-year-olds to find that low socioeconomic position is associated with higher risk of alcohol-attributable hospital contacts, regardless of differences in alcohol intake and other substance use. Similar findings were seen in the two adolescent age groups and using different measures of socioeconomic positions, highlighting the importance of addressing underlying social inequality. Concerningly, these results point towards a widespread alcohol culture of excessive drinking among adolescents as young as 15 years old. While more research is indicated to understand the causal mechanisms underlying the alcohol harm

paradox, initiatives against alcohol-related harm should prioritise young adolescents and ensure that disadvantaged groups are reached.

Contributors

JST, SK and SPM planned and designed the study. JT analysed the data. SK drafted the manuscript. SPM and SK have verified the underlying data. All authors contributed to the interpretation of study results, critical revision of the paper, and approval of the final version. All authors confirm that they had full access to all the data in the study and accept responsibility for the decision to submit for publication.

Data sharing statement

Data from the Danish National Youth Study can be shared after reasonable request to the corresponding author.

Declaration of interests

We declare no competing interests.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.jeclinm.2023.102129>.

References

- Loring B. *Alcohol and inequities - guidance for addressing inequities in alcohol-related harm*. World Health Organization; 2014.
- Probst C, Kilian C, Sanchez S, Lange S, Rehm J. The role of alcohol use and drinking patterns in socioeconomic inequalities in mortality: a systematic review. *Lancet Public Health*. 2020;5(6):e324–e332.
- Katikireddi SV, Whitley E, Lewsey J, Gray L, Leyland AH. Socioeconomic status as an effect modifier of alcohol consumption and harm: analysis of linked cohort data. *Lancet Public Health*. 2017;2(6):e267–e276.
- Beard E, Brown J, West R, et al. Deconstructing the alcohol harm paradox: a population based survey of adults in England. *PLoS One*. 2016;11(9):e0160666.
- Mäkelä P, Paljärvi T. Do consequences of a given pattern of drinking vary by socioeconomic status? A mortality and hospitalisation follow-up for alcohol-related causes of the Finnish drinking habits surveys. *J Epidemiol Community Health*. 2008;62(8):728–733.
- Sadler S, Angus C, Gavens L, et al. Understanding the alcohol harm paradox: an analysis of sex- and condition-specific hospital admissions by socio-economic group for alcohol-associated conditions in England. *Addiction*. 2017;112(5):808–817.
- World Health Organization. *Global status report on alcohol and health*; 2018. <https://www.who.int/publications/i/item/9789241565639>.
- Elder RW, Shults RA, Swahn MH, Strife BJ, Ryan GW. Alcohol-related emergency department visits among people ages 13 to 25 years. *J Stud Alcohol*. 2004;65(3):297–300.
- Linakis JG, Chun TH, Mello MJ, Baird J. Alcohol-related visits to the emergency department by injured adolescents: a national perspective. *J Adolesc Health*. 2009;45(1):84–90.
- Peña S, Mäkelä P, Härkänen T, et al. Measurement error as an explanation for the alcohol harm paradox: analysis of eight cohort studies. *Int J Epidemiol*. 2021;49(6):1836–1846.
- Pisinger V, Mikkelsen SS, Bendtsen P, Egan KK, Tolstrup JS. The Danish national youth study 2014: study design, population characteristics and non-response analysis. *Scand J Public Health*. 2020;48(2):224–232.
- Lynge E, Sandegaard JL, Rebolj M. The Danish national patient register. *Scand J Public Health*. 2011;39(7 Suppl):30–33.

