

PhD thesis

National Institute of Public Health, Faculty of Health Sciences

University of Southern Denmark

# Epidemiological studies on adolescents and alcohol

- focus on social inequality

Mathilde Vinther-Larsen  
December, 2011





## Preface

This thesis is based on research carried out from 2009 to 2011 at the Research Program for Child and Adolescents Health, National Institute of Public Health, University of Southern Denmark. The thesis was supported by grants from The Danish Health Insurance Foundation and European Research Advisory Board.

I wish to thank my advisors Pernille Due, Morten Grønbaek, and Lau C. Thygesen for sharing their insight and experience in the academic world of epidemiology, and for their support and discussions throughout the progress of my PhD. Special thanks should also be given to Professor Sally Casswell for a fruitful and inspiring stay at the Centre for Social and Health Outcomes Research and Evaluation at Massey University in Auckland, New Zealand between February 2011 and April 2011.

I would also like to thank all my co-authors for their valuable and wise contributions to the papers that are included in this thesis. I have had the privilege of working with great colleagues at the National Institute of Public Health and I am grateful for the inspiring and friendly work place that they have created for me. Further, thanks and appreciation goes to Anette Andersen, Pernille Bendtsen, and Taisia Huckle for taking the time to read my thesis and added valuable comments.

Finally, I wish to thank Kåre and Esmeralda for their patience and for reminding me of the great things that life has to offer besides writing a PhD.

Mathilde Vinther-Larsen  
Copenhagen, December 2011

**This thesis is based on the following papers:**

## Paper I:

Vinther-Larsen M, Riegels M, Rod MH, Schiøtz M, Curtis T, Grønbaek M: The Danish Youth Cohort: Characteristics of participants and non-participants and determinants of attrition. *Scandinavian Journal of Public Health*, 2010; 38: 648–656

## Paper II:

Vinther-Larsen M, Riegels M, Bendtsen P, Diderichsen F, Due P, Grønbaek M: Social inequality in drinking onset among Danish adolescents. Submitted to: *Journal of Epidemiology and Community Health*

## Paper III:

Vinther-Larsen M, Thygesen LC, Grønbaek M, Due P: Early drinking onset at age 13 and binge-drinking at age 15 – is the association socially patterned? Submitted to: *Preventive Medicine*

## Paper IV:

Vinther-Larsen M, Huckle T, You R, Casswell S: Effects of area-level deprivation on drinking patterns among adolescents. Accepted to: *Health & Place*, October 2012

## Academic Advisers:

Pernille Due, MD; Morten Grønbaek, PhD, Dr. Med; Lau C. Thygesen, PhD

National Institute of Public Health

University of Southern Denmark

---

## Table of contents

Introduction	1
Aims and structure of the thesis	2
Pathways in which socioeconomic position influence alcohol use	3
Socioeconomic position as a predictor for adolescents' alcohol use	4
Consequences of adolescents' alcohol use – the role of socioeconomic position	5
The influence of socioeconomic context on adolescents' use of alcohol	5
Material and methods	7
The Danish Youth Cohort	7
The New Zealand Alcohol Survey 2004	10
Measures of alcohol use	11
Measures of socioeconomic position	11
Confounders	12
Statistical methods	13
Summary of results	15
Is participation at baseline and attrition associated with socioeconomic factors?	15
Is there social inequality in early drinking onset?	19
Is area level deprivation associated with drinking patterns among adolescents?	21
Discussion	23
Main findings	23
Comparison with previous studies	23
Perspectives on social inequality in alcohol use	27
Limitations and strengths	29
Conclusion and implications	39
English summary	42
Danish summary	44
Reference list	46
Appendix	55
Paper I-IV	59



## Introduction

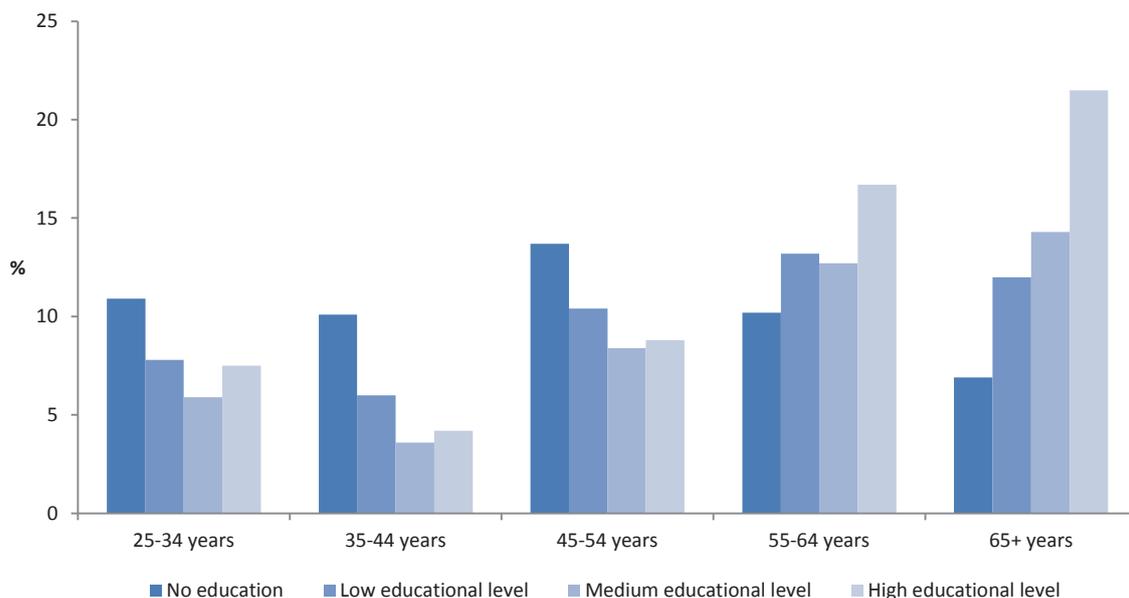
The teenage years is an important period, in which lifestyle habits develop and future lifestyles are established.<sup>1,2</sup> It is a period where the influence of parents is challenged by the influence of peers. Further, this period in life is characterised by the introduction of a range of new health related behaviours for instance introduction to alcohol, which is why these years are an especially important period for the prevention of unhealthy lifestyles such as early and heavy use of alcohol.

Adolescents in Denmark begin drinking alcohol at an early age and Danish adolescents have a high intake of alcohol compared to youth from other Western European and North American countries.<sup>3,4</sup> For instance, among Danish 15-years-olds, 56% of the girls and 57% of the boys have experienced feeling drunk at least twice,<sup>5</sup> and Danish 15-years-old have the highest frequency of drunkenness when compared with twenty-two other countries.<sup>6</sup> Although, a decrease in adolescents' use of alcohol has been observed in the past decade,<sup>5</sup> the early age of initiation and the comparatively high level of consumption among youth still makes this area an important public health challenge in Denmark.

For several decades it has been debated whether social inequality in health and health behaviour exists among adolescents. Numerous studies have found social inequality in health behaviour to be present among adolescents<sup>7,8</sup> with adolescents adopting adult behaviours: adolescents from lower socioeconomic groups have more health issues and greater prevalence of risk behaviours. However, other studies have found no clear socioeconomic pattern in adolescents' health and health behaviours.<sup>9</sup> This have led to the concept of "equalization in youth", which hypothesizes that social inequality in health and health behaviours is present in childhood, then disappears in the youth years, and emerge again in adulthood. West explained this phenomena by the influence of school, peer groups, and youth culture that are increasingly important in the youth years, and therefore outweigh the effect of socioeconomic influences from family social background.<sup>9</sup>

When it comes to social inequality in alcohol use the findings have been even more inconclusive than for other health behaviours. Among Danish adults, socioeconomic factors have played a lesser role in drinking patterns compared to other Western countries, however adults with higher socioeconomic positions do drink more than adults from lower socioeconomic positions.<sup>10</sup> Among adolescents, it is puzzling that the social gradient is unclear,<sup>11</sup> which seems to be in accordance with the concept of equalization in youth. From the Danish National Health Interview Survey 2005 the following socioeconomic gradient in drinking over the Danish Sensible Drinking Limits has been found.

**Figure 1:** Percent drinking over the Sensible Drinking Limits stratified by age and educational level. Data from the representative Danish Health Interview Survey 2010



Ref.: Data from the Danish Health Interview Survey 2010 database  
[www.sundhedsprofil2010.dk/Pages/Home.aspx](http://www.sundhedsprofil2010.dk/Pages/Home.aspx)

This figure 1 summarises the confusing picture of the association between socioeconomic position and alcohol use. It seems that, as opposed to other health behaviours, alcohol use is more frequent in better off 55+-years-old adults but the social gradient is the opposite and less strong among younger age groups. And among adolescents the social inequality in alcohol use is still questioned. This makes social inequality in alcohol use an interesting phenomenon, especially among adolescents. It raises questions as to in which direction the social gradient is among adolescents or whether there is in fact equalization in adolescents' alcohol use. When during the lifetime does social inequality in alcohol use emerge? Why is there inconsistency in research regarding social inequality in alcohol use among adolescents? How do socioeconomic circumstances in youth affect the consequences of alcohol use later on? And is adolescents' alcohol use not only affected by the individual socioeconomic position, but also by the contextual socioeconomic position? When all these questions can be answered a missing piece in the big puzzle of social inequality in alcohol use can be placed. Further, by highlighting specific groups of adolescents at risk of starting a risky alcohol career, this may have implications for future prevention of the early and large intake of alcohol among adolescents which has severe consequences.

### Aims and structure of the thesis

The overall aim of the thesis was to add to the scientific epidemiological evidence about alcohol use among adolescents focusing on the important aspects of early drinking onset.

Since early drinking onset is associated with future heavy drinking and alcohol-related problems,<sup>12-15</sup> and hereby is proximal in the causal chain of future alcohol misuse, it is of special interest to investigate early drinking onset and perform research in social inequality in relation to adolescents' drinking onset. However other alcohol measures such as binge drinking, quantity and frequency of adolescents' alcohol use will also be used in the thesis.

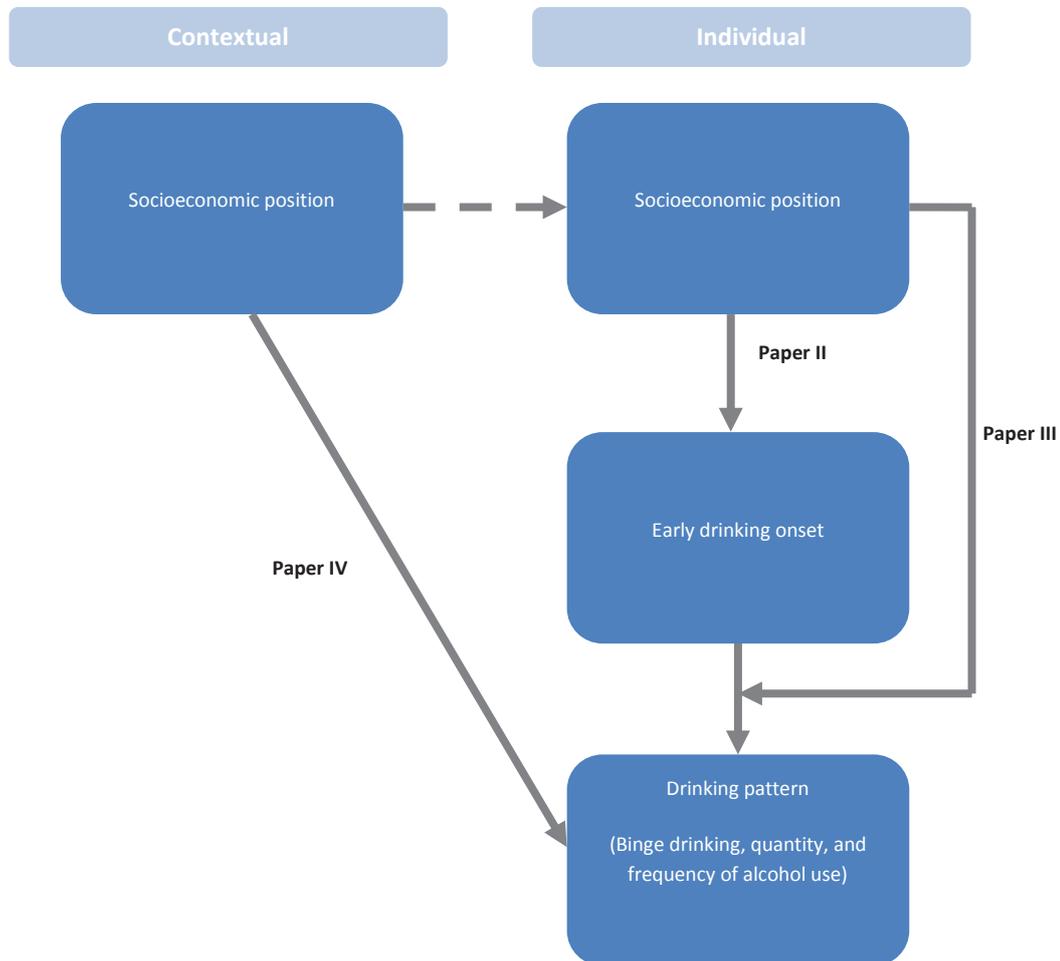
Four studies formed the basis of this thesis. The aim of **Paper I** was to describe the Danish Youth Cohort and to describe thoroughly the sampling, representativeness and attrition of the population, especially in relation to socioeconomic factors. The aim of **Paper II** was to explore if socioeconomic position works as a predictor for early drinking onset. The aim of **Paper III** was to investigate the association between early drinking onset and binge drinking and examine if this association was socially patterned. Additionally, the aim of **Paper IV** was to investigate how the area level deprivation was associated with quantity and frequency of alcohol use among adolescents.

The present thesis is structured as follows: The remaining part of this chapter will be a background section focusing on social inequality in alcohol use among adolescents. Chapter two describes the study populations and the applied methods. Chapter three summarizes the results of Papers I, II, III, and IV. Chapter four will include a discussion of the results and potential biases. Finally, main conclusions are summarized and implications of the findings are suggested in chapter five.

### **Pathways in which socioeconomic position influence alcohol use**

Different upstream and downstream mechanisms in which socioeconomic circumstances affect health have been suggested.<sup>16</sup> The model developed by Diderichsen and colleagues describes four mechanisms: 1) social stratification, 2) differential exposure, 3) differential susceptibility, and 4) differential consequences. In this thesis two of the four mechanisms will be explored. Differential exposure: exposures can be socially patterned by the social position of the individual and differential susceptibility: where individuals may be more or less vulnerable to the effect of exposures depending on their social position due to variation in social resources. Additionally, in this thesis I also use and explore the concept of more upstream mechanism, where the impact and importance of the context on the individual is acknowledged. This is of interest as community characteristics may be amenable to policy intervention. Figure 2 presents a model of the different mechanisms and hypotheses that this thesis attempted to illuminate.

**Figure 2:** Mechanisms and hypotheses of the associations between socioeconomic position at individual and contextual level and adolescents' drinking onset and drinking pattern. The main focus of the three empirical papers is presented.



In Paper II, the hypothesis that relates to differential exposure was explored: does socioeconomic position work as a predictor for early drinking. In Paper III the hypothesis that socioeconomic position affects the association between early drinking onset and later drinking pattern was explored, i.e. whether the association between early drinking onset and binge drinking was different for youth from different socioeconomic backgrounds. Or in other words whether there was differential susceptibility of early drinking among adolescents with respect to socioeconomic background. Paper IV explored the hypothesis that over and above the influence of individual socioeconomic position on alcohol use, alcohol use is also influenced by the socioeconomic context of adolescents' lives.

### **Socioeconomic position as a predictor for adolescents' alcohol use**

There have been ambiguous findings regarding social inequality in some adolescent health behaviours, especially when it comes to alcohol use. Several studies, carried out in Northern

Europe, North America, and New Zealand, found alcohol use to be socially patterned, with higher rates of drunkenness,<sup>17;18</sup> problematic alcohol use,<sup>19</sup> higher frequency of alcohol use,<sup>20;21</sup> and higher intake,<sup>22</sup> among adolescents with low socioeconomic backgrounds. However, some studies, carried out in Northern Europe and North America, suggested a reverse socioeconomic pattern in drunkenness,<sup>18</sup> and frequency of alcohol use.<sup>23-25</sup> Other studies, carried out in Northern Europe, found no socioeconomic differences in drinking onset,<sup>26</sup> occasional drinking,<sup>17</sup> and drunkenness.<sup>25</sup> Further, a recent review concluded that there was no clear pattern in the association between socioeconomic position and alcohol use among adolescents with 69% of the included high quality studies finding no relation.<sup>11</sup> It seems that previous evidence gives no clear picture of how individual socioeconomic position is associated with adolescents' alcohol use.

### **Consequences of adolescents' alcohol use – the role of socioeconomic position**

When adolescents initiate alcohol use at an early age, it may have unwanted short- and long-term consequences. Early drinking has been found to be associated with health risk behaviours (such as drug use, drunk driving, risky sexual behaviour, and smoking) and injuries in adolescence<sup>27-32</sup> and adulthood.<sup>33-38</sup> The most investigated consequences of early drinking onset have been tracking of a risky alcohol use. Early drinking has been found to be associated with intake of larger amounts of alcohol in adolescence,<sup>30;39-41</sup> with higher frequency of alcohol use both in adolescence<sup>30;31;40;42</sup> and adulthood,<sup>14;37;43</sup> and with alcohol problem drinking (binge drinking and drunkenness) in adolescence<sup>30;31;39-41;44-47</sup> and adulthood.<sup>48</sup> Further, early drinking have been found to be related to alcohol addiction among adults.<sup>12-15</sup> However, the majority of prior evidence has been based on cross-sectional data or have been investigated in small populations. Therefore, evidence from large longitudinal cohorts regarding the consequences of early drinking is needed. Additionally, few studies have addressed whether the risk of experiencing unwanted consequences of early drinking onset is the same for different socioeconomic positions. A study among young European adults found that higher education and income was protective for adverse consequences of individual drinking patterns.<sup>49</sup> A study among Finnish adults found that consequences of similar drinking patterns were more severe among those from lower socioeconomic position.<sup>50</sup> These studies indicated that there may be different susceptibility to alcohol use in various socioeconomic groups. All previous studies have concerned adult populations, and to our knowledge no studies have previously investigated socially differential susceptibility of drinking onset among adolescents.

### **The influence of socioeconomic context on adolescents' use of alcohol**

In recent years, researchers have increasingly recognised the importance of not only individual characteristics, but also how contextual characteristics shape health outcomes and behaviours.

Area level socioeconomic position has been found to influence health and health behaviours.<sup>51-57</sup> The socioeconomic profile of an area can affect individual behaviour in different ways:<sup>54</sup> *a social exchange pathway*, which means the individual is influenced by the culture and behaviours of others in the area; *a stress induced pathway*, which means living in a deprived area activates stress and in turn results in risky health behaviours; and *a structural pathway*, which means the physical environment can affect behaviour, by for example access to and availability of alcohol.

The evidence regarding the effect of area level deprivation on adolescents' alcohol use is still sparse and unclear. The majority of studies on this topic, carried out in North America or Europe, found no association between deprivation and quantity of alcohol intake.<sup>58-60</sup> However, some studies, also carried out in North America or Europe, found that frequency of alcohol use was higher in highly educated contexts,<sup>61</sup> and that living in an area with low deprivation was associated with higher frequency of alcohol use,<sup>62</sup> and with both higher frequency and quantity of alcohol use.<sup>63</sup> Additionally, a North American study found that higher area level income was associated with greater frequency of drunkenness, but that living in an area with high percentage of individuals living below poverty level was associated with greater frequency of drunkenness.<sup>64</sup> A review on area level deprivation and substance use highlighted that the effect of area level deprivation on alcohol use was less likely to be significant among youth samples compared with adult samples, and questioned whether this was due to small samples or simply because of no associations among adolescents.<sup>57</sup> This gives reason to try to clarify if socioeconomic position, not only at the individual, but also at the area level, influences adolescents' alcohol use.

## Material and methods

Three of the papers (Paper I, II, and III) were based on data from The Danish Youth Cohort, while Paper IV was based on data from New Zealand Alcohol Survey 2004. This chapter of the thesis will describe the two study populations and clarify methods used in the four papers.

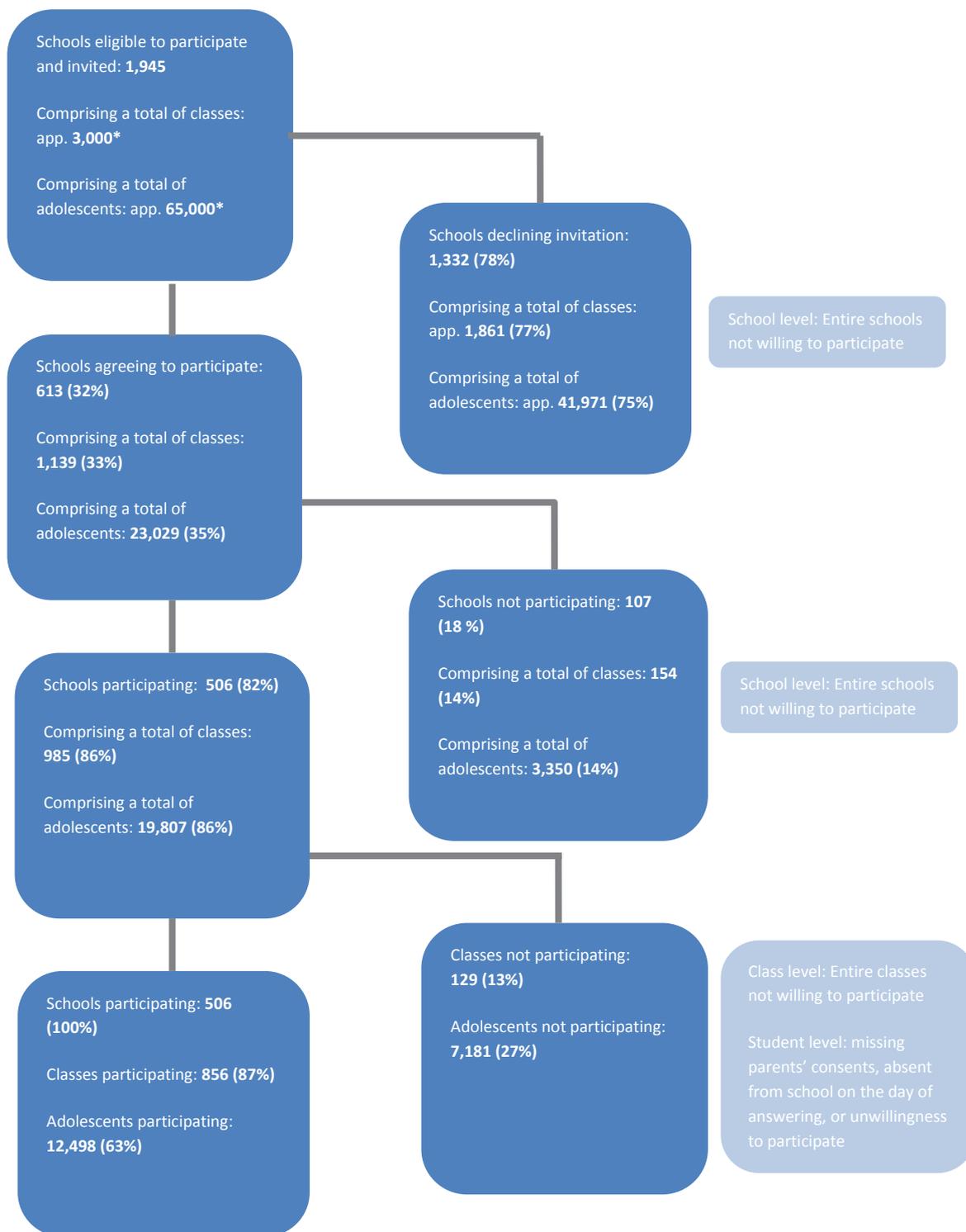
### The Danish Youth Cohort

The Danish Youth Cohort is a longitudinal cohort focusing on public health issues. It was designed and established with the particular aim of identifying determinants and consequences of early drinking onset and problematic drinking among adolescents. The Danish Youth Cohort was a nationwide, population-based survey where person-related information was obtained. The personal identification number was used to follow each adolescent through the interview rounds and was designed for future follow-up. All adolescents who answered the questionnaire had informed written consent from their parents. While completing the questionnaire, and in all further research, the adolescents' answers were anonymous to teachers, peers and researchers. The study was approved by the Danish Data Protection Agency, (J.nr.: 2004-54-1477, 2007-54-0031).

### Sampling

Participants in the Danish Youth Cohort were recruited from the total population of 7<sup>th</sup> graders in Danish schools. The adolescents were sampled in clusters of classes, with schools as the sampling units. The invitation round took place at school level, and the decision on whether or not a school class should participate was made by school principals and teachers. A total of 1,945 schools were eligible and invited, out of which 506 participated. Numbers from the Ministry of Education showed that eligible schools comprised a total of 65,000 students. A total of 506 schools and 12,498 students participated (mean age: 13.4 years; see Figure 3).

**Figure 3:** Flow chart of the collection of baseline data from year 2005. Each step in the flow chart is presented for schools, school classes, and adolescents, respectively. Level of non-participation is presented as well.



\* Numbers of classes and adolescents eligible to participate is an estimate based on numbers from the Ministry of Education.

Everyone who participated at baseline in spring 2005 was re-invited to take part in the second and third follow-ups in the 8<sup>th</sup> and 9<sup>th</sup> grades, respectively. Furthermore, in the spring 2006 and 2007, schools that were not previously invited because they did not have relevant classes at baseline but had relevant classes in spring 2006 or 2007 because of for instance school merges were invited to participate. For example, in the spring 2007 schools with no 7<sup>th</sup> or 8<sup>th</sup> grades were invited to participate with their 9<sup>th</sup> grade. At first follow-up, in the spring 2006, 7,965 adolescents participated (mean age: 14.4 years), and in second follow-up in the spring 2007 the number of participants was 5,279 (mean age: 15.3 years). Data were registered using personal identification numbers which made it possible to track each individual over the course of the study enabling researchers to conduct further surveys and register-based follow-up studies as the respondents reach adulthood.

The participation rate was calculated as the proportion of adolescents participating in the study out of the number who, according to the teachers, were registered in the given class and, consequently eligible for enrollment in the study. The participation rate for the Danish Youth Cohort 2005 was 63% (see Table 1). The sample of 12,498 adolescents represents 18.2% of the total population (n=68,764) in 7<sup>th</sup> grade in schools in Denmark in the year 2005. To improve response rates teachers were given reminders both by written letters and by phone.

**Table 1:** Number of eligible adolescent for enrolment, total population, rate of participation, and follow-up is presented for the Danish Youth Cohort for 2005, 2006, and 2007.

Year	2005	2006	2007
Number of adolescents enrolled in school classes accepting to contribute	19,807	12,977	10,284
Total population in the Danish Youth Cohort	12,498	7,965	5,279
Participation rate (%)	63 %	61 %	51 %
Number of adolescents with follow-up*		5,967	3,118
Number of adolescents with follow-up**			3,777
Follow-up from baseline (%)		48 %	25 %

\* Follow-up from 2005 to 2006 and from 2005 to 2006 to 2007

\*\* Follow-up from 2005 to 2007

### Internet based questionnaire

The data material consisted of internet-based questionnaires. The data collection took place at each school during a 45-minute lesson, and each adolescent had a computer to complete the internet-based questionnaire. Questions and possible answering categories were read aloud in headphones for each participant, giving slower readers the opportunity to participate at the same level as other adolescents. The questionnaire included questions about adolescent

health behaviour, leisure time activities, family factors, school factors and socio-demographic background variables such as ethnicity, sex, and material wealth of the family. Some of the questions in the questionnaire were developed especially for this study and some have been used in previous studies of youth cohorts, for instance the family affluence scale was developed by Health Behaviour in School-aged Children (HBSC)<sup>65</sup> and quantities on last drinking occasion, beverage by beverage was used in the European School Survey Project on Alcohol and Other Drugs (ESPAD).<sup>66</sup> The same basic questionnaire was used during all data collections, though for each follow-up more questions on additional topics were added. The layout of the questionnaire was intentionally designed to be attractive for youth and had relevant drawings for each topic.

### **The New Zealand Alcohol Survey 2004**

The New Zealand Alcohol Survey is a national survey of alcohol use in New Zealand. It was carried out as part of the Public Health Intelligence Health Behaviours Survey Monitor in which over 9,800 people aged 12-65 years were interviewed. The purpose of the alcohol survey was to provide up-to-date information on levels of alcohol use and alcohol-related problems in the population of New Zealand and examine socio-demographic differences.

### **Sampling**

The sample comprised a total of 1,828 respondents aged 12-19 years. A stratified sample design was used and within each stratum random digit dialling was used to select a household (including listed and unlisted phone numbers). The strata, when combined, covered the whole of New Zealand (strata were based on geographical areas, similar to territorial authorities, defined by Statistics New Zealand). Landline telephone coverage in New Zealand was high in 2004 (93%). A further random selection was then made to determine which individuals in the household would be interviewed. Respondents aged 12-19 years were independently and randomly selected by computer based on the number of eligible individuals living in the household. All potential respondents had an equal probability of being selected. Data were collected in 2004. An oversample of Maori (the indigenous people of New Zealand) was also collected and then weighted back down to match the corresponding population estimates obtained from Statistics New Zealand.<sup>67</sup> The response rate was 60%. The sample demographics matched the census on gender, age, socioeconomic status (education, employment, and income), ethnicity, and geographic region.<sup>68</sup> Contact and interviewing were undertaken using an in-house computer assisted telephone interviewing (CATI) system. A high level of quality control was achieved using this CATI system.<sup>69</sup> Ethical approval for the surveys was obtained from a suitably constituted Ethics Committee of the institution within which the work was undertaken (The University of Auckland).

## **Measures of alcohol use**

### **Early drinking onset**

In the Danish Youth Cohort two different measures of adolescents' early drinking onset were derived. One was based on whether the adolescent had ever tried to drink more than one beer, one glass of wine, one glass of spirits or one alcopop when answering the questionnaire in the 7<sup>th</sup> grade. This item was dichotomised as 'no' for not having tried to drink more than one unit of alcohol, and 'yes' for having tried to drink more than one unit of alcohol. The other measure was based on whether the adolescent had ever tried to be drunk when answering in 7<sup>th</sup> grade and was dichotomised as 'no' for not having tried to be drunk, and 'yes' for having tried to be drunk. In Paper I and II both measures were used, while only the first measure was used in Paper III.

### **Binge drinking**

In the second follow-up (9<sup>th</sup> grade) of the Danish Youth Cohort, the adolescents were asked how many units of beer, wine, alcopops, and spirits they drank at the last drinking occasion. All units of each alcohol type were summarized into one measure. This indicated how much in total the adolescents drank at the last drinking occasion. Binge drinking was defined as drinking five or more units of alcohol at the last drinking occasion. The total units of alcohol were dichotomised into binge drinking or not binge drinking. The measure of binge drinking was used in Paper III.

### **Quantity and frequency of alcohol use**

From the New Zealand Alcohol Survey 2004 information on quantity and frequency of adolescents' alcohol use was derived as follow: Adolescents who had been drinking within the past 12 months were asked at which of a number of mutually exclusive locations they had been drinking. For each place in which respondents had been drinking, they were asked how often they drank and how much they would drink on a typical occasion at that location. From these data the typical occasion quantity and frequency of drinking were derived. The measures of quantity and frequency of adolescents alcohol use was used in Paper IV.

## **Measures of socioeconomic position**

### **Income and occupational status of the adolescents' parents**

In Paper I, information on the total income level and occupational status of the adolescents' parents were derived from Statistics Denmark to give information on the adolescents' socioeconomic position. Total income was presented in 10<sup>th</sup> percentiles and for both the mother and father of the adolescent. Occupational status of the parents was grouped as follow: self-employed, top manager, the highest level of earners, the medium level of earners, the basic level of earners, other earners, and others. Information used was for social mother

and father (living at the same address as the adolescents), and if no information on social mother or father, information was used for biological mother or father.

### **Family Affluence Scale (FAS)**

In Paper I, II and III the individual socioeconomic position was operationalised by use of a three-item Family Affluence Scale (FAS).<sup>70</sup> The scale measured the material wealth of the family: number of cars in the household, number of holidays in the family within the last year, and ownership of own bedroom. The scale ranged from scores 0 to 5, where 0 represented the least wealthy and 5 represented the wealthiest. In the analyses, we included the family affluence scale at baseline categorized into three levels where 0-2 constituted low family affluence, 3-4 constituted medium family affluence, and 5 constituted high family affluence.

### **NZDep index of deprivation**

In Paper IV the area level socioeconomic position was obtained using the NZDep index of deprivation<sup>71</sup> which described the level of deprivation for different areas in New Zealand. The index consisted of nine deprivation-related dimensions (from Census data): income(I) (proportion receiving a means tested benefit), income(II) (proportion living in household with income below an income threshold), owned home (proportion of people not living in own home), support (proportion of people living in a single-parent family), employment (proportion of people unemployed), educational qualifications (proportion of people without any educational qualifications), living space (proportion of people living in households below a bedroom occupancy threshold), communication (proportion of people living with no access to a telephone), and transport (proportion of people living with no access to a car). NZDep scored areas from 1 to 10, for which 1 = areas of least deprivation and 10 = areas of most deprivation. Each household in the survey had Census Area Unit (CAU) information attached. A CAU is the second smallest geographical area utilised by Statistics New Zealand roughly the size of a suburb (with a median of 2,000 people). This allowed us to match respondent's geographical location to the NZDep Index (that was also calculated at the CAU level).

### **Confounders**

In Paper II, III and IV the choice of confounders to include was identified on the basis of the method of causal diagrams, as suggested by Greenland and colleagues,<sup>72</sup> which included an a priori review of the literature and logical reasoning about the relations. (See appendix for causal diagrams for Paper II, III, and IV). All identified factors were included, if available in data. In Paper II, studying the association between family affluence and early drinking onset, the covariates ethnicity (defined as country of birth of adolescents and parents' country of birth: Danes, descendants and immigrants), and age were chosen to be potential confounders. In

Paper III, studying the association between early drinking onset and binge drinking, the following set of covariates were included as baseline confounders: smoking (ever tried smoking), family structure (number of adults and siblings in the household), ethnicity (Danish origin, immigrants or descendants), peer pressure (frequency of experiencing peer pressured related to alcohol), parents' alcohol use (frequency of mother's and father's alcohol use), academic performance (own perception of academic performance), and social relations with friends (frequency of seeing friends and age of friends). In Paper IV, studying the association between area level deprivation and alcohol use, the chosen covariates were: individual socioeconomic position measured by occupation of main earner in the household (categorised into professional with university or other qualifications, director/managerial, clerical/sales/service, craftsman/skilled tradesman/manual worker/labourer, and others (which included homemaker, pensioner/retired, student, beneficiary/ unemployed, no main income earner)), ethnicity (derived from own perception of ethnic group and categorized into NZ European/European, Asian, Pacific, NZ Maori), age and sex.

## **Statistical methods**

### **Regression analyses**

For information on non-participants in Paper I we compared study participants born in 1991 with adolescents born in 1991 who did not participate in the Danish Youth Cohort (N=56,619) through registries from Statistics Denmark. Linkage was made on birth year, therefore, only participants born in 1991 being chosen to be compared with the non-participants born in 1991. Number of participants linked to Statistics Denmark was therefore N=10,697 out of the original baseline population on N=12,498. We compared the two groups on the basis of information from Statistics Denmark from 2005 regarding sex, ethnicity, geographical region of residence, type of housing, number of children in the adolescent's household, occupational status, marital status, and total income of parents. Logistic regression was conducted in Paper I to obtain odds ratios for participation and attrition.

Multilevel logistic regressions with random effects both on school and school class levels were used to calculate odds ratios of early drinking onset according to family affluence (Paper II) and for binge drinking according to early drinking onset (Paper III). In Paper II and III, we stratified the analyses for sex. In Paper III we also stratified the analyses by family affluence: by making an exposure variable combining early drinking onset with family affluence, a variable with six categories (1: non early drinking + low affluence, 2: non early drinking + medium affluence, 3: non early drinking + high affluence, 4: early drinking + low affluence, 5: early drinking + medium affluence, 6: early drinking + high affluence). Non early drinkers from families with low affluence were chosen as reference.

Multilevel linear regressions, with random effects on geographical areas, were conducted to analyse the associations between area level deprivation and quantity and frequency of alcohol use (Paper IV). In paper IV we conducted the analyses sex stratified and by controlling for sex. However, since no differences in associations were observed, we only reported the non-stratified results in paper IV. To optimize the choice of statistical model used for the linear regression in Paper IV, we checked for quadratic effects of exposure (NZDep). Therefore, NZDep was included as a quadratic linear effect in the model with quantity of alcohol intake as outcome. For all analyses in all papers significance was indicated with a p-value below 0.05 and all analyses were performed using SAS version 9.1 and 9.2.

### **Multilevel models**

An important assumption made in standard regression analyses is that there must be independence between the individual observations. When this assumption is violated, efficiency can be affected.<sup>73</sup> In the Danish Youth Cohort data were collected in clusters of school classes nested within schools, which made the assumption of independence of data at the individual level invalid. As a consequence, multilevel logistic regressions were conducted in Paper II and III to overcome the violation of independency among individuals. The effect of clustering of individual health behaviour is not only a statistical nuisance that needs to be considered in order to obtain correct statistical estimation, but it is a key concept that yields important information in itself. Multilevel models have the advantage of making possible simultaneous examination of both groups and individuals.<sup>74</sup> When hypothesising that individual health behaviour is not only influenced by individual factors but also by contextual factors, it is important to use methods that can explore contextual concepts. By using multilevel analyses, the effect of contextual factors on individuals can be obtained. Therefore, multilevel linear regression was also conducted in Paper IV in which it is investigated how deprivation at the area level influences individual alcohol use.

### **Multiple imputation**

In the Danish Youth Cohort, only 25% of the adolescents at baseline participated at the 2. follow-up two years after baseline. In Paper III we used multiple imputation to examine the effect of the low follow-up rate. Multiple imputation is a general approach to handle the problem of missing data. It takes the uncertainty about the missing data into account by creating several different plausible imputed data sets and appropriately combining results obtained from each of them.<sup>75</sup> I used multiple imputation (MI) with monotone missing method.<sup>76</sup> I imputed missing values for our outcome (binge drinking) and repeated the imputation five times. Hereafter I did the main analyses in each of the imputed data sets and combined these results by using the PROC MIANALYZE procedure.

## Summary of results

In this chapter a summary of the results from the four papers is presented.

### **Is participation at baseline and attrition associated with socioeconomic factors?**

#### **Representativeness of participants and determinants of participation**

Participants in the Danish Youth Cohort born in 1991 were compared with adolescents born in 1991 who did not participate in the Danish Youth Cohort, through registries in Statistics Denmark. We found that participants were more likely to be girls, to be of Danish ethnicity, to come from Central or Northern Jutland or Southern Denmark, and to live in one-family houses compared to non-participants. Furthermore, more frequently they came from families with two or three children, were more likely to have parents with a high occupational status, who were married and who had a higher total income. (See table 2 for percent and odds ratios relating to socioeconomic factor. The full table is presented in the result section in Paper I)

**Table 2:** Percents and odds ratios for participation in the Danish Youth Cohort in 2005 (only those born in 1991) in relation to a sex, occupation, and income of mother and father. The information came from linkage to registries from the Statistics Denmark.

Characteristics	Participants	Non-participants	OR (CI 95 %)
Total (N)	15.9 (10,697*)	84.1 (56,619)	-
<b>Sex</b>			
Girls	52.9	47.9	1
Boys	47.1	52.1	0.82 (0.78-0.85)
<b>Occupation status of mother**</b>			
Self-employed	3.3	3.7	0.73 (0.64-0.83)
Top manager	1.9	1.3	1.16 (0.98-1.37)
The highest level of earners	12.0	9.7	1
The medium level of earners	23.8	20.1	0.96 (0.89-1.03)
The basic level of earners	32.1	29.7	0.87 (0.81-0.94)
Other earners	13.3	13.9	0.77 (0.71-0.84)
Others	13.6	21.6	0.51 (0.47-0.55)
<b>Occupation status of father**</b>			
Self-employed	11.7	10.1	0.98 (0.90-1.07)
Top manager	5.8	4.6	1.07 (0.96-1.19)
The highest level of earners	13.4	11.4	1
The medium level of earners	14.0	12.3	0.97 (0.90-1.05)
The basic level of earners	28.8	27.6	0.89 (0.83-0.95)
Other earners	18.4	19.9	0.79 (0.73-0.85)
Others	7.9	14.0	0.48 (0.44-0.53)
<b>Total income of mother**</b>			
0-10 percentile	5.6	9.0	0.57 (0.52-0.63)
10-40 percentile	37.9	40.9	0.85 (0.80-0.89)
40-60 percentile	23.7	21.7	1
60-90 percentile	28.1	24.5	1.05 (0.99-1.11)
90-100 percentile	4.6	4.0	1.05 (0.94-1.16)
<b>Total income of father**</b>			
0-10 percentile	6.1	11.1	0.53 (0.49-0.59)
10-40 percentile	15.9	18.9	0.82 (0.77-0.88)
40-60 percentile	18.6	18.2	1
60-90 percentile	40.0	35.7	1.10 (1.03-1.16)
90-100 percentile	19.4	16.0	1.19 (1.11-1.27)

\* Only participant born in 1991 were linked to Statistics Denmark resulting in N=10,697 out of N=12,498.

\*\*If biological and social mother/father is not equal social mother/father is used. If no information on social mother/father, then biological mother/father is used.

**Determinants of attrition**

Participants at baseline with follow-up in 2007 (n=3,777) were compared with participants at baseline with no follow-up (n=8,721). We found that sex, family affluence, diet, physical activity, and bullying were not associated with attrition. However, adolescents whom at baseline had tried to drink one unit of alcohol, had experienced being drunk, and who smoked were less likely to have follow-up two years after baseline. (See Table 3)

**Table 3:** Odds ratios and 95% CI for attrition in 2. follow-up (2007) for main variables in the Danish Youth Cohort. Main variables were: sex, family affluence scale, self-rated health, alcohol use, smoking, use of cannabis, diet, physical activity and bullying. Information was from the self-reported questionnaire.

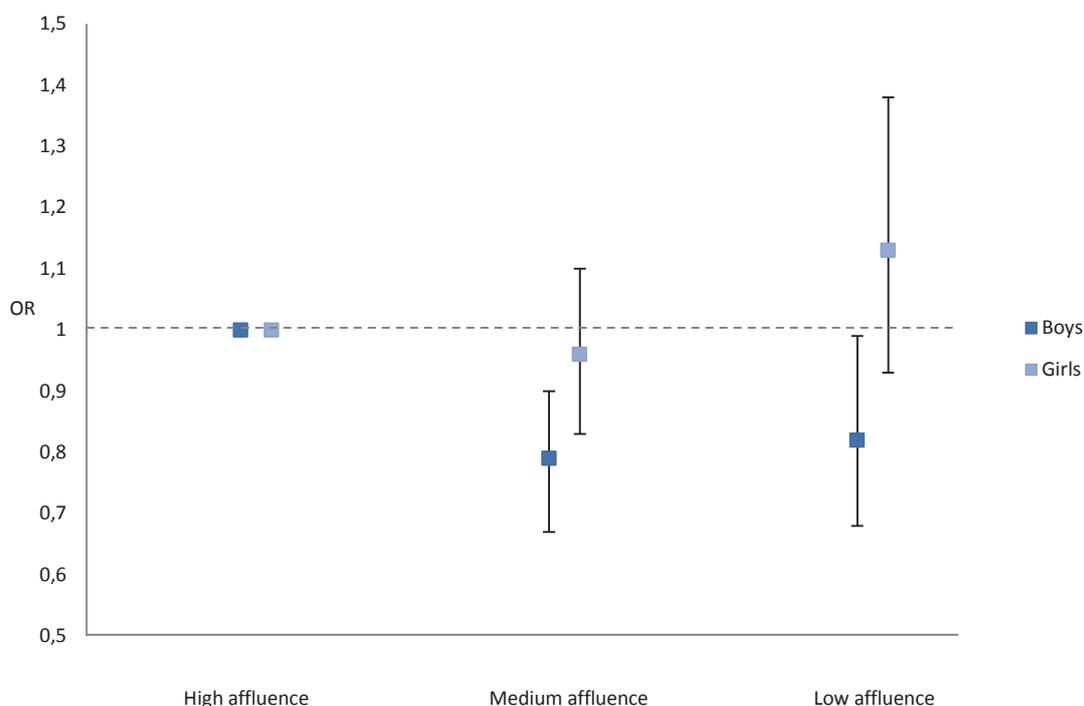
Characteristics	OR (CI 95 %)
Sex	
Girls	1
Boys	1.02 (0.96-1.08)
Family affluence (FAS)	
High	1
Medium	1.03 (0.97-1.10)
Low	0.99 (0.89-1.09)
Self-rated health	
Really good	1
Good	0.98 (0.92-1.04)
Average	0.88 (0.79-0.98)
Bad	0.76 (0.55-1.05)
Alcohol (Have ever been drunk)	
No	1
Yes	0.85 (0.77-0.94)
Alcohol (Have ever tried drinking 1 unit of alc.)	
No	1
Yes	0.87 (0.81-0.94)
Smoking (Have ever tried smoking)	
No	1
Yes, but not in 7 <sup>th</sup> grade	0.95 (0.88-1.02)
Yes	0.65 (0.49-0.88)
Cannabis (Have ever tried cannabis)	
No	1
Yes	0.89 (0.72-1.11)
Diet (Intake of fruit and vegetables)	
Almost every day or more	1
1-5 times a week	0.97 (0.91-1.03)
Never or seldom	0.98 (0.84-1.13)
Physical activity (sport/exercise in leisure time)	
4 hours a week or more	1
2-3 hours a week	0.99 (0.92-1.05)
1 hour a week or less	0.96 (0.87-1.06)
Never	0.94 (0.86-1.04)
Have been bullied	
No	1
Yes	0.96 (0.90-1.02)
Have tried to bully others	
No	1
Yes	1.00 (0.94-1.07)

### Is there social inequality in early drinking onset?

Among the 12,498 participants from the Danish Youth Cohort baseline study, 45.9% boys and 35.6% girls had tried drinking one unit of alcohol and the frequencies for having tried to be drunk were 20.5% for boys and 17.0% for girls.

For boys but not for girls, a significant association was found between family affluence and both measures of early drinking onset before and after adjustment for ethnicity and age. Boys with a low or medium family affluence had a significantly lower risk of early drinking onset measured by having ever tried drinking one unit compared to boys with high family affluence (OR for low FAS: 0.80 (95 % CI: 0.65-0.98); OR for medium FAS: 0.78 (95 % CI: 0.68-0.90)). For girls, no significant differences in risk of early drinking onset were found between groups of different family affluence.

**Figure 4:** Odds ratio and 95% CI for the association between family affluence and early drinking onset stratified by sex.



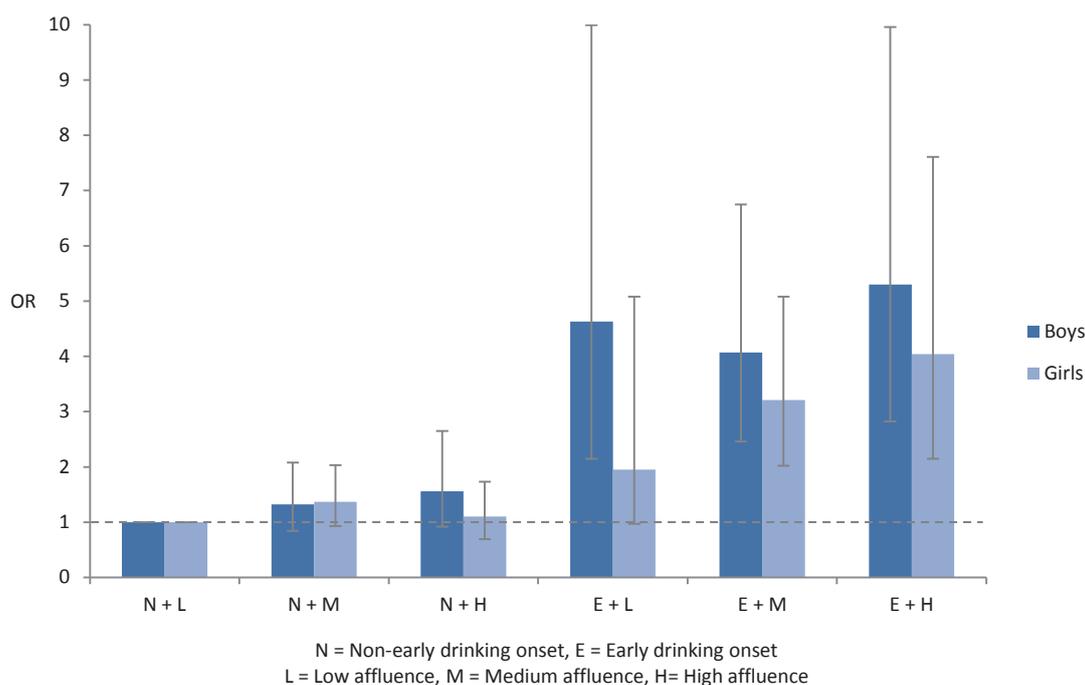
### Is early drinking onset associated with binge drinking and is the association socially patterned?