- 13 Spratt M, Carpenter J, Sterne JA, et al. Strategies for multiple imputation in longitudinal studies. *Am J Epidemiol*. 2010;172(4):478–487.
- 14 Rubin DB. *Multiple imputation for nonresponse in surveys*. 2004.
- 15 Greenland S. Dose-response and trend analysis in epidemiology: alternatives to categorical analysis. *Epidemiology*. 1995;6(4):356–365.
- 16 Harrel F. *Regression modeling strategies: with applications to linear models*. Logistic and Ordinal Regression, and Survival Analysis; 2005.
- 17 Boyd J, Bamba C, Purshouse RC, Holmes J. Beyond behaviour: how health inequality theory can enhance our understanding of the ‘Alcohol-Harm Paradox’. *Int J Environ Res Public Health*. 2021;18(11):6025.
- 18 Boyd J, Sexton O, Angus C, Meier P, Purshouse RC, Holmes J. Causal mechanisms proposed for the alcohol harm paradox—a systematic review. *Addiction*. 2022;117(1):33–56.
- 19 Peña S, Mäkelä P, Laatikainen T, et al. Joint effects of alcohol use, smoking and body mass index as an explanation for the alcohol harm paradox: causal mediation analysis of eight cohort studies. *Addiction*. 2021;116(8):2220–2230.
- 20 Diderichsen F, Hallqvist J, Whitehead M. Differential vulnerability and susceptibility: how to make use of recent development in our understanding of mediation and interaction to tackle health inequalities. *Int J Epidemiol*. 2019;48(1):268–274.
- 21 Bartley M. *Health inequality - an introduction to concepts, theories and methods*. 2004.
- 22 Hughes K, Bellis MA, Hardcastle KA, et al. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. *Lancet Public Health*. 2017;2(8):e356–e366.
- 23 Conger RD, Conger KJ, Elder GH Jr, Lorenz FO, Simons RL, Whitbeck LB. A family process model of economic hardship and adjustment of early adolescent boys. *Child Dev*. 1992;63(3):526–541.
- 24 Salom CL, Williams GM, Najman JM, Alati R. Does early socio-economic disadvantage predict comorbid alcohol and mental health disorders? *Drug Alcohol Depend*. 2014;142:146–153.
- 25 Rhew IC, Duckworth JC, Hurvitz PM, Lee CM. Within- and between-person associations of neighborhood poverty with alcohol use and consequences: a monthly study of young adults. *Drug Alcohol Depend*. 2020;212:108068.
- 26 Thern E, Ramstedt M, Svensson J. The associations between unemployment at a young age and binge drinking and alcohol-related problems. *Eur J Public Health*. 2020;30(2):368–373.
- 27 Møller SP, Pisinger VSC, Christensen AI, Tolstrup JS. Socioeconomic position and alcohol-related harm in Danish adolescents. *J Epidemiol Community Health*. 2019;73(9):839–845.
- 28 Thor S, Karlsson P, Landberg J. Social inequalities in harmful drinking and alcohol-related problems among Swedish adolescents. *Alcohol Alcohol*. 2019;54(5):532–539.
- 29 Pedersen CB. The danish civil registration system. *Scand J Public Health*. 2011;39(7 Suppl):22–25.
- 30 Galobardes B, Lynch J, Smith GD. Measuring socioeconomic position in health research. *Br Med Bull*. 2007;81-82:21–37.
- 31 Devaux M, Sassi F. Social disparities in hazardous alcohol use: self-report bias may lead to incorrect estimates. *Eur J Public Health*. 2016;26(1):129–134.
- 32 Bloomfield K. Understanding the alcohol-harm paradox: what next? *Lancet Public Health*. 2020;5(6):e300–e301.
- 33 Gore FM, Bloem PJ, Patton GC, et al. Global burden of disease in young people aged 10-24 years: a systematic analysis. *Lancet*. 2011;377(9783):2093–2102.
- 34 Lees B, Meredith LR, Kirkland AE, Bryant BE, Squeglia LM. Effect of alcohol use on the adolescent brain and behavior. *Pharmacol Biochem Behav*. 2020;192:172906.
- 35 Squeglia LM, Tapert SF, Sullivan EV, et al. Brain development in heavy-drinking adolescents. *Am J Psychiatry*. 2015;172(6):531–542.
- 36 Ahammer A, Bauernschuster S, Halla M, Lachenmaier H. Minimum legal drinking age and the social gradient in binge drinking. *J Health Econ*. 2022;81:102571.
- 37 ESPAD report 2019 results from the European school survey project on alcohol and other drugs: european monitoring centre for drugs and drug addiction. 2019.