Among the 3,777 participants from the Danish Youth Cohort who both participated in the baseline study and in the second follow-up study, 39% of the boys and 30% of the girls had

tried drinking more than one unit of alcohol.<sup>a</sup> The proportion of binge drinking boys and girls at follow-up two years later was 67% and 59%, respectively.

We found that early drinking onset was associated with higher odds of binge drinking two years after for both boys (OR= 3.33, CI 95%: 2.53-4.39) and girls (OR= 2.49, CI 95%: 1.89-3.27). For non-early drinking boys a clear social pattern was seen: the higher the affluence, the higher the risk of binge drinking. Among early drinking boys no clear pattern with family affluence were observed. Among non-early drinking girls no clear pattern with family affluence were seen, while a clear pattern in the risk of binge drinking was observed with family affluence for early drinking girls. Overall, for both boys and girls the highest risk of binge drinking two years after baseline was among early drinking adolescents from families of high affluence. However, significant interaction between early drinking onset and family affluence was not present ( $p_{\text{boys}}=0.69$ ,  $p_{\text{girls}}=0.68$ ).

**Figure 5:** Odds ratio for binge drinking according to early drinking onset separately for sex and stratified on family affluence.



It is also of interest looking at the absolute prevalence level of binge drinking in different family affluence categories according to early drinking or non-early drinking. (See table 4) Among both boys and girls, the highest prevalence of binge drinking was among early drinkers

<sup>a</sup> This proportion of girls and boys who had tried drinking more than one unit of alcohol was lower in the study population with follow-up (N=3,777) compared to the proportion calculated in the baseline population (N=12,498). This was due to attrition which resulted in a selected population, which this proportion was a result of. That alcohol use was associated with attrition is also presented in table 3.

from families with high affluence, and the lowest prevalence of binge drinking was among non-early drinking boys and girls coming from families with low affluence backgrounds.

**Table 4:** Prevalence of binge drinking at age 15 for each early-drinking category stratified by sex and family affluence.

% Binge-drinker	Family affluence			p-values
	Low	Medium	High	
Boys				
Early drinking onset				
No	45.2	56.2	63.9	<0.01
Yes	80.8	83.1	86.5	0.44
Girls				
Early drinking onset				
No	39.8	54.0	50.6	>0.01
Yes	70.2	78.4	80.4	0.25

When executing our logistic regression in the imputed data sets stratified for family affluence the same tendencies were observed: the odds of binge drinking with early drinking onset were highest among adolescents from high affluence families. However, the odds ratios were not as high as in the original data set (data not shown here, but see in the result section of Paper III).

### Is area level deprivation associated with drinking patterns among adolescents?

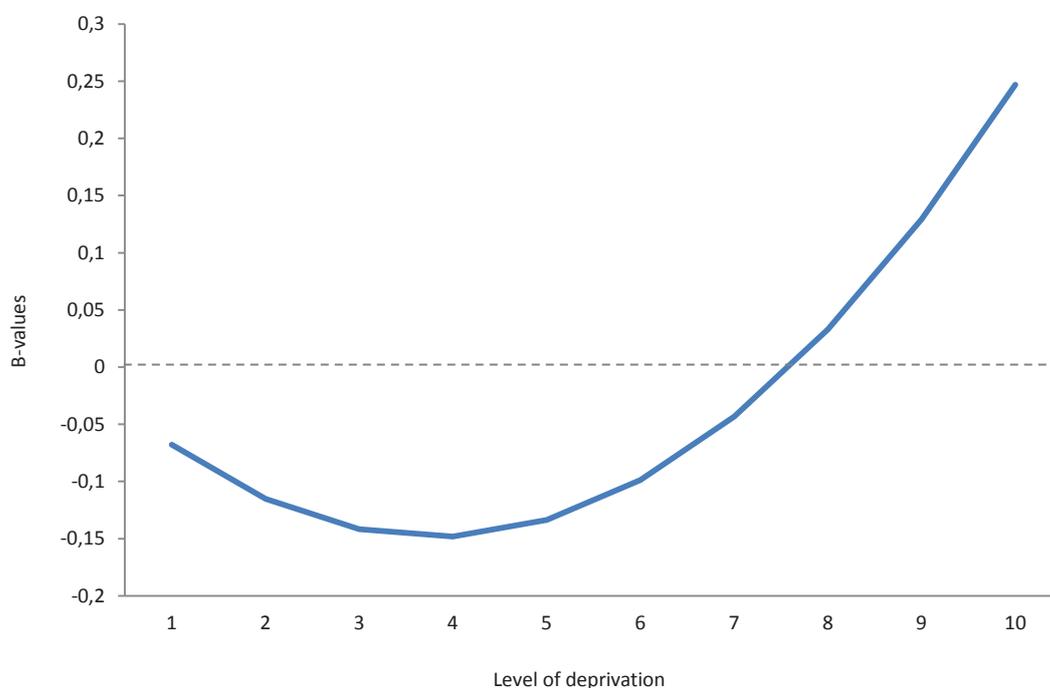
Among the 1,828 adolescents who participated in the New Zealand Alcohol Survey 2004 boys consumed 4.6 drinks on a typical drinking occasion and girls drank on average 3.5 drinks. Boys drank, on average, once a week and girls a bit less frequently.

Area level deprivation was significantly associated with quantity of alcohol intake in a J-shaped relation after controlling for age, sex, ethnicity and individual socioeconomic position (occupation of main earner in the household). The  $\beta$ -estimates decreased slightly with an average decrease on -0.03 until NZDep-category 4, and increased at an average rate of about 0.07 after NZDep-category 4. The difference in  $\beta$ -estimates between NZDep-category 1 and NZDep-category 4 was -0.08 and the difference between NZDep-category 4 and NZDep-category 10 was 0.39. This means that adolescents living in areas with the lowest deprivation

(NZDep-category 1) consumed 8% more alcohol on a typical drinking occasion than adolescents living in medium deprived areas (NZDep-category 4), and that adolescents living in areas with the highest deprivation (NZDep-category 10) consumed 48% more alcohol on a typical drinking occasion compared to adolescents living in medium deprived areas (NZDep-category 4). (See figure 6).

Area level deprivation was not associated with frequency of alcohol use after controlling for age, sex, ethnicity and individual socioeconomic position.

**Figure 6:**  $\beta$ -values for the linear association between quantity of alcohol intake and each level of deprivation given the NZdep scale. The association was adjusted for individual socioeconomic position, ethnicity and sex. The level of deprivation ranges from 1 (=low deprivation) to 10 (=high deprivation).



## Discussion

In this chapter main findings are discussed and aligned with previous evidence. Further, limitations and strengths of my research are discussed.

### Main findings

The main results of the four studies were:

- Socioeconomic factors were associated with participation at baseline in the Danish Youth Cohort; fewer from the low socioeconomic groups attended the study. Family affluence was not associated with attrition from baseline to second follow-up two years after baseline. However, alcohol use and smoking was factors that were associated with attrition.
- Social inequality in drinking onset was present among Danish boys: those at most risk of early drinking onset were boys from the most affluent families, while there were no social differences in early drinking onset among girls.
- Among Danish adolescents early drinking onset measured at age 13 was associated with binge drinking at age 15. The strength of the association varied across groups of family affluence. Those at highest risk of binge drinking were adolescents that initiated alcohol use early and came from families with high affluence.
- A J-shaped association was observed between area level deprivation and quantity of adolescents' alcohol use in New Zealand. No association between area level deprivation and frequency of drinking among adolescents was seen.

### Comparison with previous studies

#### Characteristics of participants and non-participants in the Danish Youth Cohort and determinants of attrition

Participation at baseline in the Danish Youth Cohort was associated with socioeconomic factors. Participants were more likely to have parents of high occupational status, who were married and with a higher total income. It is well known that non-participants are from lower socioeconomic positions, and our results were consistent with other studies investigating non-participants.<sup>77-81</sup> Loss to follow-up was associated with adolescents' probability of drinking and use of tobacco, but not associated with other factors tested, including family affluence. The latter finding was unexpected. As is the case for baseline participation, participation at follow-up has been found to be associated with socioeconomic factors, with those with follow-up data having higher socioeconomic position than those without follow-up.<sup>82</sup> The fact that family socioeconomic position was not associated with attrition, but associated with participation at baseline, may be due to the active parental consent form that was required to be filled out and

delivered back to the school before entering the study. This procedure implied that parents had a say in the participation of their child at baseline. When the parental consent was given at baseline, it was out of the parents' hand to decide whether their adolescent should participate at the follow-up. Therefore, baseline participation was influenced by parents while participation in follow-up was decided by schools, teachers, and the adolescents themselves. Further discussion of the influence of non-participation and attrition is given in the section on selection bias.

### **Social inequality in drinking onset**

Social differences in drinking onset existed among boys, with boys from more affluent families at the highest risk of early drinking onset. As previously mentioned in the introduction, earlier findings have shown inconsistent patterns of social inequality in adolescents' alcohol use. This may be explained by the use of different alcohol measures or different measures of socioeconomic position. We found that high family affluence was associated with greater risk of alcohol use which is consistent with at least three previous studies.<sup>18;23;24</sup> Though, our focus was on early drinking onset while other studies focussed on frequency of alcohol use. Richter and colleagues found high family affluence to be associated with both frequency of drunkenness,<sup>18</sup> and frequency of alcohol use.<sup>23</sup> Goodman and colleagues found that high parental income was associated with frequency of alcohol use.<sup>24</sup> Studies which have found the opposite socioeconomic direction in adolescents' alcohol use have primarily used occupational status,<sup>18;22</sup> or educational achievement<sup>20;83</sup> as measures for socioeconomic position. Our results using family affluence, together with the findings from the other studies using income and family affluence as indicators for socioeconomic position, suggest that it is the availability of financial resources that may be positively related to adolescents' frequency and initiation of drinking. This is also supported by a Finnish study in which drunkenness was more common among adolescents who received more pocket money.<sup>84</sup>

A Danish study by Wium-Andersen and colleagues investigating drinking onset did not find a socioeconomic gradient among adolescents when studying both income and education of parents.<sup>26</sup> An explanation for the different results found in Denmark could be that Wium-Andersen and colleagues<sup>26</sup> did not stratify by sex. Owing to the unstratified analysis of their data, aggregating the different effects for boys and girls, the effects may have eliminated each other resulting in no significant association, and possibly resulting in overlooking sex differences in the association. Another study, that examined socioeconomic position and drunkenness, reported sex differences as was the case in our study: They also only found an association with high family affluence and adolescents' drinking behaviour among boys.<sup>18</sup> It has been suggested that gender roles mediate sex differences in adolescents' alcohol use, as masculine attributes were positively related to drinking and feminine attributes were

negatively related to drinking.<sup>85</sup> The differential effect that we found by sex could therefore be a result of different gender roles and gender expectancies in different socioeconomic positions. If boys from high socioeconomic positions are expected to have a more masculine behaviour compared to boys from low socioeconomic positions, this could explain that boys from high socioeconomic positions begin drinking at an earlier point in time. However, a more masculine behaviour could also be more present among boys from low affluent families or not be associated with socioeconomic positions at all, and therefore not help explaining my findings. Additionally, social inequality in health has been found to be more pronounced for men than for women.<sup>86</sup> The same may be true for health behaviours which then can explain the sex differences in our findings.

Choice of indicator for socioeconomic position may also play a role in explaining this sex differences in our study.<sup>86</sup> We measured socioeconomic position by material affluence (numbers of cars, holidays within the last year, and having their own bedroom). These factors may be more influential in positioning boys compared to how girls are influenced by material resources, however no differential item functioning has been found for sex and the three included items.<sup>87</sup> Another hypothesis explaining the sex difference may be that girls and boys begin drinking in different settings, which may depend on socioeconomic position. It has previously been stated that rather large differences are seen in how boys and girls drink: with boys having a higher prevalence of drinking and drunkenness than girls.<sup>88</sup> However, a gender convergence in drinking patterns is beginning to evolve, where the gender gap between boys and girls is shrinking in West Europe caused by a relative decrease in boys alcohol use compared to girls.<sup>6</sup> Further research is still needed to explain the sex differences found in this study.

### **Is the association between early drinking onset at age 13 and binge drinking at age 15 socially patterned?**

Many studies have previously found negative consequences of early drinking,<sup>14;15;39-41;46;47</sup> However, only few of these studies were conducted using large longitudinal cohorts.<sup>15;40</sup> Therefore, our finding that early drinking onset was associated with an elevated risk of binge drinking measured two years later provides additional evidence of the consequences of early drinking onset.

Only a few studies have investigated the social differentiation in the consequences of alcohol use. Two studies have found that alcohol use has different consequences according to different socioeconomic strata: one study in Europe found that higher education and income was protective for adverse consequences of individual drinking patterns,<sup>49</sup> and another study

among Finnish adults found that consequences of similar drinking patterns were more severe among those from lower socioeconomic position.<sup>50</sup>

Diderichsen and colleagues suggested pathways in which socioeconomic circumstances affect health and health behaviour.<sup>16</sup> Both pathways, “differential exposure” (which suggests that the determinants are socially patterned), and “differential vulnerability” (which suggests that individuals may be more or less vulnerable to the effect of determinants depending on their other resources), may be mechanisms that contribute to the explanation of social differences in consequences of alcohol use among adults.<sup>89</sup> We found that adolescents from families with high affluence had the highest risk of binge drinking given early drinking onset, while other studies among adults found that it was adults from low socioeconomic groups that had the highest risk of more health-related consequences given the same alcohol intake. This difference could be explained by the choice of outcome used. In our study we focused on binge drinking which is a consumption measure and represents tracking of risky alcohol use, while the studies among adults focused on more health-related consequences such as mortality rates and injuries.<sup>49,50</sup> When focusing on a consumption measure as the outcome among adolescents, financial resources and hereby accessibility to excessive drinking, may be the explanation for our findings: adolescents from families of high affluence are at highest risk of binge drinking given early drinking onset.

### **Effects of area level deprivation on drinking patterns among adolescents**

To our knowledge, no previous studies have found a J-shaped relation between area level deprivation and quantity of alcohol intake among adolescents. Studies assessing relationships between area level socioeconomic position and drinking patterns among young people have been relatively rare and findings have been mixed.<sup>57</sup> The majority of studies have found no association between area level socioeconomic position and quantity of alcohol intake.<sup>58-60</sup> However, our findings that adolescents living in the most deprived areas were the ones that consumed the most alcohol after adjusting for individual socioeconomic position have been supported by other studies from North America and Europe. A large study in an adult population found that living in a deprived area was associated with a high quantity of alcohol intake.<sup>54</sup> Further, a study found that living in an area with low deprivation was associated with greater frequency of alcohol use among adolescents,<sup>62</sup> and another study also supported that living in deprived areas was associated with both greater frequency and quantity of alcohol use.<sup>63</sup> A study of a regional sample in New Zealand has observed a similar association with higher quantities of alcohol consumed among adolescents living in areas of high deprivation.<sup>90</sup> The above-mentioned studies all support the right arm of our J-shaped curve: that living in areas with high deprivation is associated with quantity of alcohol intake. The left arm of the J-shaped association may be explained by the New Zealand context, where greater disposable

income may have allowed for a modest increase in typical occasion quantity among adolescents living in the least deprived areas (over those living in medium deprived areas) even though community advantage may be generally protective. The result that higher disposable income among adolescents enables more extensive use has been found elsewhere.<sup>57</sup>

We found that area level deprivation was associated with quantity but not frequency of alcohol use. A review by Karriker-Jaffe also suggested differing associations of area level deprivation in adult populations according to measures of heavy alcohol use versus non heavy alcohol use.<sup>57</sup> At the individual level and in a young adult population, this was supported by Casswell and colleagues who found that high frequency of drinking was associated with higher affluence while high alcohol quantity was associated with lower levels of education.<sup>21</sup> Therefore our finding of a significant association with quantity and non-significant association with frequency of alcohol use seems plausible.

### **Perspectives on social inequality in alcohol use**

Social variation in alcohol use is an interesting phenomenon and findings often contradict what has been found for other health behaviours. In this thesis we found that high individual socioeconomic position was associated with early drinking onset among adolescents in Denmark, while an opposite area level socioeconomic gradient in adolescents' drinking behaviour was seen in New Zealand. To explain the gradient in Denmark I may look at the drinking pattern for adults and the Danish drinking culture. Among Danish adults the same pattern can be observed: the most affluent individuals have the highest risk of an alcohol risk behaviour.<sup>10</sup> Further, drinking alcohol is an integral part of the Danish lifestyle and alcohol is regularly consumed by the majority of Danes.<sup>91</sup> Therefore, it is not surprising that Danish adolescents see their parents and all other close adults as role models and adapt their behaviour.

Explanations for the opposite gradient in New Zealand may be that a higher accessibility to alcohol have been found in more deprived areas in New Zealand,<sup>92</sup> where higher density of alcohol outlets is associated with increased quantity of alcohol intake among adolescents in New Zealand.<sup>90</sup>

The contradicting finding of the gradient between the Danish and the New Zealand population may be explained by the different levels under investigation: individual socioeconomic position versus area level socioeconomic position. Therefore, it is of interest to see if the findings from New Zealand has been found in a Danish population and vice versa. In the population from

New Zealand, we also investigated the individual level of socioeconomic position, and found a higher quantity of alcohol intake at the individual level among adolescents age 12-19 from families with low occupational level in New Zealand (see Paper IV for more details). This was the opposite finding compared to the results among 13-years-old Danish adolescents from Paper II. In this thesis, we have not investigated the effects of area level socioeconomic position on adolescents' alcohol use in a Danish context. However, a previous Danish study conducted in the Danish Youth Cohort did not find socioeconomic position at the school district-level to be associated with early drinking onset.<sup>93</sup> Therefore, it seems likely that the contradictory result of an opposite socioeconomic gradient in alcohol use found in Paper II and IV cannot be explained by levels of analysis, but that in fact there is a different socioeconomic gradient in the two populations.

Numerous other factors may contribute to explain the mixed findings between the Danish and the New Zealand population. Conditions are different for adolescents in Denmark and New Zealand when looking at drinking patterns, and structural, demographical and political factors. For instance, adolescents from New Zealand initiate alcohol use later than Danish adolescents;<sup>5;94</sup> the average litre pure alcohol consumed per capita is smaller in New Zealand compared with Denmark,<sup>95</sup> and the age limit for purchasing alcohol is more strict in New Zealand compared with Denmark. In New Zealand adolescents under 18 may not drink outside private residences or private functions unless accompanied by their parent or legal guardian, and may only be supplied with alcohol through their parent or legal guardian.<sup>96</sup> In Denmark, when this data were collected, adolescents have to be 16 for purchasing alcohol (the age for purchasing spirits have afterwards been raised to 18).<sup>96</sup>

We found that social inequality was present in adolescents' drinking onset (Paper II), in the association between early drinking onset and binge drinking, though not significant (Paper III), and in quantity of alcohol intake (Paper IV). Therefore I cannot support West<sup>9</sup> who argued that a process of social equalization of behaviours is present among adolescents, at least not when it comes to alcohol use. To explain the equalization in youth, West described that the influence of the school, the peer group, or youth culture cut across the influence of the family background and neighbourhood in Scotland. However, in comparison Denmark may not have as strong youth subcultures as is the case in Scotland. The Danish alcohol culture implies that drinking is the norm and that drinking alcohol is not considered as a deviant behaviour not only among adolescents but also among the adult Danish population. This may contribute to the patterns of inequality, which emerge among Danish adolescents. Further, differences in school systems between countries may reinforce or diminish the influence of socioeconomic position. Compared to the Scottish, the Danish school system is more neighbourhood-based with students remaining in the same school class throughout their youth years,<sup>97</sup> which render

that Danish adolescents may have a more stable groups of peers resulting in no continuous need to position themselves toward peers through alcohol use. My results may also reflect that in Denmark peers are less influential compared to the family background. A Danish study found that socioeconomic health inequalities in adolescence were less strongly related to informal social relations with friends but more related to relations with parents.<sup>98</sup> This supports that in Denmark family background may influence adolescents' behaviour more than peer groups. Further, we found that area level deprivation was associated with the individual adolescent's alcohol intake which suggests that the factors of school, peer group and youth culture do not cut across the influence of the neighbourhood they are living in. In conclusion, I do not find support for West's equalization hypothesis this may be explained by cultural differences among countries.

## **Limitations and strengths**

### **Strengths**

In the following section the different major strengths that characterise the different papers are presented.

In Paper I the obvious strength was the possibility to link participants and non-participants to Statistics Denmark. From the participants in the Danish Youth Cohort personal identification numbers were obtained. This gave me the opportunity to link participants to registries of Statistics Denmark. Participants could then be compared with all Danish adolescents born at the same time by a variety of factors. This rendered the possibility to describe who were missing in the study population and compare participants to the eligible population. Further, information obtained from Statistics Denmark is overall seen as valid and not subject to major misclassification since it is built primarily on administrative registries and not on self-reports. Another strength of Paper I was the possibility to undertake attrition analyses. This gave information about those with and without follow-up.

In Paper II information from the baseline population of the Danish Youth Cohort was used. The large number of adolescents participating in the baseline study should be highlighted. A total of 12,498 adolescents participated, which is 18% of the total population of 7<sup>th</sup> graders in spring 2005.

In Paper III the longitudinal data in the Danish Youth Cohort was used. In comparison with other studies investigating consequences of alcohol use among adolescents, our study was executed in a large, longitudinal population. A total of 3,777 adolescents participated in the

second follow-up two years after baseline. Causal relations should be investigated in a longitudinal perspective, which this data endorsed.

In Paper IV we had data available at area level, which made it possible to investigate how the socioeconomic position of the neighbourhood level, beyond individual socioeconomic position, was associated with individual alcohol intake of the adolescent. This was a major strength of this study.

### **Limitations**

In the previous section several strengths of the studies have been highlighted. In this section the limitations, with focus on selection bias, misclassification of exposures and outcome measures as well as confounding issues, are discussed.

#### *Selection bias*

Selection bias is present if the association between a given exposure and a given outcome differ between participants and non-participants.<sup>99</sup> Selection bias can occur at enrollment to the study cohort, but also at follow-up. Both scenarios need to be considered when discussing selection bias.

In the Danish Youth Cohort, a response rate of 63% was obtained at baseline. This should be seen in the light of decreasing rates of participation that have been reported over the past years in population based studies.<sup>100;101</sup> In Denmark, the same pattern has been present in cohort studies in adult populations,<sup>102</sup> and in other adolescent populations.<sup>103</sup> We found, in Paper I, that the participants in the Danish Youth Cohort differed from the non-participants with regard to almost all of the socio-demographic factors measured. Participants had stronger socioeconomic resources compared to non-participants. As mentioned earlier in the thesis, parental consent may have affected baseline participation, resulting in higher participation among adolescents with parents from higher socioeconomic positions. When participants are not representative of the eligible population, selection bias may be present. In relation to Paper II, selection bias would, however, only be present if early drinking onset was differently associated with family affluence, apart from random errors, among participants and non-participants. A variation in family affluence was present among participants in the Danish Youth Cohort, and we believe that differentiation may be present and hereby represent the spectra of affluence. However, I cannot exclude that for instance adolescents of very low affluence were not represented and that they in fact begin to drink early.

The findings that early drinking onset was associated with binge drinking (Paper III) were based on the longitudinal cohort. Therefore it is important to discuss how attrition may affect the

cohort and hereby result in selection bias. Only 30% of the baseline participants were followed up two years later. In Paper I, we analysed factors associated with attrition and found no association with family affluence, but an association between attrition and alcohol use and smoking. Those whom did not participate at follow-up two years after baseline were more likely to have been drinking early, which may have affected our results. However, if selection bias was present, the association between early drinking onset and binge drinking should have been different for participants and non-participants. I cannot be certain that this was not the case, therefore I performed multiple imputations, where missing at follow-up were imputed on the basis of baseline information. This analysis was executed to clarify the effect of the high attrition. The results from this analysis reduced the size of the risk of binge drinking among early drinkers in all groups of family affluence, but showed the same direction of association. This suggests that attrition in the Danish Youth Cohort may affect the size of the effects, but not the direction of association and thus not the conclusion as to who were at most risk of binge drinking. However, when using multiple imputations to address missing observations the assumption of missing at random (MAR) is used. MAR assumes that the missing observation in a variable has the same distribution as the observed observations in the variable given other observed variables.<sup>104</sup> This means that using multiple imputations, missing observations can be predicted from observed variables. However, if missing observation is not MAR, but not missing at random (NMAR), where the missing observations of a variable are dissimilar to the observed observation of the variable given other observed variables,<sup>104</sup> the assumption in multiple imputation is violated. However, since MAR or NMAR is dependent on the distribution of unobserved data, it was difficult to determine which was present in our analysis. However, when imputing data the baseline information on observed variables was taken into account, and the probability that other variables not in data should predict attrition seems small.

The New Zealand Alcohol Survey had an overall weighted response rate on 60%. We did not have information on the non-participants, therefore selection bias cannot be ruled out. However, the method of data collection was a stratified sample design which reflected the New Zealand population on the basis of geographic regions and level of urbanization. Telephone numbers were selected within stratum so that all households did have an equal chance of being called. Within each household: zero, one or more respondents were randomly selected by the computer for an interview. Each telephone number was tried at least 10 times in an effort to reach those seldom at home. However, the landline coverage at time of data collection in 2004 was 93%, therefore not all of the population was reachable by phone. Additionally, an oversample of Maori (the indigenous people of New Zealand) was also collected and then weighted back down to match the corresponding population estimates obtained from Statistics New Zealand.<sup>67</sup> The sample demographics matched the census well for

demographic variables.<sup>68</sup> Therefore bias due to selection of the data may not have influenced the results considerably.

#### *Misclassification of measures of socioeconomic position*

The total income and the occupational status of mother and father of the adolescent were used in Paper I as a measure of socioeconomic position. The information was obtained from the Statistics Denmark and has been found to be of good validity.<sup>105;106</sup> Therefore, the measure of income and occupation used in Paper I seemed not to be subject of severe misclassification.

The Family Affluence Scale was used in Paper I-III and was used to operationalise family affluence which was a measure of the socioeconomic position of the parents of the adolescent. Some adolescents may have difficulties answering questions about parents' occupation and income.<sup>107</sup> Using this indirect measure of the parents' socioeconomic position, instead of a more direct question about the parents' occupation, education or income, may give a higher validity and fewer missing. Further, an international study found that family affluence is in accordance with parental socioeconomic position. Internationally, a great number of adolescents were unable to give sufficient information on their parents' occupation, which rendered it impossible to place the parents in a social group.<sup>108</sup> On the other hand, almost all adolescents were able to answer questions concerning the number of cars owned by the household, ownership of own bedroom, and number of family holidays in the past year which constituted the family affluence scale.<sup>108</sup> Previous studies have found good correspondence between the adolescents' answers and their parents' answers to the FAS-questions, and only the question concerning number of family holidays rendered poor agreement.<sup>109</sup> This indicates no serious misclassification of the reporting of the family affluence scale.

It is still debatable, though, whether the family affluence scale is a proper operationalisation for socioeconomic position, and if it does in fact capture the concept of socioeconomic position. It is possible to call into question whether these factors measure the socioeconomic position of the family properly when taking into account the material development that has taken place in Denmark and other western countries during the last 5-10 years. For instance number of holidays in the past year and ownership of own bedroom may not differentiate the affluence of the adolescents well enough, due to the fact that over the years more than one holiday per year and having their own bedroom are more common situations due to an increase in the general level of affluence in the population. Further, the measurement of car ownership may not differentiate well enough either. For instance some wealthy families living in larger cities in Denmark may not prioritise buying a car even though they have the financial means to do so. In the baseline data collection of the Danish Youth Cohort the family influence

scale was included as a three item measure. Additionally, a second version of the family affluence scale has been developed and an item regarding ownership of computer has been added to measure the family affluence.<sup>65</sup> Using the second version instead of the first version of the family affluence scale may have measured the socioeconomic position of the adolescent more adequately, however, data limitation made this impossible. Although the family affluence scale has some pitfalls, we believe it differentiated the extremes of socioeconomic position. Therefore, using the family affluence scale to operationalise socioeconomic position seemed useful.

In Paper III NZDep index of deprivation was used as exposure variable. It was used to capture the level of deprivation of the local area, in which the adolescents in New Zealand lived. In the majority of previous studies among adolescent populations, only single item measures such as percentage with low income or percentage below the poverty level have been used to operationalise the deprivation of an area.<sup>58;60;61;64</sup> The NZDep index of deprivation is a robust composite measure of area level socioeconomic position.<sup>110</sup> It measures nine different aspects of an area's socioeconomic position (based on Census data). Pickett and colleagues, in their review of effects of neighbourhood context on health outcomes, highlight that using a composite measure rather than a single item measure may better reflect the underlying concept of a neighbourhood's socioeconomic position.<sup>52</sup> However, use of the composite measure as is the case in our study rendered the assumption that all nine items had equal weight in the overall measure. This assumption may be too strong to make. Further, using a *composite* measure of an areas deprivation may still not capture the *real contextual* deprivation. Measures such as community attributes may be more appropriate if hypothesising that area level deprivation affects the individual only through the structural pathway, which means the physical environment affects the behaviour. However, our results may be a sum of different pathways where also the characteristics of the sum of the individuals in the neighbourhood affect each individual. This includes the social exchange pathway, which means each individual may be influenced by the culture and behaviours of others in the area, and the stress induced pathway, which means living in a deprived area activates stress and in turn results in risky health behaviours.<sup>54</sup>

#### *Misclassification of measures of alcohol use*

The adolescents' self-report of early drinking onset, binge drinking, and quantity and frequency of alcohol use could have been misclassified which could have lead to significant bias, if the misclassification was differential. Self-report of alcohol use among Danish adults has been evaluated and is overall seen as valid.<sup>111</sup> Among adolescents, a study found that self-reported quantity and frequency of alcohol use correlated well with monthly diary reports, but that questionnaires tend to underestimate the prevalence of drinkers.<sup>112</sup> In Paper I early

drinking onset was used as possible determinant for attrition, in Paper II early drinking onset was used as an outcome variable and in Paper III, it was used as an exposure variable. Early drinking onset was measured by whether the adolescents had ever experienced drinking one unit of alcohol and whether they had tried to be drunk. However, young people might tend to over report intake of alcohol if they perceive the behavior to be desirable.<sup>113</sup> Therefore, early drinking onset could have been influenced by exaggerations where some adolescents reported that they had tried to drink or to be drunk while this was not actually the case. However, since confidentiality was attempted for the collection of data, it is unlikely that this potential bias is a major concern. An underestimation of the prevalence of early drinkers may also be present as suggested by Koning and colleagues.<sup>112</sup> However, differential misclassification would only be present if the misclassification of early drinking was different according to different groups of affluence: for instance if adolescents coming from families with low affluence reported they had tried drinking, when actually they had not, then it would have resulted in an underestimation of the association. In Paper III, the measure of binge drinking was calculated as a sum of four variables (measuring units of beer, wine, spirits and alcopops), which may have lead to misunderstandings, when asking about *one* drinking occasion. This could have influenced the prevalence of binge-drinkers, and if adolescents from families with low affluence had more difficulties understanding the configuration of the questionnaire this may have caused differential misclassification. Another problem of this measure needs to be highlighted. Adolescents' alcohol use fluctuates from occasion to occasion, and one drinking occasion may not be representative for their normal alcohol intake. Better information of their usual intake may have been collected if they had answered a question of their alcohol intake for a *usual* drinking occasion and not, as done in this study, *last* drinking occasion.

In Paper IV quantity and frequency of adolescents' alcohol intake were used as outcome variables. Misclassification of alcohol use can also be influenced by exaggerations where the adolescent tends to over report intake of alcohol. But this would only result in differential misclassification if exaggerations of alcohol intake were associated with for instance living in a deprived area, where our right arm of the J-shaped association may have been overestimated. However, comparison of data from the New Zealand Alcohol Survey with taxable alcohol in New Zealand (calculated by Statistics New Zealand) showed that the volume accounted for by the survey data when scaled to a population level, accounted for 91% of the taxable alcohol use.<sup>114</sup> Additionally, call backs were undertaken to respondents who reported consuming large amounts of alcohol on a typical occasion to check respondent answers. Further, these consumption measures have been found to have good validity and give a very good approximation to alcohol available for consumption in New Zealand.<sup>69</sup> Therefore I believe that our measurements of alcohol intake in Paper IV were not subject to serious misclassification.

In sum, misclassification in the reporting of alcohol use was possible; however, if there was any misclassification in the studies it was possibly non-differential.

### *Confounding*

Confounding occurs if an estimated association between exposure and outcome is affected by a common cause of the exposure and outcome.<sup>99</sup> A covariate cannot be a confounder unless it is a risk factor for the outcome, is associated with the exposure, and is not an intermediate variable between exposure and outcome.

In Paper II-IV the confounders were identified on the basis of the method of causal diagrams, as suggested by Greenland and others,<sup>72</sup> (see appendix for causal diagrams for each paper). In Paper II, ethnicity and age were potential confounders for the association between family affluence and early drinking and were adjusted for. In Paper IV, ethnicity, age, and individual socioeconomic position (measured by occupation of main earner in the household) were confounders for the association between area deprivation and quantity and frequency of alcohol use. Many other risk factors for early drinking and for alcohol use were considered to be included as potential confounders in the two studies. However, since the exposure variables in Paper II and Paper IV were measures of socioeconomic position, which were proximal factors to many covariates, the non-included risk factors would probably have been intermediate variables in the association, and therefore not fulfil the criteria for a confounder.

Nevertheless, in relation to Paper IV, unmeasured confounding in relation to individual socioeconomic position needs to be highlighted. As mentioned earlier, the area level deprivation was measured by the NZDep index of deprivation, which is a composite measure of area level socioeconomic position.<sup>110</sup> Using a composite deprivation measure makes it difficult to differentiate the true contextual effect of living in a deprived area, from the compositional effect which is the sum of individual characteristics. For instance the association that we found could reflect that a higher proportion of residents with lower socioeconomic position in an area may increase the likelihood of unfavourable health practices in youth rather than a true contextual effect. If we did not adjust adequately for individual socioeconomic position confounding may have been present. To measure the adolescent's socioeconomic position we used a measure of the occupation of main earner of the household. The validity of adolescents' reports of their parents' occupations has been questioned.<sup>70</sup> However, others have found good accordance between adolescents' and parents' reports.<sup>115</sup> I compared the distribution of the variable in the youth sample with the distribution in an adult sample and found no significant differences. Therefore, the adolescents' self-report seemed reliable for the occupation of the main earner in the household. However, using occupation of the main earner in the household as sole measurement of individual socioeconomic position may not

adequately capture the individual socioeconomic position. Therefore, unmeasured confounding may have been present, and hereby I cannot preclude that compositional effects caused by non-adequate control for individual socioeconomic position can be part of explaining the J-shaped association in Paper IV.

In Paper III, several risk factors for binge drinking were not available and the association may have been affected by unmeasured confounding. Covariates such as adverse childhood experiences and level of maturity are some of the factors that may be potentially unmeasured confounders. Not having the opportunity to adjust for maturity may have resulted in an overestimation of the association between early drinking onset and binge drinking (if being mature causes early drinking and being mature causes the adolescent to binge-drink more). However, how much the unmeasured confounder affects the association between early drinking onset and binge drinking depends on how strong the unmeasured confounder is associated with the exposure and the outcome. I had no information on these issues in my studies.

In sum, serious bias caused by unmeasured confounding seemed unlikely for the associations in Paper II. However, the association between area level deprivation and alcohol intake may have been influenced by unmeasured confounding where individual socioeconomic position may not have been adequately adjusted for. Further, the association between early drinking onset and binge drinking may also have been influenced by some unmeasured confounding factors.

#### *Multilevel analyses*

In multilevel analyses data from different levels (e.g. individual, school, area) are integrated in analyses and interpretations. When defining the different levels, overseeing or missing a level may affect the efficiency since the assumption of independency among individual may be violated.<sup>73</sup> In Paper II and III the levels used were individual level, school class and school level. In Paper IV the individual and area level were used. In Paper II and III, it is plausible that a level representing the peer level should have been considered in the analyses. If this is true, it could have affected the efficiency of the found estimates. However, it was not possible to incorporate this missing level due to lack of data on this issue. Also, higher levels than school could have been of interest, such as municipality or other area specific demarcations. In Paper IV we studied characteristics on an area level, however, in this analysis lower levels of peer groups were missing.

When using multilevel models it is also important to consider if the sample size of each level are sufficient to make accurate estimates and standard errors. Paper II was based on 12,498

adolescents nested in 856 school classes nested in 506 schools. On average, at each school 1.7 classes participated including an average of 14.6 adolescents. Paper III, in which we used the longitudinal cohort 3,777 adolescents were nested in 420 school classes nested in 259 schools. On average, at each school 1.6 classes participated containing on average 9.0 adolescents. In Paper IV, 1,828 adolescents participated within 628 areas. The number of participants needed at each level to secure accurate estimates and standard errors is still to be agreed upon.<sup>74</sup> I believe that the included sample sizes at each level were acceptable, although a larger average number of adolescents per school class would have been more satisfying.

### **Summary of strengths and limitations**

My studies have some major strengths compared to prior studies in relation to each of the different topics investigated by the different papers. However, the presented limitations give some drawbacks for my confidence in my results. In the following section, a summary of the strengths and limitations for each paper are given.

I believe my Paper I was not subject to major limitations. It tried to illuminate the major drawback of the Danish Youth Cohort: the low response rate and hereby the selected population by characterising the non-participants and factors associated with attrition. Both Paper II and Paper III should be seen in light of the results of Paper I.

In Paper II, the major limitation was that it was conducted in a cross-sectional design which questions the causal inference. However, I believe that family affluence do come prior to early drinking in the causal chain. In comparison, Paper II was conducted in a longitudinal cohort. However the drawback of this was a smaller and more selected population. The longitudinal cohort is still large compared to previous cohort studies among adolescents. However, when we stratify both by sex and family affluence the number in each strata was limited. Multiple imputation of data was used to try to account for the fact that the study population was more selected than the baseline population. Further, for both Paper II and III potential limitations were the misclassification of the alcohol measures and the measure of family affluence, which may not measure the socioeconomic position of the adolescents properly. However, I believe the adolescents' self-report of alcohol gave a good approximation of their actual use, and therefore these limitations were not of major concern, if acknowledging that family affluence only is one of many indicators for socioeconomic position. In sum, given the limitations, I believe my results of Paper II and Paper III can be trusted.

In relation to Paper IV, several drawbacks need to be highlighted. The study population was not large, and the response rate was not high, which may have resulted in a selected population. Further, the major strength of the paper, the opportunity to measure deprivation

on area level, was also one of the major limitations. It can be questioned whether the NZdep actually captured contextual deprivation or if the results were more a result of the compositional effect of the socioeconomic position of the individuals living in the area. I believe that a J-shaped curve exists between area level deprivation and alcohol use. However, further research is needed to clarify explanations of my findings.

## Conclusion and implications

Whether there is social inequality in alcohol use among adolescents has been debated as previous evidence has been inconclusive and unclear. The lack of evidence raises questions such as: Is there in fact equalization in youth; when in the lifetime does social inequality in alcohol use emerges; why is there inconsistency in previous studies; and is social inequality present in consequences of early drinking onset. The findings presented in this thesis add some answers to the puzzling phenomena of social inequality in alcohol use among adolescents.

I find that social inequality in alcohol use as measured by drinking onset and binge drinking is present in the years of youth. Adolescents are subject to socially differential exposure and differential susceptibility to alcohol use. I conclude that there is social inequality in drinking onset and binge drinking among Danish adolescents at the individual level, leaving children from more affluent backgrounds at higher risk. In New Zealand, quantity of alcohol intake among youth is also socially patterned at the area level, where living in the highest deprived area is associated with highest intake of alcohol. Further, I conclude that beginning to drink at an early age is a front runner for future risk behaviour such as later binge drinking. The highest risk of binge drinking is among early drinking adolescents coming from families with high affluence. In sum, I conclude that social equalization in adolescents' alcohol use does not exist, but that the patterns are complicated and less straightforward than what is observed for other risk behaviour such as for example smoking.

In relation to future research, my findings suggest that socioeconomic factors are associated with participation in studies among adolescents, but in our study family affluence is not associated with attrition. Alcohol use is, however, associated with attrition, leaving adolescents who have tried to be drunk with a lower probability to participating in follow-up. This information is useful in planning future large data collections among adolescents. In the future, invitations to participate should be prioritised to a representative sample of the eligible population and perhaps use of passive instead of active parental consent form should be imposed. Further, to avoid large attrition researchers should be aware and include in their initially planning the massive resources that progressive reminders requires. When planning a future follow-up study in a school setting, it is important to be aware of the challenges that a school setting represents. For example, making the engagement to participate as close to the adolescents as possible, but also acknowledging the power of decision-makers, the researcher should thoroughly consider who the invitations should be sent to and who should be the contact person, for instance the health counselor in the municipality, the school principal, the school health nurse or the teacher. Further, acknowledging that participating in a follow-up

study is time consuming for participants and contact persons at schools, combined with a well planned project may results in high response rates and low attrition in future studies.

The previous inconsistent evidence on social inequality in alcohol use among adolescents may reflect differences such as: different measures of socioeconomic position and alcohol use, different demographic factors such as age groups and how sex has been included in the analyses, and different contexts. I have studied sex differences, used different measures of alcohol use in the youth years, have conducted the analyses at different levels with different data design, and have used different study populations. However, further research is still needed to try to explain the sex differences in social inequality in early drinking onset. Future studies may investigate if the association between family affluence and early drinking can be explained by different factors according to sex using mediation analyses. Additionally, to infer causality, analyses of risk factors of early drinking onset need to be conducted in a longitudinal setting. My findings suggest that early alcohol use may not have the same consequences for all socioeconomic groups. However, to provide more long-term evidence of this susceptibility for early alcohol use we need to conduct analyses with longer periods of follow-up. Further, it could be interesting to investigate if there is more pronounced susceptibility for early drinking when looking at health-related consequences, compared to the alcohol measure used in this thesis. To understand the mechanisms of how area level deprivation affects the adolescents' alcohol use, in-depth analysis of how attributes of the context affects adolescents' alcohol use is warranted. The opportunity to conduct an analysis in a large longitudinal cohort with different measures of socioeconomic position and alcohol use, for different age groups, at the individual as well as at different contextual levels, stratified by sex, in different countries, would be a future interesting study. This future study would help clarify the field further than what this thesis can attribute. Hereafter, when the evidence is clear on which social and demographic groups that are at highest risk for a risky alcohol use, designing an intervention study focusing on minimising the risky alcohol use and the social inequality in alcohol use would be important.

Causal inference, followed by public health implications based on isolated findings such as those presented in this thesis should not be drawn. Recommendations should always be based on numerous studies with convincing evidence. However, on the basis of my findings I suggest that the following public health implications should be debated and considered. To postpone drinking onset, prevention strategies should be focusing on groups of high-risk. My findings suggest these groups to be boys from affluent family backgrounds. Since categorising adolescents to be in high or low affluent groups seems easy in the data processing, it may be difficult in real life to make a clear cut-point for who is from high affluent families and hereby in a high-risk group. My findings also suggest that postponing early drinking onset is a great

tool of preventing later excessive drinking. Further, high alcohol intake is found among adolescents living in deprived areas, so in New Zealand prevention strategies should focus on adolescents living in these areas. To overcome and prevent risky alcohol behaviour such as early drinking, binge drinking and high level of alcohol intake among adolescents, there may also be a need for more general prevention strategies. Structural policy changes may be an effectful way to reach all groups of adolescents despite the affluence of their family and whether they live in a deprived area or not. Previous research has found indications that alcohol policy changes have differential effects on various population groups and consumer groups, with younger ages assumed to be more influenced.<sup>116</sup> Therefore, structural implications such as adjusting tax-level of alcohol, elevating prices of alcohol, and elevate or simply enforce the age limit for purchasing alcohol would be interesting factors to implement.

Further, to postpone early alcohol drinking and prevent excessive drinking, not only structural implications should be focused on, but interaction between schools and parents should also be recognised as important. Since in most countries schooling is compulsory and is a setting for interaction and development of peer groups, the school is a unique arena to enhance the health status of young people.<sup>117</sup> Therefore, to acknowledge that school setting is an arena where alcohol policies and intervention strategies can be carried out with beneficial effects may be important when preventing early drinking onset, binge drinking and high alcohol intake. Further, when discussing adolescents' alcohol use the role of the parents should also be acknowledged. In a new report, findings from a large British longitudinal cohort suggested that parenting style was the strongest and the only statistically significant predictor of whether the adolescent would drink excessively at age 16.<sup>118</sup> My findings that adolescents' alcohol use is associated with *family* affluence also recognize the importance of parental influence when preventing risky alcohol behaviour such as early drinking onset and later binge drinking. I suggest that in relation to early drinking onset, binge drinking and high alcohol intake high-risk strategies focusing on boys from affluent families as well as adolescents from New Zealand living in deprived areas should be implemented. However, it could be in combination with more general strategies such as elevating prices, reduce the accessibility and enforcing the purchase age limit, that has been recommended by the Danish Commission on Prevention.<sup>119</sup> Further, evidence-based school interventions as well as imposing the role of the parents are also general strategies that could be enforced. Using different approaches in different arenas seems to be an indispensable starting point when discussing future prevention strategies in relation to adolescents' alcohol use.

## English summary

**Introduction:** For several decades it has been debated whether social inequality in health and health behaviour exists among adolescents. Numerous studies have found social inequality in health behaviour to be present among adolescents with adolescents adopting adult behaviours: adolescents from lower socioeconomic groups have more health issues and greater prevalence of risk behaviours. However, other studies have found no clear socioeconomic pattern in adolescents' health and health behaviours. When it comes to social inequality in alcohol use the findings have been even more inconclusive than for other health behaviours, especially among adolescents.

**Aim:** The overall aim of the thesis was to add scientific epidemiological evidence about alcohol use among adolescents focusing on the important aspects of early drinking onset. Since early drinking onset is associated with future heavy drinking and alcohol-related problems, and hereby is proximal in the causal chain of future alcohol misuse, it was of special interest to investigate early drinking onset and do research in social inequality in relation to adolescents' drinking onset. Other alcohol measures such as binge drinking, quantity and frequency of adolescents' alcohol intake were also touched upon.

**Material:** Three of the papers (paper I, II, and III) were based on data from the Danish Youth Cohort, while paper IV was based on data from the New Zealand Alcohol Survey 2004. The Danish Youth Cohort is a longitudinal cohort where person-related information was obtained. Participants in the Danish Youth Cohort were recruited from the total population of 7th graders in Danish schools. The adolescents were sampled in clusters of classes, with schools as the sampling units. A total of 1,945 schools were eligible and invited, out of which a total of 506 schools and 12,498 students participated at baseline in 2005 (mean age: 13.4 years). The New Zealand Alcohol Survey is a national survey of alcohol use in New Zealand. The sample covered the whole of New Zealand and comprised a total of 1,828 respondents aged 12-19 years.

**Methods:** For information on non-participants, participants born in 1991 were compared with adolescents born in 1991 who did not participate in The Danish Youth Cohort by selected socio-demographic factors through registries from Statistics Denmark. In this article (Paper I) logistic regression was conducted to obtain odds ratios for participation and attrition. Multilevel logistic regressions with random effects on both school and school class levels were used to calculate odds ratios of early drinking onset according to family affluence (Paper II) and of binge drinking according to early drinking onset (Paper III). Multilevel linear regressions with random effects on geographical areas were conducted to analyse the associations between area level deprivation and quantity and frequency of alcohol intake, respectively (Paper IV).

Results: The main results in the thesis were: Socioeconomic factors were associated with participation at baseline in the Danish Youth Cohort, though attrition was not associated with family affluence. Social inequality in drinking onset was present among Danish boys: those at most risk of early drinking onset were boys from the most affluent families, while there were no social differences in early drinking onset among girls. Early drinking onset was associated with binge drinking at age 15. The strength of the association varied across groups of family affluence; those at highest risk of binge drinking, were adolescents that initiated alcohol use early and came from families with high affluence. A J-shaped association was observed between area level deprivation and quantity of adolescents' alcohol use in New Zealand. No association between area level deprivation and frequency of drinking was seen.

Conclusion: On the basis of this thesis, I conclude social inequality in alcohol use already emerge in the youth years, that differential exposure and differential susceptibility may be important mechanisms in how socioeconomic position is associated with alcohol use, and that social inequality in alcohol use among adolescents not only exist at individual level, but also exist at area level at least in New Zealand. Further I conclude that beginning to drink at an early age is a front runner for future risk behaviour such as later binge drinking.

## Danish summary

Dansk titel: Epidemiologiske studier om unge og alkohol – med fokus på social ulighed

Introduktion: I flere årtier har det været debatteret om der er social ulighed i unges sundhedsadfærd og sundhed. Flere studier har fundet, at der er social ulighed i sundhedsadfærd blandt unge, hvor de unge adopterer de voksnes adfærd: unge fra lav socioøkonomisk gruppe har flere sundhedsproblemer og en større prævalens af risikoadfærd. Andre studier har derimod ikke fundet nogen klar socioøkonomisk tendens i unges sundhed og sundhedsadfærd. Evidensen er specielt uklar vedrørende alkoholadfærd. Det overordnede formål med denne afhandling var at generere mere epidemiologisk evidens indenfor området unge og alkohol. Det er specielt interessant at fokusere på tidlig alkoholdebut og social ulighed i tidlig alkoholdebut, fordi tidlig alkoholdebut er associeret med fremtidigt højt alkoholforbrug, hvormed tidlig alkoholdebut er i begyndelsen af den kausale kæde for senere alkoholmisbrug. Andre alkohol mål såsom binge drinkning, kvantiteten og frekvensen af alkoholindtag indgår dog også i afhandlingen.

Materiale: Tre af artiklerne (Artikel I, II og III) var baseret på data fra Unges hverdag (the Danish Youth Cohort), og artikel IV var baseret på data fra the New Zealand Alcohol Survey 2004. Unges hverdag er en longitudinel kohorte, hvor der er indsamlet personrelateret information. Deltagerne i Unges hverdag blev udvalgt fra den alle 7. klasser fra danske skoler. Informationen fra de unge blev indsamlet i klynger af skoleklasser indenfor de deltagende skoler. Der var 1.945 skoler som blev inviteret, hvoraf 506 skoler, som inkluderede 12.498 elever, deltog i baselineundersøgelsen i 2005 (gennemsnitsalderen var 13,4 år). The New Zealand Alcohol Survey 2004 er en national befolkningsundersøgelse af alkoholvaner i New Zealand. Deltagerne var fra hele New Zealand og bestod af 1.828 deltagere i alderen 12-19 år.

Metode: For at få information om personer der ikke deltog i Unges hverdag blev deltagere, der var født i 1991, sammenlignet på forskellige socio-demografiske faktorer med personer, der var født i 1991 som ikke deltog ved opkobling til registre fra Danmarks Statistik. I den artikel (Artikel I) blev logistisk regression benyttet til at få odds ratios for deltagelse og for manglende opfølgning. Multilevel logistisk regression med random effekt på både skoleklasse og skole niveau blev benyttet til at beregne odds ratios for tidlig alkoholdebut givet familiens materielle velstand (Artikel II) og for binge drinkning givet tidlig alkoholdebut (Artikel III). Multilevel lineær regression med random effekter på geografiske områder blev benyttet til at undersøge sammenhængen mellem områdedeprivation og henholdsvis kvantiteten og frekvensen af alkoholindtag (Artikel IV).

Resultater: Hovedresultaterne fra afhandlingen var: Socioøkonomiske faktorer var associeret med deltagelse ved baselineundersøgelsen i Unges hverdag, hvorimod opfølgning ikke var associeret med familiens materielle velstand. Der var social ulighed i alkoholdebut blandt drengene: drenge fra de mest velstillede familier havde højest risiko for at starte tidligt med at drikke, mens der ikke var socioøkonomiske forskelle i tidlig alkoholdebut blandt piger. Tidlig alkoholdebut var associeret med binge drinkning ved alder 15. Størrelsen på associationen varierede mellem grupper af familiens materielle velstand, hvor dem med højest risiko for binge drinkning, var unge der var startet tidligt med at drikke og som kom fra en familie med høj materiel velstand. Sammenhængen mellem områdedeprivation og kvantiteten af unges alkoholindtag var J-formet i New Zealand. Der var ingen association mellem områdedeprivation og frekvensen af alkoholindtag.

Konklusion: På baggrund af denne afhandling konkluderer jeg, at der ikke er nogen social udligning i unges alkoholadfærd, hvilket betyder at den sociale ulighed i alkohol allerede opstår i ungdomsårene, at differentiell eksponering og differentiell sårbarhed kan være vigtige mekanismer for hvordan socioøkonomisk position er relateret til alkoholadfærd, og at social ulighed i alkoholindtag blandt unge ikke kun er til stede på individniveau, men også eksisterer på kontekstuel niveau. Ydermere konkluderer jeg, at det at begynde at drikke tidligt, er en forløber for en fremtidig risikofyldt adfærd såsom binge drinkning.

---

## Reference list

- (1) Masten AS, Faden VB, Zucker RA, Spear LP. Underage drinking: a developmental framework. *Pediatrics* 2008; 121 Suppl 4:S235-S251.
- (2) Kleinert S. Adolescent health: an opportunity not to be missed. *Lancet* 2007; 369(9567):1057-1058.
- (3) Currie C, Nic Gabhain S, Godeau E, Roberts C, Smith R, Currie D et al. Inequalities in young people's health: HBSC international report from the 2005/2006 Survey. 2008. Copenhagen, World Health Organisation.
- (4) Hibell B, Guttormsson U, Ahlström S, Balakireva O, Bjarnason T, Kokkevi A et al. The 2007 ESPAD report - Substance Use among Students in 35 European Countries. 2009. Stockholm.
- (5) Rasmussen M, Due P, (ED). Skolebørnsundersøgelsen 2010 [Health Behaviour in School-aged Children Suvery 2010]. Rasmussen M, Due P, (ED), editors. 2011. Copenhagen, National Institute of Public Health, University of Southern Denmark.
- (6) Kuntsche E, Kuntsche S, Knibbe R, Simons-Morton B, Farhat T, Hublet A et al. Cultural and gender convergence in adolescent drunkenness: evidence from 23 European and North American countries. *Arch Pediatr Adolesc Med* 2011; 165(2):152-158.
- (7) Vereecken CA, Inchley J, Subramanian SV, Hublet A, Maes L. The relative influence of individual and contextual socio-economic status on consumption of fruit and soft drinks among adolescents in Europe. *Eur J Public Health* 2005; 15(3):224-232.
- (8) Tuinstra J, Groothoff JW, van den Heuvel WJ, Post D. Socio-economic differences in health risk behavior in adolescence: do they exist? *Soc Sci Med* 1998; 47(1):67-74.
- (9) West P. Health inequalities in the early years: is there equalisation in youth? *Soc Sci Med* 1997; 44(6):833-858.
- (10) Bloomfield K, Grittner U, Rasmussen HB, Petersen HC. Socio-demographic correlates of alcohol consumption in the Danish general population. *Scand J Public Health* 2008; 36(6):580-588.
- (11) Hanson MD, Chen E. Socioeconomic status and health behaviors in adolescence: a review of the literature. *J Behav Med* 2007; 30(3):263-285.
- (12) Kraus L, Bloomfield K, Augustin R, Reese A. Prevalence of alcohol use and the association between onset of use and alcohol-related problems in a general population sample in Germany. *Addiction* 2000; 95(9):1389-1401.
- (13) Prescott CA, Kendler KS. Age at first drink and risk for alcoholism: a noncausal association. *Alcohol Clin Exp Res* 1999; 23(1):101-107.

- (14) Pitkanen T, Lyyra AL, Pulkkinen L. Age of onset of drinking and the use of alcohol in adulthood: a follow-up study from age 8-42 for females and males. *Addiction* 2005; 100(5):652-661.
- (15) Grant BF, Stinson FS, Harford TC. Age at onset of alcohol use and DSM-IV alcohol abuse and dependence: a 12-year follow-up. *J Subst Abuse* 2001; 13(4):493-504.
- (16) Diderichsen F, Evans T, Whitehead M. The Social Basis of Disparities in Health. In: Evans T, Whitehead M, Diderichsen F, Bhuiya A, Wirth M, editors. *Challenging inequities in health. From ethics to action*. Oxford: Oxford University Press; 2001. 13-23.
- (17) West P, Sweeting H. *A Review of Young People's Health and Health Behaviours in Scotland*. 2002. Glasgow, MRC Social & Public Health Sciences Unit.
- (18) Richter M, Leppin A, Nic GS. The relationship between parental socio-economic status and episodes of drunkenness among adolescents: findings from a cross-national survey. *BMC Public Health* 2006; 6:289.
- (19) Verburg JA, Toet J, van Ameijden EJ. Smoking, alcohol and drug use in Utrecht, The Netherlands, risk groups and socioeconomic differences in 1999 and 2003. *Ned Tijdschr Geneesk* 2005; 149(38):2113-2118.
- (20) Neufeld KJ, Peters DH, Rani M, Bonu S, Brooner RK. Regular use of alcohol and tobacco in India and its association with age, gender, and poverty. *Drug Alcohol Depend* 2005; 77(3):283-291.
- (21) Casswell S, Pledger M, Hooper R. Socioeconomic status and drinking patterns in young adults. *Addiction* 2003; 98(5):601-610.
- (22) Droomers M, Schrijvers CT, Casswell S, Mackenbach JP. Occupational level of the father and alcohol consumption during adolescence; patterns and predictors. *J Epidemiol Community Health* 2003; 57(9):704-710.
- (23) Richter M, Vereecken CA, Boyce W, Maes L, Gabhainn SN, Currie CE. Parental occupation, family affluence and adolescent health behaviour in 28 countries. *Int J Public Health* 2009; 54(4):203-212.
- (24) Goodman E, Huang B. Socioeconomic status, depressive symptoms, and adolescent substance use. *Arch Pediatr Adolesc Med* 2002; 156(5):448-453.
- (25) Due P, Holstein B. Alkoholforbrug og sociale faktorer blandt 11-15 årige [Alcohol Consumption and Social Factors among 11-15 year old]. *Nordisk Psykologi* 1991; 43(4).
- (26) Wium-Andersen MK, Wium-Andersen IK, Becker U, Thomsen SF. Alkoholdebutalderen hos 7-18-årige unge [Onset of alcohol consumption in 7-18-year-old children and adolescents]. *Ugeskr Laeger* 2009; 171(46):3345-3349.
- (27) Wagner FA, Velasco-Mondragon HE, Herrera-Vazquez M, Borges G, Lazcano-Ponce E. Early alcohol or tobacco onset and transition to other drug use among students in the state of Morelos, Mexico. *Drug Alcohol Depend* 2005; 77(1):93-96.

- 
- (28) DuRant RH, Smith JA, Kreiter SR, Krowchuk DP. The relationship between early age of onset of initial substance use and engaging in multiple health risk behaviors among young adolescents. *Arch Pediatr Adolesc Med* 1999; 153(3):286-291.
- (29) Hingson RW, Assailly JP, Williams AF. Underage drinking: frequency, consequences, and interventions. *Traffic Inj Prev* 2004; 5(3):228-236.
- (30) Gruber E, DiClemente RJ, Anderson MM, Lodico M. Early drinking onset and its association with alcohol use and problem behavior in late adolescence. *Prev Med* 1996; 25(3):293-300.
- (31) Rothman EF, DeJong W, Palfai T, Saitz R. Relationship of age of first drink to alcohol-related consequences among college students with unhealthy alcohol use. *Subst Abuse* 2008; 29(1):33-41.
- (32) Komro KA, Tobler AL, Maldonado-Molina MM, Perry CL. Effects of alcohol use initiation patterns on high-risk behaviors among urban, low-income, young adolescents. *Prev Sci* 2010; 11(1):14-23.
- (33) Hingson R, Heeren T, Zakocs R, Winter M, Wechsler H. Age of first intoxication, heavy drinking, driving after drinking and risk of unintentional injury among U.S. college students. *J Stud Alcohol* 2003; 64(1):23-31.
- (34) Hingson R, Heeren T, Levenson S, Jamanka A, Voas R. Age of drinking onset, driving after drinking, and involvement in alcohol related motor-vehicle crashes. *Accid Anal Prev* 2002; 34(1):85-92.
- (35) Hingson RW, Heeren T, Jamanka A, Howland J. Age of drinking onset and unintentional injury involvement after drinking. *JAMA* 2000; 284(12):1527-1533.
- (36) Hingson R, Heeren T, Winter MR, Wechsler H. Early age of first drunkenness as a factor in college students' unplanned and unprotected sex attributable to drinking. *Pediatrics* 2003; 111(1):34-41.
- (37) Tennant FS, Jr., Detels R. Relationship of alcohol, cigarette, and drug abuse in adulthood with alcohol, cigarette and coffee consumption in childhood. *Prev Med* 1976; 5(1):70-77.
- (38) Hingson RW, Heeren T, Edwards EM. Age at drinking onset, alcohol dependence, and their relation to drug use and dependence, driving under the influence of drugs, and motor-vehicle crash involvement because of drugs. *J Stud Alcohol Drugs* 2008; 69(2):192-201.
- (39) Pedersen W, Skrandal A. Alcohol consumption debut: predictors and consequences. *J Stud Alcohol* 1998; 59(1):32-42.
- (40) Fergusson DM, Horwood LJ, Lynskey MT. The prevalence and risk factors associated with abusive or hazardous alcohol consumption in 16-year-olds. *Addiction* 1995; 90(7):935-946.

- 
- (41) Kuntsche E, van d, V, Engels R. The earlier the more? Differences in the links between age at first drink and adolescent alcohol use and related problems according to quality of parent-child relationships. *J Stud Alcohol Drugs* 2009; 70(3):346-354.
- (42) Andersen A, Due P, Holstein BE, Iversen L. Tracking drinking behaviour from age 15-19 years. *Addiction* 2003; 98(11):1505-1511.
- (43) O'Grady KE, Arria AM, Fitzelle DM, Wish ED. Heavy Drinking and Polydrug Use among College Students. *J Drug Issues* 2008; 38(2):445-466.
- (44) Vieira DL, Ribeiro M, Laranjeira R. Evidence of association between early alcohol use and risk of later problems. *Rev Bras Psiquiatr* 2007; 29(3):222-227.
- (45) Kypri K, Paschall MJ, Langley J, Baxter J, Cashell-Smith M, Bourdeau B. Drinking and alcohol-related harm among New Zealand university students: findings from a national Web-based survey. *Alcohol Clin Exp Res* 2009; 33(2):307-314.
- (46) Warner LA, White HR. Longitudinal effects of age at onset and first drinking situations on problem drinking. *Subst Use Misuse* 2003; 38(14):1983-2016.
- (47) Hawkins JD, Graham JW, Maguin E, Abbott R, Hill KG, Catalano RF. Exploring the effects of age of alcohol use initiation and psychosocial risk factors on subsequent alcohol misuse. *J Stud Alcohol* 1997; 58(3):280-290.
- (48) Eliassen M, Kaer SK, Munk C, Nygard M, Sparen P, Tryggvadottir L et al. The relationship between age at drinking onset and subsequent binge drinking among women. *Eur J Public Health* 2009; 19(4):378-382.
- (49) Kuendig H, Plant ML, Plant MA, Kuntsche S, Miller P, Gmel G et al. Beyond drinking: differential effects of demographic and socioeconomic factors on alcohol-related adverse consequences across European countries. *Eur Addict Res* 2008; 14(3):150-160.
- (50) Makela P, Paljarvi 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.
- (51) Marmot M. Social determinants of health inequalities. *Lancet* 2005; 365(9464):1099-1104.
- (52) Pickett KE, Pearl M. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *J Epidemiol Community Health* 2001; 55(2):111-122.
- (53) Macintyre S, Ellaway A, Cummins S. Place effects on health: how can we conceptualise, operationalise and measure them? *Soc Sci Med* 2002; 55(1):125-139.
- (54) Stimpson JP, Ju H, Raji MA, Eschbach K. Neighborhood deprivation and health risk behaviors in NHANES III. *Am J Health Behav* 2007; 31(2):215-222.

- 
- (55) Galea S, Ahern J, Tracy M, Vlahov D. Neighborhood income and income distribution and the use of cigarettes, alcohol, and marijuana. *Am J Prev Med* 2007; 32(6 Suppl):S195-S202.
- (56) Galea S, Ahern J, Tracy M, Rudenstine S, Vlahov D. Education inequality and use of cigarettes, alcohol, and marijuana. *Drug Alcohol Depend* 2007; 90 Suppl 1:S4-15.
- (57) Karriker-Jaffe KJ. Areas of disadvantage: a systematic review of effects of area-level socioeconomic status on substance use outcomes. *Drug Alcohol Rev* 2011; 30(1):84-95.
- (58) Breslin FC, Adlaf EM. Part-time work and adolescent heavy episodic drinking: the influence of family and community context. *J Stud Alcohol* 2005; 66(6):784-794.
- (59) Ecob R, Macintyre S. Small area variations in health related behaviours; do these depend on the behaviour itself, its measurement, or on personal characteristics? *Health Place* 2000; 6(4):261-274.
- (60) Song EY, Reboussin BA, Foley KL, Kaltenbach LA, Wagoner KG, Wolfson M. Selected community characteristics and underage drinking. *Subst Use Misuse* 2009; 44(2):179-194.
- (61) Karvonen S, Rimpela A. Socio-regional context as a determinant of adolescents' health behaviour in Finland. *Soc Sci Med* 1996; 43(10):1467-1474.
- (62) Lo CC, Anderson AS, Minugh PA, Lomuto N. Protecting Alabama Students From Alcohol and Drugs: A Multi-Level Modeling Approach. *J Drug Issues* 2006; 36:687-718.
- (63) Trim RS, Chassin L. Neighborhood socioeconomic status effects on adolescent alcohol outcomes using growth models: exploring the role of parental alcoholism. *J Stud Alcohol Drugs* 2008; 69(5):639-648.
- (64) Reboussin BA, Preisser JS, Song EY, Wolfson M. Geographic clustering of underage drinking and the influence of community characteristics. *Drug Alcohol Depend* 2010; 106(1):38-47.
- (65) Currie C, Roberts C, Morgan A, Smith R, Settertoboulte W, Rasmussen OSVB. Young people's health in context. *Health Behaviour in School-aged Children (HBSC) study: international report from the 2001/2002 survey*. Candace Currie CRAMRSWSOSVBR, editor. 2004. Copenhagen, WHO Regional Office for Europe.
- (66) Hibell B, Andersson B, Bjarnason T, Ahlström S, Balakireva O, Kokkevi A et al. The ESPAD Report 2003. Alcohol and Other Drug Use Among Students in 35 European Countries. 2004. Stockholm, The Swedish Council for Information on Alcohol and Other Drugs (CAN) and the Pompidou Group at the Council of Europe.
- (67) Statistics New Zealand. Household Economic Survey: Year ended 30 June 2004. [http://www stats census2006 govt nz/browse\\_for\\_stats/people\\_and\\_communities /Households/HouseholdsEconomicSurvey\\_HOTPYJun04](http://www.stats.govt.nz/browse_for_stats/people_and_communities/Households/HouseholdsEconomicSurvey_HOTPYJun04), 2009
- (68) Huckle T, You RQ, Casswell S. Increases in quantities consumed in drinking occasions in New Zealand 1995-2004. *Drug Alcohol Rev* 2011; 30(4):366-371.

- 
- (69) Casswell S, Huckle T, Pledger M. Survey data need not underestimate alcohol consumption. *Alcohol Clin Exp Res* 2002; 26(10):1561-1567.
- (70) Currie C, Molcho M, Boyce W, Holstein B, Torsheim T, Richter M. Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. *Soc Sci Med* 2008; 66(6):1429-1436.
- (71) Salmond C, Crampton P, King P, Waldegrave C. NZiDep: a New Zealand index of socioeconomic deprivation for individuals. *Soc Sci Med* 2006; 62(6):1474-1485.
- (72) Greenland S, Pearl J, Robins JM. Causal diagrams for epidemiologic research. *Epidemiology* 1999; 10(1):37-48.
- (73) Goldstein H. *Multilevel Statistics Model*. London: Wiley; 2002.
- (74) Kawachi I, Berkman L (ED). *Neighborhoods and Health*. Oxford: Oxford University Press; 2003.
- (75) Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ* 2009; 338:b2393.
- (76) Yuan Y. *Multiple Imputation for Missing Data: Concepts and New Development*. 2005. Rockville, SAS Institute Inc.
- (77) Tolonen H, Dobson A, Kulathinal S. Effect on trend estimates of the difference between survey respondents and non-respondents: results from 27 populations in the WHO MONICA Project. *Eur J Epidemiol* 2005; 20(11):887-898.
- (78) Jousilahti P, Salomaa V, Kuulasmaa K, Niemela M, Vartiainen E. Total and cause specific mortality among participants and non-participants of population based health surveys: a comprehensive follow up of 54 372 Finnish men and women. *J Epidemiol Community Health* 2005; 59(4):310-315.
- (79) Tjonneland A, Olsen A, Boll K, Stripp C, Christensen J, Engholm G et al. Study design, exposure variables, and socioeconomic determinants of participation in Diet, Cancer and Health: a population-based prospective cohort study of 57,053 men and women in Denmark. *Scand J Public Health* 2007; 35(4):432-441.
- (80) Sonne-Holm S, Sorensen TI, Jensen G, Schnohr P. Influence of fatness, intelligence, education and sociodemographic factors on response rate in a health survey. *J Epidemiol Community Health* 1989; 43(4):369-374.
- (81) Drivsholm T, Eplov LF, Davidsen M, Jorgensen T, Ibsen H, Hollnagel H et al. Representativeness in population-based studies: a detailed description of non-response in a Danish cohort study. *Scand J Public Health* 2006; 34(6):623-631.
- (82) Thygesen LC, Johansen C, Keiding N, Giovannucci E, Gronbaek M. Effects of sample attrition in a longitudinal study of the association between alcohol intake and all-cause mortality. *Addiction* 2008; 103(7):1149-1159.

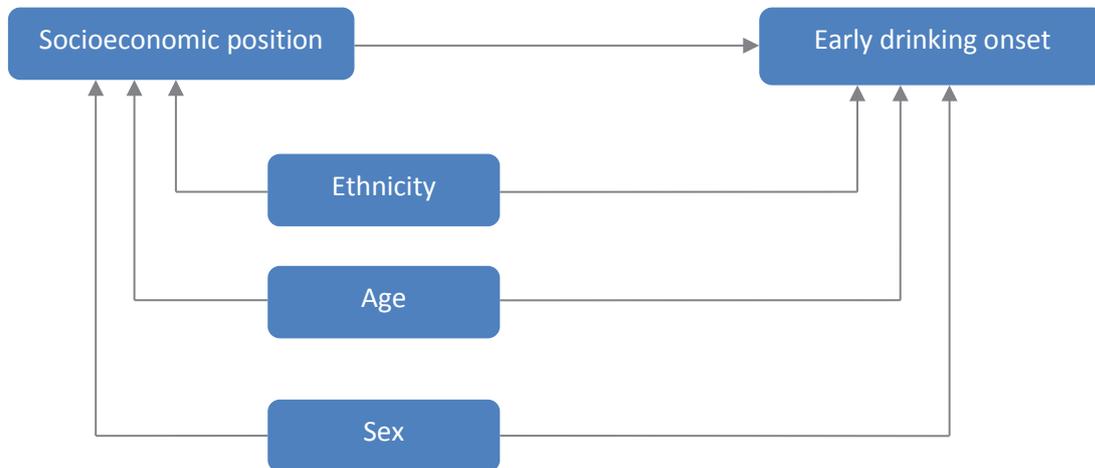
- 
- (83) Droomers M, Schrijvers CT, Stronks K, van de Mheen D, Mackenbach JP. Educational differences in excessive alcohol consumption: the role of psychosocial and material stressors. *Prev Med* 1999; 29(1):1-10.
- (84) Lintonen T, Rimpela M, Vikat A, Rimpela A. The effect of societal changes on drunkenness trends in early adolescence. *Health Educ Res* 2000; 15(3):261-269.
- (85) Huselid RF, Cooper ML. Gender roles as mediators of sex differences in adolescent alcohol use and abuse. *J Health Soc Behav* 1992; 33(4):348-362.
- (86) Macintyre S, Hunt K. Socio-economic Position, Gender and Health - How do they interact. *Journal of Health Psychology* 1997; 2(3):315-334.
- (87) Schnohr CW, Kreiner S, Due EP, Currie C, Boyce W, Diderichsen F. Differential Item Functioning of a Family Affluence Scale: Validation Study on Data from HBSC 2001/02. *Social Indicators Research* 2008; 89(1):79-95.
- (88) Simons-Morton BG, Farhat T, ter Bogt TF, Hublet A, Kuntsche E, Nic GS et al. Gender specific trends in alcohol use: cross-cultural comparisons from 1998 to 2006 in 24 countries and regions. *Int J Public Health* 2009; 54 Suppl 2:199-208.
- (89) Schmidt LA, Mäkelä P, Rehm J, Room R. Alcohol: equity and social determinants. In: Blass E, Kurup AS, editors. *Equity, social determinants and public health programmes*. 2010.
- (90) Huckle T, Huakau J, Sweetsur P, Huisman O, Casswell S. Density of alcohol outlets and teenage drinking: living in an alcogenic environment is associated with higher consumption in a metropolitan setting. *Addiction* 2008; 103(10):1614-1621.
- (91) National Institute of Public Health, The Danish National Board of Health. *Sundhedsprofil 2010 [The Danish Health Interview Survey 2010 database]*. [www.sundhedsprofil2010.dk/Pages/Home.aspx](http://www.sundhedsprofil2010.dk/Pages/Home.aspx) [ 2011
- (92) Hay GC, Whigham PA, Kypri K, Langley JD. Neighbourhood deprivation and access to alcohol outlets: a national study. *Health Place* 2009; 15(4):1086-1093.
- (93) Stock C, Ejstrud B, Vinther-Larsen M, Schlattmann P, Curtis T, Gronbaek M et al. Effects of school district factors on alcohol consumption: results of a multi-level analysis among Danish adolescents. *Eur J Public Health* 2011; 21(4):449-455.
- (94) Huckle T. *Alcohol Use in New Zealand - Key results of the 2004 New Zealand Health Behaviours Survey – Alcohol Use*. 2007. Wellington, New Zealand, Ministry of Health.
- (95) Gmel G, Rylett M. *Consumption. Global status report on alcohol and health*. Geneva: World Health Organisation; 2011. 2-19.
- (96) International Center for Alcohol Policies (ICAP). *Minimum Age Limits Worldwide*. [www.icap.org/table/minimumagelimitsworldwide](http://www.icap.org/table/minimumagelimitsworldwide) [ 2010
- (97) West P, Sweeting H. Evidence on equalisation in health in youth from the West of Scotland. *Soc Sci Med* 2004; 59(1):13-27.

- 
- (98) Due P, Lynch J, Holstein B, Modvig J. Socioeconomic health inequalities among a nationally representative sample of Danish adolescents: the role of different types of social relations. *J Epidemiol Community Health* 2003; 57(9):692-698.
- (99) Rothman J, Greenland S. *Modern Epidemiology*. Washington: Lippincott-Raven Publishers; 1998.
- (100) Morton LM, Cahill J, Hartge P. Reporting participation in epidemiologic studies: a survey of practice. *Am J Epidemiol* 2006; 163(3):197-203.
- (101) De Leeuw ED, De Heer W. Trends in household survey nonresponse: A longitudinal and international comparison. In: Groves RM, Dillman DA, Eltinge JL, Little RJA, editors. *Survey nonresponse*. New York: Wiley; 2002. 41-54.
- (102) Kjoller M, Thoning H. Characteristics of non-response in the Danish Health Interview Surveys, 1987-1994. *Eur J Public Health* 2005; 15(5):528-535.
- (103) Rasmussen M, Due P, (ED). *Skolebørnsundersøgelsen 2006 [Health Behaviour in School-aged Children Survey 2006]*. 2007. Copenhagen, Institut of Public Health, University of Copenhagen.
- (104) Raghunathan TE. What do we do with missing data? Some options for analysis of incomplete data. *Annu Rev Public Health* 2004; 25:99-117.
- (105) Baadsgaard M, Quitzau J. Danish registers on personal income and transfer payments. *Scand J Public Health* 2011; 39(7 Suppl):103-105.
- (106) Petersson F, Baadsgaard M, Thygesen LC. Danish registers on personal labour market affiliation. *Scand J Public Health* 2011; 39(7 Suppl):95-98.
- (107) Andersen D. Fik vi svar på det vi spurgte om? [Were the questions answered?]. In: Andersen D, Ottosen M, editors. *Børn som respondenter [Children as respondents]*. Copenhagen: The Danish National Institute of Social Research; 2002.
- (108) Currie CE, Elton RA, Todd J, Platt S. Indicators of socioeconomic status for adolescents: the WHO Health Behaviour in School-aged Children Survey. *Health Educ Res* 1997; 12(3):385-397.
- (109) Andersen A, Krolner R, Currie C, Dallago L, Due P, Richter M et al. High agreement on family affluence between children's and parents' reports: international study of 11-year-old children. *J Epidemiol Community Health* 2008; 62(12):1092-1094.
- (110) Blakely T, Pearce N. Socio-economic position is more than just NZDep. *N Z Med J* 2002; 115(1149):109-111.
- (111) Gronbaek M, Heitmann BL. Validity of self-reported intakes of wine, beer and spirits in population studies. *Eur J Clin Nutr* 1996; 50(7):487-490.
- (112) Koning I, Harakeh Z, Engels R, Vollebergh W. A comparison of self-reported alcohol use measures by early adolescents: Questionnaires versus diary. *Journal of Substance Use* 2010; 15(3):166-173.

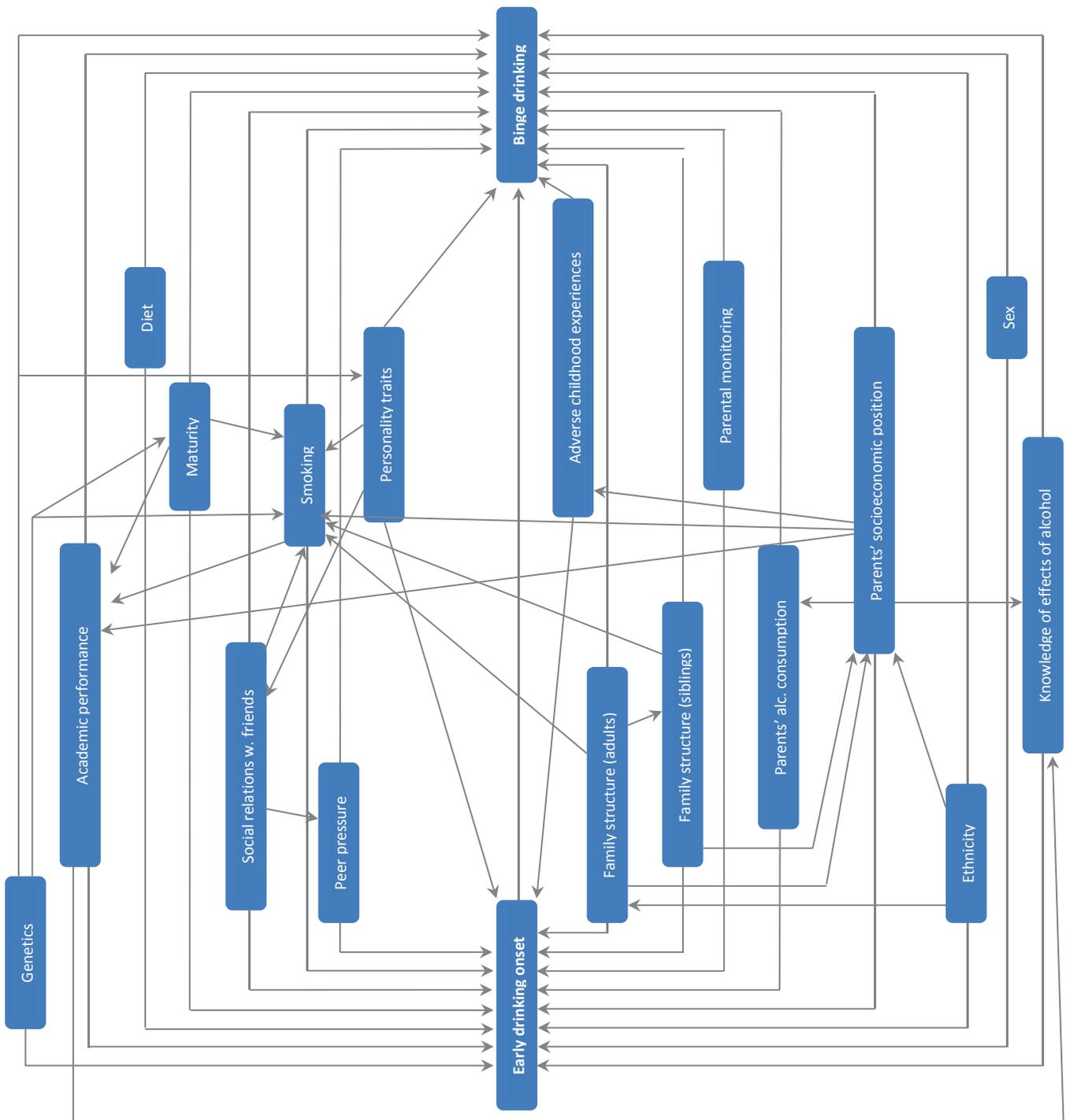
- 
- (113) Hagger-Johnson G. Alcohol in Use in Youth (Survey Question Bank, Topic Overview 3). 1-12. 2011. United Kingdom, UK Data Archive, University of Leeds.
- (114) Social and Health Outcomes Research and Evaluation (SHORE). Comparing survey data with taxable alcohol. 2006. Auckland, SHORE, Massey University.
- (115) Lien N, Friestad C, Klepp KI. Adolescents' proxy reports of parents' socioeconomic status: How valid are they? *J Epidemiol Community Health* 2001; 55(10):731-737.
- (116) Bloomfield K, Rossow I, Norstrom T. Changes in alcohol-related harm after alcohol policy changes in Denmark. *Eur Addict Res* 2009; 15(4):224-231.
- (117) Maes L, Lievens J. Can the school make a difference? A multilevel analysis of adolescent risk and health behaviour. *Soc Sci Med* 2003; 56(3):517-529.
- (118) Bartlett J, Grist M, Hahn B. "Binge-drinking behind the headlines..." - under the influence. 2011. London, Demos.
- (119) Forebyggelseskommissionen [Commission for Prevention]. Vi kan leve længere og sundere - forebyggelseskommissionens anbefalinger til en styrket forebyggende indsats [We can live longer and healthier]. 2009. Copenhagen, Forebyggelseskommissionen [Commission for Prevention].

## Appendix

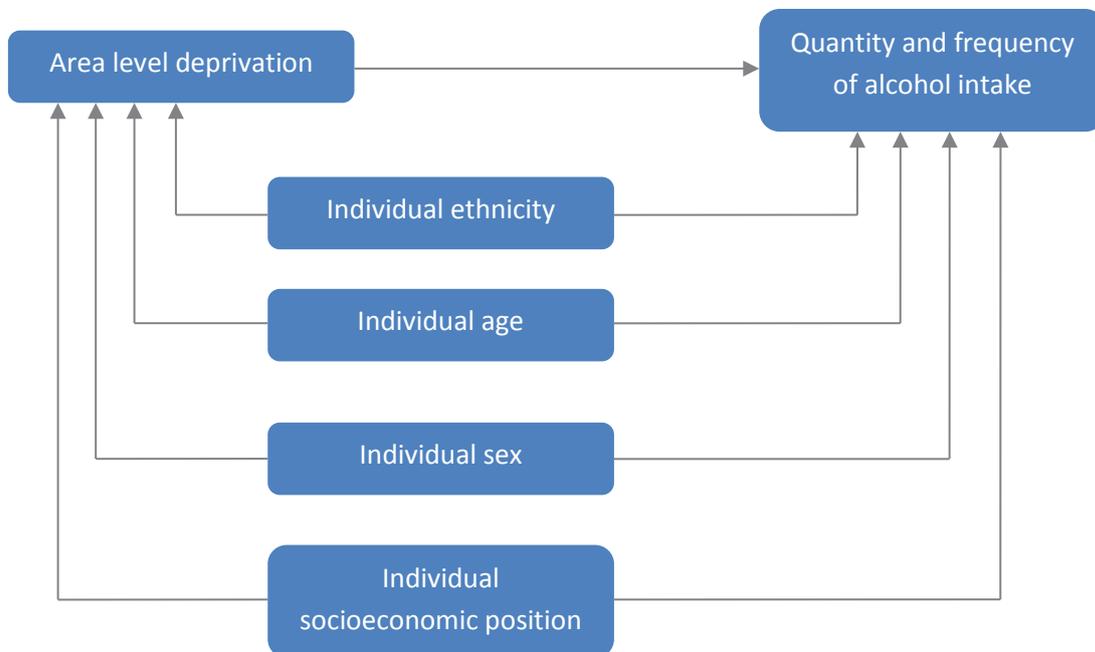
Causal diagram for the association between socioeconomic position and early drinking onset



Causal diagram for the association between early drinking onset and binge drinking



Causal diagram for the association between area level deprivation and alcohol intake



## Paper I-IV



## Paper I

### **Erratum for Paper I**

Errors in table 2:

Prevalence of have ever tried to be drunk is not correct. The correct prevalence is 20.5% for boys and 17.0% for girls. The prevalence presented in Paper I is for have ever tried feeling an effect of drinking alcohol.





STUDY DESIGN ARTICLE

## The Danish Youth Cohort: Characteristics of participants and non-participants and determinants of attrition

MATHILDE VINTHER-LARSEN<sup>1</sup>, METTE RIEGELS<sup>1</sup>, MORTEN HULVEJ ROD<sup>1</sup>,  
MICHAELA SCHIØTZ<sup>2</sup>, TINE CURTIS<sup>1</sup> & MORTEN GRØNBÆK<sup>1</sup>

<sup>1</sup>National Institute of Public Health, University of Southern Denmark, Copenhagen, Denmark, and <sup>2</sup>Institute of Public Health, University of Copenhagen, Copenhagen, Denmark

### Abstract

**Aims:** The aim of this paper is to describe the design and methods used in the Danish Youth Cohort and to give a description of the study participants with special attention to a comparison between participants and non-participants regarding socio-demographic characteristics. **Methods:** A total of 1,945 schools were invited, out of which 506 participated. The participating 7th grades comprised a total of 12,498 responding adolescents. The response rate for the Danish Youth Cohort established in 2005 was 63%. The sample of 12,498 adolescents represents 18.2% of all pupils ( $n = 68,764$ ) in the 7th grade (mean age: 13.4 years) in Danish schools in 2005. The cohort was followed up in spring 2006 and spring 2007, where the adolescents were in the 8th (mean age: 14.4 years) and 9th (mean age: 15.3 years) grades, respectively. **Results:** We found that compared with non-participants the participants were significantly more likely to be girls, to be of Danish ethnicity, and to live in one-family houses. Furthermore, participants more often came from families with two or three children, were more likely to have parents with a high occupational status, parents who were married and parents with a higher total income. Loss to follow-up was only associated with adolescents' higher probability of drinking and use of tobacco, and none of the other factors were associated with attrition. **Conclusions:** The participants in the Danish Youth Cohort represent a great variety of different groups of socio-demographic factors, although they differ from non-participants as regards a range of socio-demographic factors. This should be taken into account in future analyses.

**Key Words:** Adolescents, alcohol, participation, representativity, study design

### Background

The Danish Youth Cohort (DYC) is a recently established longitudinal cohort focusing on public health and social science issues. It was designed and established with the particular aim of identifying determinants and consequences of early drinking onset and problematic drinking among adolescents. However, the cohort also aims at addressing research questions in other scientific areas within health and lifestyles among adolescents.

The need for knowledge about non-participants has become of special importance in recent years. Over the years, decreasing rates of participation have been reported in population-based

studies [1,2]. In Denmark, the same pattern is present in cohort studies in adult populations [3] and in adolescent populations [4]. Furthermore, many studies have found socioeconomic and health differences between participants and non-participants [5–9]. Consequently, differences may be present between participants and non-participants in distribution of the exposure to an outcome. This questions whether the results from population-based studies can be generalized to the background population, and thus results in an increasing challenge to epidemiologic studies based on cohorts. Therefore, both non-participation at baseline and loss to follow-up are problems that need to be considered in

Correspondence: Mathilde Vinther-Larsen, National Institute of Public Health, University of Southern Denmark, Øster Farimagsgade 5, DK-1399 Copenhagen K, Denmark. E-mail: mvl@niph.dk

(Accepted 7 May 2010)

© 2010 the Nordic Societies of Public Health  
DOI: 10.1177/1403494810374222

cohort-based studies. However, due to data limitations only a few survey studies have the possibility to accomplish this need.

The Danish Youth Cohort is registered using the unique personal identification number, which makes it possible to conduct register-based studies and enables us to study both the characteristics of loss to follow-up and the differences between participants and non-participants at baseline. Furthermore, the cohort is unique because few previous studies have used internet-based questionnaires, and only few longitudinal cohorts have been initiated among adolescents.

This paper describes the overall design and methods used in the study and compares the study participants with non-participants regarding socio-demographic characteristics both at baseline and follow-up.

## **Materials and methods**

The Danish Youth Cohort is a nationwide, population-based survey where person-related information was obtained. The personal identification number is used to follow each student through the interview rounds and will also be used for future follow-up.

### *Pilot study*

A baseline study for an intervention project was used as a pilot study for the cohort. It was conducted in autumn 2004 in the beginning of the 7th grade, and the questionnaire was tested. A total of 4,819 adolescents from 150 schools participated in the pilot study. The questionnaire was subsequently revised and improved.

### *Study design*

Participants in the Danish Youth Cohort were recruited from the total population of 7th graders in Danish schools. The adolescents were sampled in clusters of classes, with schools as sampling units. In order to be eligible for inclusion at baseline, schools had to have at least one stream of grade 7. The invitation round took place at school level, and the decision on whether or not a school class should participate was made by school principals and teachers. A total of 1,945 schools were eligible and invited, out of which 506 participated. Numbers from the Ministry of Education show that eligible schools comprised a total of 65,000 students. A total of 506 schools and 12,498 students participated (mean age: 13.4 years; see Figure 1).

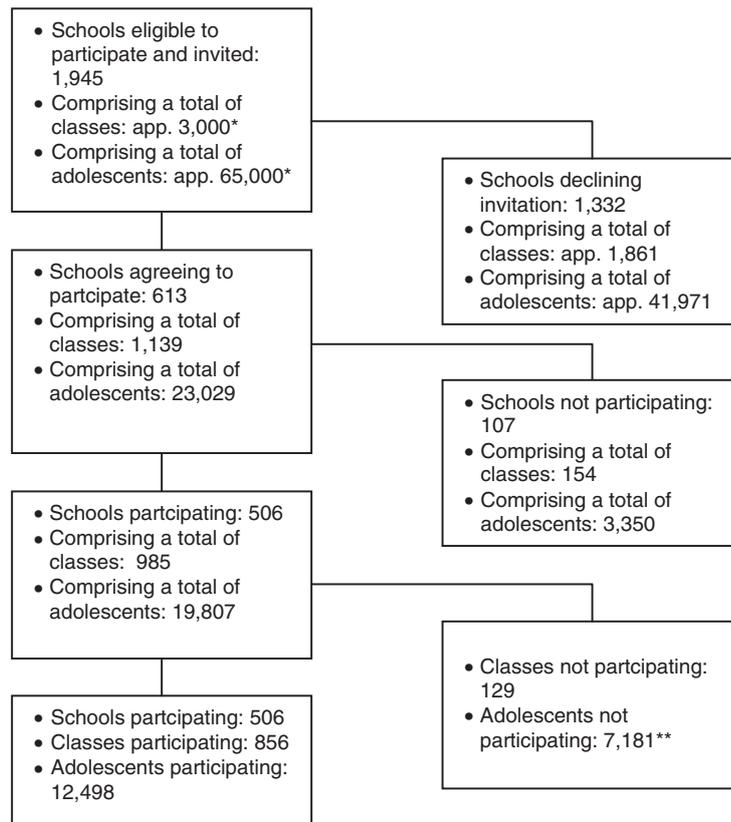
Everyone who participated in wave one in spring 2005 was re-invited to take part in the second and third follow-up data collections where the adolescents were in the 8th and 9th grades, respectively. Furthermore, in spring 2006 and 2007, schools who previously had not been invited because they did not have relevant classes for the given period were invited to participate. For example, in the spring 2007 schools with no 7th or 8th grades were invited to participate with their 9th grade in 2007. In wave two, in spring 2006, a total number of 7,965 participated (mean age: 14.4 years), and in wave three in spring 2007 the number of participants was 5,279 (mean age: 15.3 years). Data were registered using personal identification numbers, which made it possible to track the answers of individual participants over the course of the study, and which will enable us to conduct further surveys and register-based follow-up studies as the respondents reach adulthood.

The participation rate was calculated as the proportion of adolescents participating in the study out of the number who, according to the teachers, were registered in the given class and, thus, possible candidates for enrolment in the study. The participation rate for the Danish Youth Cohort 2005 was 63% (see Table I). The sample of 12,498 adolescents represents 18.2% of the total population ( $n = 68,764$ ) in the 7th grade in schools in Denmark. To obtain a high response rate each year during data collection, teachers were given reminders both by written letters and by phone.

### *Internet-based questionnaire*

The data material consisted of internet-based questionnaires, which were answered by students from the 7th, 8th, and 9th grades in Danish schools in 2005, 2006 and 2007, respectively. The data collection took place in each school during a 45-minute lesson, and each adolescent had their own computer to complete the internet-based questionnaire. Questions and possible answering categories were read aloud in headphones to each participant, giving slower readers the opportunity to participate at same level as other adolescents.

The questionnaire contained information on adolescent health behaviour, lifestyle, leisure time, family factors, school factors and background variables such as ethnicity, sex, and material wealth of the family. Some of the questions in the questionnaire were made especially for this study and some have been used in previous studies of youth cohorts. The same basic questionnaire was used during all three waves, though for each new wave more questions on new



\*Number of classes and adolescents eligible to participate are an estimate with background in numbers from the Ministry of Education. \*\*The high number of adolescents not participating though schools had participated is due to entire classes not participating, missing parents' consents, absent from school on the day of answering, or unwillingness to participate.

Figure 1. Flow chart of the collection of data from year 2005.

Table I. Rate of participation in the Danish Youth Cohort 2005–2007.

Year	(2004)	2005	2006	2007
Number of adolescents that were expected by teacher to participate		19,807	12,977	10,284
Total population the Danish Youth Cohort	(4,818)	12,498	7,965	5,279
Participation rate		63%	61%	51%
Number of adolescents with follow-up <sup>a</sup>			5,967	3,118
Number of adolescents with follow-up <sup>b</sup>				3,777
Follow-up			48%	25%

<sup>a</sup>Follow-up from 2005 to 2006 and from 2005 to 2006 to 2007. <sup>b</sup>Follow-up from 2005 to 2007.

topics were added. The layout of the questionnaire was youthful and had relevant drawings for each topic.

#### *Ethnographic study*

In addition to the internet-based survey, two two-month periods of ethnographic fieldwork were carried out in a rural community. The fieldwork made use of a combination of participant observation and

semi-structured interviews in a study of the everyday life of a group of 13–16 year olds. Findings from the ethnographic study were used when revising the survey questionnaires, and the results have been reported elsewhere [10,11].

#### *Ethical aspects*

All students who answered the questionnaire had informed written consent from their parents.

While completing the questionnaire and in all further research, the adolescents' answers were anonymous to teachers, peers and researchers. The study was approved by the Danish Data Protection Agency.

### *Statistics*

When describing the study cohort simple frequencies were used. To compare participants with non-participants we compared participants born in 1991 ( $n=10,697$ ) with adolescents born in 1991 who did not participate in the Danish Youth Cohort ( $n=56,619$ ) through registries from Statistics Denmark. We compared the two groups on the basis of information from 2005 regarding sex; ethnicity; geographical region of residence; type of housing; number of children in the adolescent's household; occupational status, marital status, and total income of parents. To be able to determine attrition we compared at baseline (7th grade in 2005) those participants for whom we had follow-up data in the 9th grade in 2007 with those for whom we did not have follow-up data. For both analyses we used a multivariate logistic regression. This method was used owing to the causal connection between several of the parameters.

## **Results**

### *Baseline description of the Danish Youth Cohort*

Of the participants, 48.9% were boys. Mean age for boys was 13.5 years and for girls 13.4 years. Most participants were from the year group 1991. Among boys, 28% had experienced being drunk compared with 23% of the girls. A total of 16% of the boys and 17% of the girls had ever tried smoking in the 7th grade. Striking gender differences were seen in relation to healthy eating and physical activity. Sixty-seven per cent of the girls ate vegetables or fruits almost every day compared with only 45% among boys, and 58% of the boys were physically active for four hours or more during a week compared with only 46% among the girls. The majority of both girls and boys were of normal weight/underweight, categorized according to Cole et al. [12] (91% of girls and 88% of boys). Twenty-one per cent of the girls and 20% of the boys lived with only one adult. With regard to the families' material wealth (FAS-scale, which is categorized into six groups) [13] the majority of both boys and girls fell into the medium wealthy categories; however, approximately 12% of both boys and girls were in the three less wealthy categories. Also, the majority of both boys and girls were ethnic Danes (97% and 96%, respectively; see Table II).

### *Representativeness of participants and determinants of participation*

Participants born in 1991 were compared with adolescents born in 1991 who did not participate in the Danish Youth Cohort through registries in Statistics Denmark. We found that participants were more likely to be girls, to be of Danish ethnicity, to come from Central or Northern Jutland or Southern Denmark, and to live in one-family houses. Furthermore, they more frequently came from families with two or three children, were more likely to have parents with a high occupational status, to have parents who were married and who had a higher total income (see Table III).

### *Determinants of attrition*

Participants at baseline with follow-up in 2007 ( $n=3,777$ ) were compared with participants at baseline with no follow-up ( $n=8,721$ ). We found that sex, FAS-score, diet, physical activity, and bullying did not determine attrition. However, adolescents who at baseline had tried drinking one unit of alcohol, had experienced being drunk, and who smoked were less likely to have follow-up two years after baseline (see Table IV).

## **Discussion**

We found that compared with non-participants the participants were significantly more likely to be girls, to be of Danish ethnicity, and to live in one-family houses. Also, participants more often came from families with two or three children, were more likely to have parents with a high occupational status, to have parents who were married and parents with a higher total income. Loss to follow-up was only associated with adolescents' higher probability of drinking and use of tobacco, and none of the other factors were associated with attrition.

From previous studies we know that a large number of Danish adolescents begin drinking alcohol at 13 or 14 years of age [4,14]. Therefore the baseline population was selected to be 7th graders, where most of the population was 13 years of age. This allows us to investigate drinking onset through quantitative follow-up analyses.

Studies have investigated internet- versus paper-and-pencil-based questionnaires. When adolescents are the target group of the sample, studies have found that the use of internet-based questionnaires were evaluated more positively by the participants, gave equal values and led to higher response rates than did paper-and-pencil questionnaires [15]. However, some studies have found paper-and-pencil

questionnaires to be more adequate for some items [16] and some populations [17]. In this study, the collection of data was done by internet-based questionnaires. This gave us the opportunity to make interactive filtering through the questionnaires. For example, when registering with the personal identification number, which is sex specific, the computer guided boys to skip questions about menstruation. Another advantage of internet-based questionnaires was that the questions were read aloud in receivers given to each student. This was meant to minimize disturbing elements, reduce misinterpretation of items,

and to allow slower readers to participate on the same levels as their classmates. The disadvantages of using internet-based questionnaires can be the lack of appropriate IT equipment at some schools, and the fact that some participants might not be able to use a computer. However, most Danish adolescents of this generation have grown up with IT and are therefore most likely to be familiar with computers. A study has found that internet-based questionnaires are useful tools in settings where the number of persons with internet access is high [18]. In this study participants were given access to a computer at their school when

Table II. Selected baseline characteristics of the study cohort in 2005.

Baseline characteristics	Boys %	(n)	Girls %	(n)
Total	48.9	(6110)	51.1	(6388)
Year of birth				
1988	0.02	(1)	0.1	(4)
1989	0.4	(22)	0.3	(18)
1990	16.2	(991)	8.0	(514)
1991	82.5	(5,038)	88.6	(5659)
1992	1.0	(58)	3.0	(193)
Alcohol (have ever been drunk)				
No	72.0	(4,377)	77.3	(4914)
Yes	28.0	(1,703)	22.7	(1445)
Smoking (Ever tried smoking)				
No	68.6	(4,154)	70.4	(4462)
Yes, but not in 7th grade	15.4	(929)	12.9	(820)
Yes	16.0	(969)	16.7	(1057)
Diet (intake of fruit and vegetables)				
Almost every day or more	45.0	(2,705)	66.5	(4181)
1–5 times a week	48.0	(2,877)	30.4	(1913)
Never or seldom	7.0	(418)	3.0	(190)
Physical activity (sport or exercise in leisure time)				
4 hours a week or more	58.3	(3,357)	46.2	(2739)
2–3 hours a week	23.1	(1,332)	31.0	(1837)
1 hour a week or less	6.7	(386)	10.8	(642)
Never	11.9	(688)	11.9	(707)
BMI <sup>a</sup>				
Normal weight/ underweight	88.0	(4,896)	90.5	(5660)
Overweight	10.7	(646)	8.4	(573)
Obese	1.3	(77)	1.1	(69)
Family structure				
Living with two adults	79.8	(4,692)	78.1	(4796)
Living with only one adult	19.6	(1,149)	21.2	(523)
Living with others	0.6	(36)	0.7	(43)
FAS (Family affluence scale)				
5	23.8	(1444)	20.6	(1307)
4	37.3	(2264)	37.0	(2343)
3	25.7	(1561)	28.4	(1797)
2	10.6	(646)	11.1	(706)
1	2.2	(136)	2.6	(166)
0	0.3	(20)	0.3	(18)
Ethnicity				
Danish	96.7	(5818)	96.1	(5617)
Descendants	1.6	(90)	1.9	(113)
Immigrants	1.7	(101)	2.0	(123)

<sup>a</sup>Body mass index (BMI): weight categories were calculated according to Cole et al. [12] using self-reported weight and height.

Table III. Percentages and odds ratios (OR) for participation in the Danish Youth Cohort in 2005 (born in 1991) in relation to sex, ethnicity, geography, household characteristics, occupation, marital status, and income of mother and father.<sup>a</sup>

Characteristics	Participants	Non-participants	OR (CI 95%)
Total ( <i>n</i> )	15.9 (10,697)	84.1 (56,619)	-
Sex			
Girls	52.9	47.9	1
Boys	47.1	52.1	0.82 (0.78–0.85)
Ethnicity			
Danish	95.2	89.4	1
Immigrants	2.1	4.7	0.43 (0.37–0.49)
Descendants	2.9	5.9	0.43 (0.38–0.49)
Geographical regions			
The Capital Region	21.8	27.6	1
Region Zealand	11.4	16.2	0.89 (0.82–0.95)
Region South Denmark	26.5	22.4	1.50 (1.41–1.50)
Region Central Jutland	25.0	23.3	1.36 (1.28–1.44)
Region North Jutland	15.2	10.5	1.83 (1.71–1.97)
Type of housing			
Single-family house	77.1	66.3	1
Terrace, chain, or double house	22.5	32.7	0.59 (0.56–0.62)
Flat	0.4	1.0	0.37 (0.28–0.50)
Number of children in the household			
1	21.1	24.0	0.85 (0.81–0.90)
2 or 3	72.6	67.7	1
>3	6.2	8.3	0.70 (0.64–0.76)
Occupation status of mother <sup>b</sup>			
Self-employed	3.3	3.7	0.73 (0.64–0.83)
Top manager	1.9	1.3	1.16 (0.98–1.37)
The highest level of earners	12.0	9.7	1
The medium level of earners	23.8	20.1	0.96 (0.89–1.03)
The basic level of earners	32.1	29.7	0.87 (0.81–0.94)
Other earners	13.3	13.9	0.77 (0.71–0.84)
Others	13.6	21.6	0.51 (0.47–0.55)
Occupation status of father <sup>b</sup>			
Self-employed	11.7	10.1	0.98 (0.90–1.07)
Top manager	5.8	4.6	1.07 (0.96–1.19)
The highest level of earners	13.4	11.4	1
The medium level of earners	14.0	12.3	0.97 (0.90–1.05)
The basic level of earners	28.8	27.6	0.89 (0.83–0.95)
Other earners	18.4	19.9	0.79 (0.73–0.85)
Others	7.9	14.0	0.48 (0.44–0.53)
Marital status of mother <sup>b</sup>			
Married/registered partnership	76.1	70.1	1
Divorced/dissolved partnership	11.0	13.8	0.74 (0.69–0.79)
Widow	1.0	1.2	0.76 (0.62–0.94)
Unmarried	11.9	14.9	0.73 (0.69–0.78)
Marital status of father <sup>b</sup>			
Married/registered partnership	79.8	75.1	1
Divorced/dissolved partnership	8.8	11.4	0.73 (0.68–0.78)
Widower	0.5	0.4	0.99 (0.72–1.35)
Unmarried	10.9	13.1	0.79 (0.74–0.85)
Total income of mother <sup>b</sup>			
0–10 percentile	5.6	9.0	0.57 (0.52–0.63)
10–40 percentile	37.9	40.9	0.85 (0.80–0.89)
40–60 percentile	23.7	21.7	1
60–90 percentile	28.1	24.5	1.05 (0.99–1.11)
90–100 percentile	4.6	4.0	1.05 (0.94–1.16)
Total income of father <sup>b</sup>			
0–10 percentile	6.1	11.1	0.53 (0.49–0.59)
10–40 percentile	15.9	18.9	0.82 (0.77–0.88)
40–60 percentile	18.6	18.2	1
60–90 percentile	40.0	35.7	1.10 (1.03–1.16)
90–100 percentile	19.4	16.0	1.19 (1.11–1.27)

<sup>a</sup>Information from linkage to register. <sup>b</sup>If biological and social mother/father is not equal, social mother/father is used. If no information on social mother/father, then biological mother/father is used.

Table IV. Odds ratios (OR) for follow-up in the Danish Youth Cohort 2005–2007 given sex, FAS, self-rated health, alcohol, smoking, use of cannabis, diet, physical activity and bullying.<sup>a</sup>

Characteristics	OR (CI 95 %)
Sex	
Girls	1
Boys	1.02 (0.96–1.08)
FAS (Family affluence scale)	
High	1
Medium	1.07 (1.00–1.14)
Low	1.04 (0.94–1.15)
Self-rated health	
Very good	1
Good	0.98 (0.92–1.04)
Average	0.88 (0.79–0.98)
Bad	0.76 (0.54–1.05)
Alcohol (Have ever been drunk)	
No	1
Yes	0.85 (0.77–0.95)
Alcohol (have ever tried drinking one unit of alcohol)	
No	1
Yes	0.87 (0.81–0.94)
Smoking (ever tried smoking)	
No	1
Yes, but not in 7th grade	0.95 (0.88–1.02)
Yes	0.65 (0.48–0.87)
Have tried cannabis	
No	1
Yes	0.89 (0.72–1.11)
Diet (intake of fruit and vegetables)	
Almost every day or more	1
1–5 times a week	0.97 (0.91–1.03)
Never or seldom	0.97 (0.84–1.12)
Physical activity (sport or exercise in leisure time)	
4 hours a week or more	1
2–3 hours a week	0.98 (0.92–1.05)
1 hour a week or less	0.96 (0.86–1.06)
Never	0.94 (0.85–1.03)
Have tried been bullied	
No	1
Yes	0.96 (0.90–1.02)
Have tried bullying	
No	1
Yes	1.0 (0.94–1.07)

<sup>a</sup>Information from self-reported questionnaire.

answering the questionnaire and therefore accessibility was not a problem.

We aimed at a high response rate because non-participants tend to have different health characteristics from the rest of the sample and their omission, therefore, may result in bias. Compared with other observational studies, a participation rate of 63% for the first data collection in 2005 was low, but acceptable. Optimally we would like to know who the non-participants are and why they did not participate. To come closer to knowing who the non-participants are and thereby potentially to be able to make general

conclusions from this study cohort about all Danish 7th graders, we compared participants with non-participants on the basis of information from 2005 regarding sex, ethnicity, geographical region of residence, type of housing, number of children in the adolescent's household, occupational status, marital status, and total income of parents. Information for comparing participants with non-participants was obtained from central Danish registries based on administrative information, which gave the data high validity compared with self-reported data. This helps determine whether the cohort is representative of 7th grade adolescents in Denmark with reference to several factors. We found that the participants in the Danish Youth Cohort differed from the non-participants with regard to almost all included socio-demographic factors. Our finding could be due to the fact that schools with more well-functioning students also have greater resources to participate, as compared to schools in more deprived areas. However, differences in participation are presumably also due to a likely association between school attendance and socio-demographic factors. It is more difficult to explain why 27% of those eligible did not participate. A factor that might greatly have influenced the response rate is the need for parents' consent to participate in the study. Several studies have found that obtaining active parents' consent affects the response rate negatively [19–21], and that parents consenting are related to different socio-demographic factors [20,22]. In our study we also found a lower participation among non-ethnic Danish adolescents. This could be a result of difficulties by parents of these non ethnic Danish adolescents to understand the letter with information on the study. This may affect the consent rate and thereby the response rate. We did try to overcome this potential problem in the study design by translating the letter into Arabic, though it may not have been sufficient. Furthermore, in another Danish school-based survey (Health Behaviour in School-aged Children – HBSC) it has been reported that 10% of eligible students were absent from school on the day of the survey due to vacation, illness, etc. [23]. This can also be assumed to be the case in our study, and thereby explain some of our non-response. To obtain a higher response rate in the future we could have made it possible for students who were absent on the day of the survey to be questioned on another day. Also, more time and energy should have been spent on involving parents to increase the number of parents consenting to their child's participation. Another factor that might have influenced the rather low response rate might be the fact that invitations were sent to teachers or school principals and not directly to the students. Schools or teachers might not have resources or energy to

participate in the study although the individual adolescents did. On the other hand, because data collection took place in school, the cohort may include some adolescents that would not have participated if the data collection had been outside school. The lack of resources for schools and teachers to participate even though they found the study interesting and important might be seen in the large number of schools that did not participate even though they had accepted (see Figure 1). Our study confirms what is already known from other previous study cohorts: that lower socioeconomic groups are under-represented in epidemiological studies [3,5,7–9,24,25]. Therefore, when using data descriptively, this non-representativity needs to be taken into account. Methods to account for low participation rates in cohort studies have been introduced [26]. Future analyses of the Danish Youth Cohort may overcome the rather low participation rate, and thereby the skewed sample, by for example weighting some characteristics of non-participation. However, the discrepancy in characteristics between participants and non-participants at baseline has no crucial effect on future analyses exploring relations within the longitudinal cohort – only if the non-response is related to both the exposure and to the outcome of interest. Although the representativeness could be questioned, one of the advantages of this study is, nevertheless, that overall 18% of the total year group of 7th graders did participate in 2005. This gives a good sample size that makes it possible to perform analyses and compare groups within demographic and socioeconomic characteristics.

Regarding attrition, only 25% were followed up from baseline in 2005 to the second follow-up in 2007. Non-response can potentially induce non-response bias [27]. A number of previous studies have shown that attrition is indeed associated with such unfavourable risk factors [28–30]. In the Danish Youth Cohort, however, loss to follow-up was only associated with drinking and smoking and none of the other factors were associated with attrition. In particular, the fact that FAS was not associated with attrition was surprising because socioeconomic factors, as mentioned earlier, have been suggested to be associated with attrition. However, another measurement than FAS of parents' socioeconomic position could give other results. Some suggest, however, that an equalization in youths' health might be present [31] and the same patterns as in our study might be seen relating to attrition. We believe that data from the Danish Youth Cohort can be used to investigate research questions that require longitudinal data. However, in future research on alcohol or smoking the high attrition should be considered.

The Danish Youth Cohort offers a unique potential for epidemiological research within the area of adolescent health behaviour. Many research projects may be put into practice by the use of this longitudinal cohort study among Danish adolescents. Questioned causal relations between adolescents' lifestyles and health, along with determinants of different outcomes, can hopefully be confirmed. Future updates and linkages with other data sources such as the criminal registry and the injury register will further expand the potential of the database. Using the unique personal identification number the cohort can be followed in Danish registries, and this might answer questions concerning the relationship between adolescent behaviour and adult health and lifestyle.

### Acknowledgements

We extend our thanks to all the adolescents who participated in the Danish Youth Cohort. Furthermore, acknowledgements are made to all the teachers who helped gather the origin of this cohort. The Danish Health Insurance Fund; the European Research Advisory Board; the Danish National Board of Health; the Danish Ministry of Interior and Health; and the Danish Medical Research Council funded the study.

### References

- [1] Morton LM, Cahill J, Hartge P. Reporting participation in epidemiologic studies: a survey of practice. *Am J Epidemiol* 2006;163(3):197–203.
- [2] De Leeuw ED, De Heer W. Trends in household survey nonresponse: a longitudinal and international comparison. In: Groves RM, Dillman DA, Eltinge JL, Little RJA, editors. *Survey nonresponse*. New York: Wiley; 2002. pp. 41–54.
- [3] Kjoller M, Thoning H. Characteristics of non-response in the Danish Health Interview Surveys, 1987–1994. *Eur J Public Health* 2005;15(5):528–535.
- [4] Andersen A, Damsgaard MT, Due EP, Henriksen PW, Holstein BE, Krølner R, et al. Health behaviour among school-aged children. In: Rasmussen M, Due EP, editors. *Copenhagen: Institute of Public Health, University of Copenhagen*; 2007.
- [5] Tolonen H, Dobson A, Kulathinal S. Effect on trend estimates of the difference between survey respondents and non-respondents: results from 27 populations in the WHO MONICA Project. *Eur J Epidemiol* 2005;20(11):887–98.
- [6] Jousilahti P, Salomaa V, Kuulasmaa K, Niemela M, Vartiainen E. Total and cause specific mortality among participants and non-participants of population based health surveys: a comprehensive follow up of 54 372 Finnish men and women. *J Epidemiol Community Health* 2005;59(4):310–15.
- [7] Tjønneland A, Olsen A, Boll K, Stripp C, Christensen J, Engholm G, et al. Study design, exposure variables, and socioeconomic determinants of participation in Diet, Cancer and Health: a population-based prospective cohort study of 57,053 men and women in Denmark. *Scand J Public Health* 2007;35(4):432–41.

- [8] Sonne-Holm S, Sørensen TI, Jensen G, Schnohr P. Influence of fatness, intelligence, education and sociodemographic factors on response rate in a health survey. *J Epidemiol Community Health* 1989;43(4):369–74.
- [9] Drivsholm T, Eplov LF, Davidsen M, Jørgensen T, Ibsen H, Hollnagel H, et al. Representativeness in population-based studies: a detailed description of non-response in a Danish cohort study. *Scand J Public Health* 2006;34(6):623–31.
- [10] Jørgensen MH, Curtis T, Christensen PH, Gronbaek M. Harm minimization among teenage drinkers: findings from an ethnographic study on teenage alcohol use in a rural Danish community. *Addiction* 2007;102(4):554–9.
- [11] Tutenges S, Rod MH. “We got incredibly drunk... It was damned fun” Drinking stories among Danish youth. *J Youth Studies* 2009;12(4):355–70.
- [12] Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320(7244):1240–3.
- [13] Currie C, Molcho M, Boyce W, Holstein B, Torsheim T, Richter M. Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. *Soc Sci Med* 2008;66(6):1429–36.
- [14] National Board of Health D. [Survey of 11–15 years old adolescents’ lifestyle and health 1997–2006]. Copenhagen: National Board of Health, Denmark; 2008.
- [15] Mangunkusumo RT, Moorman PW, Van Den Berg-de Ruiten AE, Van Der LJ, De Koning HJ, Raat H. Internet-administered adolescent health questionnaires compared with a paper version in a randomized study. *J Adolesc Health* 2005;36(1):70–6.
- [16] Vereecken CA, Maes L. Comparison of a computer-administered and paper-and-pencil-administered questionnaire on health and lifestyle behaviors. *J Adolesc Health* 2006;38(4):426–32.
- [17] Kongsved SM, Basnov M, Holm-Christensen K, Hjøllund NH. Response rate and completeness of questionnaires: a randomized study of Internet versus paper-and-pencil versions. *J Med Internet Res* 2007;9(3):e25.
- [18] Balter KA, Balter O, Fondell E, Lagerros YT. Web-based and mailed questionnaires: a comparison of response rates and compliance. *Epidemiology* 2005;16(4):577–9.
- [19] White VM, Hill DJ, Effendi Y. How does active parental consent influence the findings of drug-use surveys in schools? *Eval Rev* 2004;28(3):246–60.
- [20] Esbensen FA, Miller MH, Taylor TJ, He N, Freng A. Differential attrition rates and active parental consent. *Eval Rev* 1999;23(3):316–35.
- [21] Esbensen FA, Melde C, Taylor TJ, Peterson D. Active parental consent in school-based research: how much is enough and how do we get it? *Eval Rev* 2008;32(4):335–62.
- [22] Bergstrom JP, Partington S, Murphy MK, Galvao L, Fayram E, Cisler RA. Active consent in urban elementary schools: an examination of demographic differences in consent rates. *Eval Rev* 2009;33(5):481–96.
- [23] Health Behaviour in School-aged Children 2006 (HBSC): population, methods, and distribution of answers. Copenhagen: Institute of Public Health, University of Copenhagen; 2007.
- [24] Pietila AM, Rantakallio P, Laara E. Background factors predicting non-response in a health survey of northern Finnish young men. *Scand J Soc Med* 1995;23(2):129–36.
- [25] Shahar E, Folsom AR, Jackson R. The effect of nonresponse on prevalence estimates for a referent population: insights from a population-based cohort study. Atherosclerosis Risk in Communities (ARIC) Study Investigators. *Ann Epidemiol* 1996;6(6):498–506.
- [26] Greenland S, Finkle WB. A critical look at methods for handling missing covariates in epidemiologic regression analyses. *Am J Epidemiol* 1995;142(12):1255–64.
- [27] Groves RM. Nonresponse rates and nonresponse bias in household surveys. *Public Opinion Quarterly* 2006;70(5, Special Issue):646–75.
- [28] McCoy TP, Ip EH, Blocker JN, Champion H, Rhodes SD, Wagoner KG, et al. Attrition bias in a US Internet survey of alcohol use among college freshmen. *J Stud Alcohol Drugs* 2009;70(4):606–14.
- [29] Eaton WW, Anthony JC, Tepper S, Dryman A. Psychopathology and attrition in the epidemiologic catchment area surveys. *Am J Epidemiol* 1992;135(9):1051–9.
- [30] Garcia M, Fernandez E, Schiaffino A, Borrell C, Marti M, Borrás JM. Attrition in a population-based cohort eight years after baseline interview: the Cornella Health Interview Survey Follow-up (CHIS.FU) Study. *Ann Epidemiol* 2005;15(2):98–104.
- [31] West P. Health inequalities in the early years: is there equalisation in youth? *Soc Sci Med* 1997;44(6):833–58.



## Paper II



**Title:** Social inequality in early drinking onset among adolescents in Denmark

**Authors:**

Mathilde Vinther-Larsen<sup>1</sup>, Mette Riegels<sup>1</sup>, Pernille Bendtsen<sup>1</sup>, Finn Diderichsen<sup>2</sup>, Pernille Due<sup>1</sup>, Morten Grønbaek<sup>1</sup>

**Author Affiliations:**

<sup>1</sup>National Institute of Public Health, University of Southern Denmark, Copenhagen, Denmark

<sup>2</sup> Department of Social Medicine, Institute of Public Health, University of Copenhagen, Copenhagen, Denmark

**Correspondence to:**

Mathilde Vinther-Larsen  
National Institute of Public Health,  
Øster Farimagsgade 5, DK-1399 Copenhagen K.  
Telephone +45 65507777  
E-mail: mvl@niph.dk

**Keys words:** Family affluence, alcohol, adolescents

**Total page count:** 14

**Word count (text excluding abstract, references, tables):** 2720 (max 3000)

**Word count (abstract):** 142 (max 250)

**Abstract:**

**Background:** Social inequality in health behaviour is well documented, but whether social inequality in drinking onset exists is still unclear. Therefore, the objective of this study is to investigate the association between socioeconomic position and drinking onset.

**Methods:** Information on family affluence and drinking onset was obtained from 12,498 adolescents participating in 'The Danish Youth Cohort' in the spring 2005. The adolescents were sampled in clusters of school classes and we used multilevel models to analyse data.

**Result:** We found that social inequality in drinking onset is present among Danish boys: boys from the wealthiest families had the highest risk of early drinking onset, while no differences were seen among girls.

**Conclusion:** We conclude that social inequality in early drinking onset is present among Danish boys with the most affluent boys at highest risk. We find no inequality among Danish girls.

## **Introduction:**

Social inequality has been observed in many types of health behaviour among adolescents, e.g. unhealthy diet,(1) smoking and low physical activity,(2) finding adolescents with lower socioeconomic position at highest risk. However, there are still ambiguous findings regarding social inequality in some health behaviours among adolescents, especially when it comes to alcohol behaviour where findings have been inconsistent. Several studies, carried out in Northern Europe, North America, and New Zealand, have found alcohol behaviour to be socially patterned, with high rates of drunkenness,(3;4) problematic alcohol use,(5) high frequency of alcohol use,(6;7) and high consumption (8) associated with low socioeconomic position. However, some studies, carried out in Northern Europe and North America, have suggested a reverse socioeconomic pattern in drunkenness,(4) and frequency of alcohol use.(9-11) Other studies, carried out in Northern Europe, found no socioeconomic differences in drinking onset,(12) occasional drinking,(3) and drunkenness.(11) Further, a recent review concluded that there was no clear pattern of the association between socioeconomic position and alcohol consumption, with 69% of the included high quality studies finding no relation.(13)

Explanations for the mixed findings can be various. It may imply that social inequalities vary in different settings and populations. A study have found that the association between family affluence as well as parental occupation and drunkenness differed according to country and gender.(9) Another explanation for the various findings is that inequalities may depend on which measure of alcohol is used. Which alcohol measures that are related to socioeconomic position most strongly seems to be unclear. Moreover, the use of different socioeconomic measures seems to be a contributing factor for explaining the ambiguous findings regarding social inequality in adolescents' alcohol behaviour. A study found that high family affluence was associated with high frequency of drunkenness while low parental occupation was associated with high frequency of drunkenness.(4) This is supported by a study by Casswell et al., who found that different measures of individual level socioeconomic position affected aspects of drinking pattern differently: Among young adults, high income was associated with high frequency of alcohol intake, and low educational was associated with drinking high quantities.(7) Further, Kuntsche et al., 2004 conclude that financial resources seems to be one of the ways that socioeconomic position affect binge drinking among adolescents.(14) The above mentioned studies indicate that education of parents, occupation of parents and material wealth may reflect different aspects of socioeconomic position that may each have different effects on youth drinking behaviour.

Since early drinking onset is associated with future heavy drinking and alcohol-related problems,(15-17) and because drinking onset is often first in the causal chain of known risk factors for alcohol misuse, it is of special interest to investigate social inequality in relation to adolescents' drinking onset. Additionally, given that family affluence is one of the factors that previous research has found to influence adolescents alcohol consumption, the objective of this study is to clarify if socioeconomic position measured by family affluence is associated with adolescents' early drinking onset.

## Methods:

### *Study population*

This study is based on data from The Danish Youth Cohort, which aims at identifying risk factors for adolescents' health and health behaviour. The Danish Youth Cohort is a nationwide, population-based survey in which person-related information on adolescent health behaviour, lifestyle, leisure time, family factors, school factors and background variables such as ethnicity, sex, and the material wealth of the adolescents' families were collected. The adolescents were sampled in clusters of school classes, with schools as sampling units. The data material consisted of internet-based questionnaires, which were answered by students from the 7<sup>th</sup> grade in Danish schools (mean age 13.4 years). The study population consists of 12,498 students, which corresponds to 18.2 % of the total population of 7<sup>th</sup> graders (N=68,764) in Danish schools in the year 2005. The participation rate, calculated as percentage of respondents from the students enrolled in the study by their teachers, was 63 %. All students who answered the questionnaire had informed consent from their parents. While completing the questionnaire and in all further research, the adolescents' answers were anonymous to teachers, peers and researchers. The study was approved by The Danish Data Protection Agency.(18)

### *Measurements*

The individual socioeconomic position was operationalised by a three-item Family Affluence Scale (FAS).(19) The scale measured the material wealth of the family: number of cars in the household (0/1/2 or more), number of holidays in the family within the last year (none/once/twice or more), and ownership of own bedroom (no=0/yes=1). The scale ranges from scores 0 to 5, where 0 represents the least wealthy and 5 represents the wealthiest. FAS was categorised into three levels, where 0-2 constituted low socioeconomic position, 3-4 constituted medium socioeconomic position, and 5 constituted high socioeconomic position.

We used two different measures to measure adolescents' early drinking onset. One was based on whether the adolescent had ever tried to drink more than one beer, one glass of wine, one glass of spirits or one alcopop, and was dichotomised as 'no' for not have tried to drink more than one unit of alcohol, and 'yes' for have tried to drink more than one unit of alcohol. The other measure was based on whether the adolescent had ever tried to be drunk, and was dichotomised as 'no' for not have tried to be drunk, and 'yes' for have tried to be drunk. The covariates sex, ethnicity (defined as country of birth of adolescents and parents' country of birth: Danes, descendants and immigrants), and age were chosen to be potential confounders.

### *Statistical analysis*

In this study, data were collected in clusters of school classes nested within schools, which makes the assumption of independence of data at the individual level invalid. The intraclass correlation coefficients for drinking onset between schools was ICC=0.05 and between school classes was ICC=0.04. As a consequence multilevel analyses were used. We performed the statistical analyses by using a multilevel logistic regression model with random effects on schools and school classes. Crude Odds Ratio (OR) and OR adjusted for ethnicity and age were presented in this study. A significant interaction was seen for sex and early drinking onset. Therefore all analyses were executed separately for boys and girls.

To test for significant effects a Wald-test was applied. Significance was indicated with a p-value <0.05. All analyses were performed in the statistical programme SAS version 9.2.

## Results:

### *Baseline characteristics*

The mean age for those with early drinking onset was 0.1 years higher among boys compared to girls. There were more boys than girls that have tried drinking one unit of alcohol (Girls: 35.6 % and boys: 45.9%) and who have tried to be drunk (Girls: 17.0% and boys 20.5%). Among girls, no significant difference was seen in the frequency of having tried drinking one unit in the different groups of FAS. However, there was a higher frequency of girls who had tried to be drunk in the low FAS group. Among boys a significant difference in the proportion of early drinkers, for both measures, was observed with the highest frequency seen among boys with high FAS. For both girls and boys, the highest frequency of early drinkers was seen among adolescents of Danish origin. See table 1.

Table 1: Baseline characteristics of 12,498 adolescents participating in ‘The Danish Youth Cohort’ in the spring of 2005.

	Girls				Boys							
	%	N	Early drinkers (one unit)	p-value	Early drinkers (drunk)	p-value	%	N	Early drinkers (one unit)	p-value	Early drinkers (drunk)	p-value
Total population	51.1	(6388)	35.6	-	17.0	-	48.9	(6110)	45.9	-	20.5	-
Age (mean)	13.4	-	13.4	-	13.4	-	13.5	-	13.5	-	13.5	-
Ethnicity												
Danish	96.1	(5818)	36.5	<0.0001	17.2	0.0037	96.7	(5616)	47.2	<0.0001	21.0	<0.0001
Desc. and immig.	3.9	(236)	16.4		9.9		3.3	(191)	21.2		9.5	
FAS												
Low	14.0	(890)	37.9	0.1579	19.8	0.0213	13.2	(802)	42.9	<0.0001	21.4	0.0006
Medium	65.3	(4140)	34.9		16.1		63.0	(3825)	44.6		19.1	
High	20.6	(1307)	36.5		17.7		23.8	(1444)	51.4		23.8	

\*FAS: Family affluence scale

### *Association between family affluence and drinking onset*

A significant association was seen between FAS and both measures of early drinking onset among boys before and after adjustment for ethnicity and age. Boys with a low or medium FAS score had a significantly lower risk of early drinking onset measured by ever tried drinking one unit compared to boys with high FAS (OR for low FAS: 0.80 (95 % CI: 0.65-0.98); OR for medium FAS: 0.78 (95 % CI: 0.68-0.90)). In relation to drinking onset measured by ever tried to be drunk, only boys with a medium FAS had a significantly lower risk drinking onset compared to boys with high FAS (OR for medium FAS 0.76 (95% CI: 0.65-0.88)). For girls there were no differences in the risk of early drinking onset between the three FAS groups. (Ever tried drinking one unit: OR for low FAS score: 1.18 (95 % CI: 0.96-1.45); OR for medium FAS score: 0.94 (95 % CI: 0.81-1.09) Ever tried to be drunk: OR for low FAS score: 1.15 (95 % CI: 0.90-1.46); OR for medium FAS score: 0.88 (95 % CI: 0.74-1.05 ). See table 2.

Table 2: Odds ratio (OR) of drinking onset for the categorised FAS.

	Girls				Boys			
	OR*	95 % CI	OR**	95 % CI	OR*	95 % CI	OR**	95 % CI
Have ever tried drinking one unit								
FAS score								
High	1	-	1	-	1	-	1	-
Medium	0.92	0.81-1.06	0.96	0.83-1.10	0.77	0.67-0.87	0.79	0.67-0.90
Low	1.04	0.86-1.25	1.13	0.93-1.38	0.73	0.60-0.87	0.82	0.68-0.99
Have ever tried to be drunk								
FAS score								
High	1	-	1	-	1	-	1	-
Medium	0.87	0.73-1.04	0.88	0.74-1.05	0.74	0.64-0.87	0.76	0.65-0.88
Low	1.11	0.88-1.41	1.15	0.90-1.46	0.89	0.71-1.12	0.93	0.75-1.17

\*Unadjusted OR

\*\* OR adjusted for: ethnicity and age

## Discussion:

### *Social inequality in drinking onset*

There is inconsistency in the findings of the relation between socioeconomic position and adolescents drinking behaviour. Several studies have investigated the association between socioeconomic position and various measures of drinking behaviour in youth, but findings have been heterogeneous. Our study is among the first to investigate the relationship between family affluence and drinking onset in a large population of youth. We found that social differences in drinking onset exist among boys with boys from more affluent families at highest risk of early drinking onset. This is consistent with some other studies. Richter et al. found high family affluence to be associated with both frequency of drunkenness,(4) and frequency of alcohol intake.(9) Goodman et al. also found high income of parents to be associated with frequency of alcohol intake.(10) Studies that have found the opposite socioeconomic direction in adolescents drinking behaviour have primarily used occupational status,(4;8) or educational achievement(6;20) as measures for socioeconomic position. Our results together with the findings from the other studies using income and family affluence as indicator for socioeconomic position indicate that it may be that the availability of financial resources is positively related to adolescents' frequency and initiation of drinking. This is also supported by a finish study where drunkenness was more common among adolescents' who received more pocket money.(21)

The other studies finding high affluence to be related to adolescents drinking behaviour had primarily investigated drinking outcomes measured by frequency, while our study investigates drinking onset. Another Danish study investigating drinking onset did not find a socioeconomic gradient when looking at both income and education of parents.(12) An explanation for the different results in Denmark could be that Wium-Andersen et al. did not stratify by gender. Another study, that examined socioeconomic position and drunkenness, also reported gender differences.(4) As in our study, they only find an effect of high family affluence on adolescents drinking behaviour among boys. It has been suggested that gender roles mediate sex differences in adolescents' alcohol behaviour, as masculine attributes were positively related to drinking and feminine attributes were negatively related to drinking.(22) The differential

effect that we found for sex could therefore be a result of different gender roles and gender expectancies in different socioeconomic positions. If boys from high socioeconomic positions are expected to have more masculine behaviour than boys from low socioeconomic positions, this could explain that boys from high socioeconomic positions begin drinking at an earlier point in time. Another hypothesis explaining the different findings regarding sex could be that girls and boys begin drinking in different settings that may depend on socioeconomic position. It has previously been stated that rather large differences are seen in how boys and girls drink.(23) However, a gender convergence in drinking patterns is beginning to evolve.(24) Though, further research is still needed to explain the sex differences found in this study.

#### *Strengths and limitations of the study*

The theoretically eligible subjects for this study are all 68.764 students who attended the 7<sup>th</sup> grade in Denmark in the spring of 2005. The study population consists of 12,498 students, which corresponds to 18.2 % of the total population of 7<sup>th</sup> graders (N=68,764) in Danish schools in the year 2005. If the relation between socioeconomic position and early drinking onset is different, apart from random errors, between the group of participants and the group of non-participant the study would be subject to selection bias. Non-participants are often of lower socioeconomic position (25;26), and this is also evident in our study.(18) Due to the fact that our participants are not representative of the eligible population, selection bias may be present. However, selection bias would be present only if early drinking onset is differently associated with socioeconomic position among participants and non-participants. It seems plausible that non-participating schools and school classes come from less wealthy areas where the teachers have less resources or energy to participate in the study. Nevertheless, it does not seem plausible that the association between family affluence and drinking onset should be different for non-participants.

The Family Affluence Scale is used to operationalise the exposure variable – the socioeconomic position of the adolescents. Some adolescents may have difficulties answering questions about parents' occupation and income.(27) Using this indirect measure for the parents' socioeconomic position, instead of a more direct question about the parents' occupation, education or income, therefore gives a higher percentage of valid answers. Further, a study has found that FAS is in good accordance with parents' socioeconomic position: A great number of adolescents were unable to give sufficient information on their parents' occupation, which rendered it impossible to place the parents in a social group.(28) On the other hand, almost all adolescents were able to answer a number of questions concerning the family's number of cars, holidays etc.(28) The number of cars owned by the household, ownership of own bedroom, and number of family holidays in the past year constitute FAS. Previous studies have found good correspondence between the adolescents' answers and their parents' answers to the FAS-questions, and only the question concerning number of family holidays rendered poor agreement.(29) This indicates no serious misclassification of the reporting of the exposure. Therefore, in this study socioeconomic position is operationalised into FAS, which indicates the material wealth of the family. It is still debatable, though, whether this is a proper operationalisation, and if FAS does in fact capture the concept of socioeconomic position. It is possible to call into question whether these factors measure the socioeconomic position of the family properly when taking into account the material development that has taken place in Denmark or other western countries during the last 5-10 years. For instance number of holidays in the past year and ownership of own bedroom might not differentiate the adolescents affluence well enough, due to the fact that over the years more than one holiday and own bedroom are more common due to an increase in the general level of affluence in the population. Further, the measurement of car ownership might also not differentiate well enough, due to that some wealthier families living in larger cities do not prioritise buying a car even though they have the financial means to do so. Even though FAS

have some pitfalls, we believe it will differentiate the extremes of socioeconomic position. Therefore, using the FAS score to operationalise socioeconomic position seems useful. The concern of differential item function, where the scale works different for different groups, should also be addressed. One study has found that differential item function is present for gender for the FAS III scale, where Danish boys more often have computer.(30) This means that more boys than girls may be in the higher affluence groups. This also indicate that FAS might measure more than just the socioeconomic position, it also measures different preference and cultures among boys and girls. The outcome is early drinking onset measured by whether the adolescents ever had experienced drinking one unit of alcohol and whether they have tried being drunk when asked in the spring of 2005. The measure in this study is seen as reliable and is not thought to be remarkably influenced by misclassification. Early drinking onset could be influenced, though, by exaggerations, where some adolescents might report they have tried drinking or being drunk while they actually have not tried. However, since the collection of data was confidential this potential bias is not seen as a concern. No studies have investigated if misclassification of drinking onset differs according to sex. However, it should be noted that our results could be influenced by differential misclassification by sex, but the misclassification between sexes should be rather large to influence our findings.

#### *Conclusion and implications*

In this study, we found that social inequality in drinking onset is present among Danish boys: those at most risk of early drinking onset are boys from the most affluent families, while there are no social differences in early drinking onset among girls. The findings imply that in order to postpone the onset of drinking in adolescents, prevention strategies should have special attention to boys in higher affluent groups.

#### **Acknowledgements**

We gratefully acknowledge the statistical assistance of statistician Søren Rasmussen, National Institute of Public Health, Denmark.

The European Research Advisory Board and the Danish Health Insurance Fund funded the study.

#### **Key-Points**

- Socioeconomic patterns in adolescent alcohol behavior are unclear
- Social inequality in early drinking onset is present among boys leaving boys from families with high affluence at higher risk
- The findings imply that in order to postpone the onset of drinking in adolescents, prevention strategies should have special attention to boys from high affluent families.

## Reference list:

- (1) Vereecken CA, Inchley J, Subramanian SV, Hublet A, Maes L. The relative influence of individual and contextual socio-economic status on consumption of fruit and soft drinks among adolescents in Europe. *Eur J Public Health* 2005 Jun;**15**:224-32.
- (2) Tuinstra J, Groothoff JW, van den Heuvel WJ, Post D. Socio-economic differences in health risk behavior in adolescence: do they exist? *Soc Sci Med* 1998 Jul;**47**:67-74.
- (3) West P, Sweeting H. A Review of Young People's Health and Health Behaviours in Scotland. Glasgow: MRC Social & Public Health Sciences Unit; 2002.
- (4) Richter M, Leppin A, Nic GS. The relationship between parental socio-economic status and episodes of drunkenness among adolescents: findings from a cross-national survey. *BMC Public Health* 2006;**6**:289.
- (5) Verburg JA, Toet J, van Ameijden EJ. Smoking, alcohol and drug use in Utrecht, The Netherlands, risk groups and socioeconomic differences in 1999 and 2003. *Ned Tijdschr Geneesk* 2005 Sep 17;**149**:2113-8.
- (6) Neufeld KJ, Peters DH, Rani M, Bonu S, Brooner RK. Regular use of alcohol and tobacco in India and its association with age, gender, and poverty. *Drug Alcohol Depend* 2005 Mar 7;**77**:283-91.
- (7) Casswell S, Pledger M, Hooper R. Socioeconomic status and drinking patterns in young adults. *Addiction* 2003 May;**98**:601-10.
- (8) Droomers M, Schrijvers CT, Casswell S, Mackenbach JP. Occupational level of the father and alcohol consumption during adolescence; patterns and predictors. *J Epidemiol Community Health* 2003 Sep;**57**:704-10.
- (9) Richter M, Vereecken CA, Boyce W, Maes L, Gabhainn SN, Currie CE. Parental occupation, family affluence and adolescent health behaviour in 28 countries. *Int J Public Health* 2009;**54**:203-12.
- (10) Goodman E, Huang B. Socioeconomic status, depressive symptoms, and adolescent substance use. *Arch Pediatr Adolesc Med* 2002 May;**156**:448-53.
- (11) Due P, Holstein B. Alcohol Consumption and Social Factors among 11-15 year old [Alkoholforbrug og sociale faktorer blandt 11-15 årige]. *Nordisk Psykologi* 1991;**43**:313-325.
- (12) Wium-Andersen MK, Wium-Andersen IK, Becker U, Thomsen SF. [Onset of alcohol consumption in 7-18-year-old children and adolescents]. *Ugeskr Laeger* 2009 Nov 9;**171**:3345-9.
- (13) Hanson MD, Chen E. Socioeconomic status and health behaviors in adolescence: a review of the literature. *J Behav Med* 2007 Jun;**30**:263-85.
- (14) Kuntsche E, Rehm J, Gmel G. Characteristics of binge drinkers in Europe. *Soc Sci Med* 2004 Jul;**59**:113-27.

- (15) Grant JD, Scherrer JF, Lynskey MT, Lyons MJ, Eisen SA, Tsuang MT, et al. Adolescent alcohol use is a risk factor for adult alcohol and drug dependence: evidence from a twin design. *Psychol Med* 2006 Jan;**36**:109-18.
- (16) Pitkanen T, Lyyra AL, Pulkkinen L. Age of onset of drinking and the use of alcohol in adulthood: a follow-up study from age 8-42 for females and males. *Addiction* 2005 May;**100**:652-61.
- (17) Andersen A, Due P, Holstein BE, Iversen L. Tracking drinking behaviour from age 15-19 years. *Addiction* 2003 Nov;**98**:1505-11.
- (18) Vinther-Larsen M, Riegels M, Rod MH, Schiotz M, Curtis T, Gronbaek M. The Danish Youth Cohort: Characteristics of participants and non-participants and determinants of attrition. *Scand J Public Health* 2010 Jun; **38**:648-656.
- (19) Currie C, Roberts C, Morgan A, Smith R, Settertoboulte W, Rasmussen OSVB. Young people's health in context. *Health Behaviour in School-aged Children (HBSC) study: international report from the 2001/2002 survey*. Copenhagen: WHO Regional Office for Europe; 2004.
- (20) Droomers M, Schrijvers CT, Stronks K, van de Mheen D, Mackenbach JP. Educational differences in excessive alcohol consumption: the role of psychosocial and material stressors. *Prev Med* 1999 Jul;**29**:1-10.
- (21) Lintonen T, Rimpela M, Vikat A, Rimpela A. The effect of societal changes on drunkenness trends in early adolescence. *Health Educ Res* 2000 Jun;**15**:261-9.
- (22) Huselid RF, Cooper ML. Gender roles as mediators of sex differences in adolescent alcohol use and abuse. *J Health Soc Behav* 1992 Dec;**33**:348-62.
- (23) Demant J. Youth drinking with purpose - intersections of age and sex in teenage identity work. *Nordic studies on Alcohol and Drugs* 2007;**24**:149-76.
- (24) Kuntsche E, Kuntsche S, Knibbe R, Simons-Morton B, Farhat T, Hublet A, et al. Cultural and gender convergence in adolescent drunkenness: evidence from 23 European and North American countries. *Arch Pediatr Adolesc Med* 2011 Feb;**165**:152-8.
- (25) Drivsholm T, Eplöv LF, Davidsen M, Jørgensen T, Ibsen H, Hollnagel H, et al. Representativeness in population-based studies: a detailed description of non-response in a Danish cohort study. *Scand J Public Health* 2006;**34**:623-31.
- (26) Kjoller M, Thoning H. Characteristics of non-response in the Danish Health Interview Surveys, 1987-1994. *Eur J Public Health* 2005 Oct;**15**:528-35.
- (27) Andersen D. Were the questions answered? [Fik vi svar på det vi spurgte om?]. In: Andersen D, Ottosen M, editors. *Children as respondents [Børn som respondenter]*. Copenhagen: The Danish National Institute of Social Research; 2002.
- (28) Currie CE, Elton RA, Todd J, Platt S. Indicators of socioeconomic status for adolescents: the WHO Health Behaviour in School-aged Children Survey. *Health Educ Res* 1997 Sep;**12**:385-97.

- (29) Andersen A, Krolner R, Currie C, Dallago L, Due P, Richter M, et al. High agreement on family affluence between children's and parents' reports: international study of 11-year-old children. *J Epidemiol Community Health* 2008 Dec;**62**:1092-4.
- (30) Schnohr CW, Kreiner S, Due EP, Currie C, Boyce W, Diderichsen F. Differential Item Functioning of a Family Affluence Scale: Validation Study on Data from HBSC 2001/02. *Social Indicators Research* 2008 Oct;**89**:79-95.



## Paper III



**Title:** Early drinking onset at age 13 and binge-drinking at age 15 – is the association socially patterned?

**Authors:** Mathilde Vinther-Larsen, Lau C. Thygesen, Morten Grønbaek, Pernille Due.

**Author Affiliations:**

National Institute of Public Health, University of Southern Denmark, Copenhagen, Denmark

**Correspondence to:**

Mathilde Vinther-Larsen

National Institute of Public Health, University of Southern Denmark

Øster Farimagsgade 5A, DK-1353 Copenhagen K

Telephone +45 65507777

E-mail: mvl@niph.dk

**Key words:** Early drinking onset, binge drinking, socioeconomic position, adolescents

**Running Head:** Effect of early drinking onset on binge-drinking

**Total page count:** 24

**Word count (text excluding abstract, references, tables):** 3250

**Word count (abstract, max 200):** 197

**No Conflicts of interests to declare.**

**Funding:**

The Danish Youth Cohort was carried out by the National Institute of Public Health, University of Southern Denmark and was funded by The Danish Health Insurance Fund; the European Research Advisory Board; the Danish National Board of Health; the Danish Ministry of Interior and Health; and the Danish Medical Research Council funded the study. The Danish Health Insurance Fund and the European Research Advisory Board funded this analysis.

## **Abstract**

**Objective:** The aim of this study was to investigate whether an association between early drinking onset and binge drinking exists in a large longitudinal adolescent cohort, and whether the association varies across socioeconomic groups.

**Design and setting:** This study was based on data from the Danish Youth Cohort. Web-based questionnaires were answered by students from 7<sup>th</sup> grade in Danish schools in 2005 (mean age 13.4 years), who were followed-up in 2007 (n=3,777). We used multilevel logistic regression to examine the association between early drinking onset at baseline and binge-drinking two years later.

**Findings:** We found that drinking onset before the age of 13 is associated with higher odds of binge drinking at age 15 for both boys (OR= 3.33, CI 95%: 2.53-4.39) and girls (OR= 2.49, CI 95%: 1.89-3.27). For both boys and girls the highest risk of binge drinking two years after baseline is among early drinking adolescents from families with high affluence.

**Conclusions:** We conclude that early drinking is associated with later binge drinking in adolescence, and that the relative risk varies by family affluence. This means that there may be social differentiation in the consequences of early drinking onset, though with a positive gradient.

## Introduction

When adolescents initiate alcohol use at an early age, it may have unwanted short- and long-term consequences. Early drinking has been found to be associated with health risk behaviours (such as drug use, drunk driving, risky sexual behaviour, and smoking) and injuries in adolescence (Wagner et al. 2005; DuRant et al. 1999; Hingson et al. 2004; Gruber et al. 1996; Rothman et al. 2008; Komro et al. 2010) and adulthood. (Hingson et al. 2003b; Hingson et al. 2002; Hingson et al. 2000; Hingson et al. 2003a; Tennant, Jr. and Detels 1976; Hingson et al. 2008) The most investigated consequences of early drinking onset have been tracking of a risky alcohol use. Early drinking has been found to be associated with intake of larger amounts of alcohol in adolescence, (Gruber et al. 1996; Pedersen and Skrandal 1998; Fergusson et al. 1995; Kuntsche et al. 2009) with higher frequency of alcohol use both in adolescence (Gruber et al. 1996; Rothman et al. 2008; Fergusson et al. 1995; Andersen et al. 2003) and adulthood, (Tennant, Jr. and Detels 1976; O'Grady et al. 2008; Pitkanen et al. 2005) and with alcohol problem drinking (binge drinking and drunkenness) in adolescence (Gruber et al. 1996; Pedersen and Skrandal 1998; Rothman et al. 2008; Vieira et al. 2007; Kypri et al. 2009; Fergusson et al. 1995; Kuntsche et al. 2009; Warner and White 2003; Hawkins et al. 1997) and adulthood. (Eliassen et al. 2009) Further, early drinking has been found to be related to alcohol addiction among adults (Kraus et al. 2000; Prescott and Kendler 1999; Pitkanen et al. 2005; Grant et al. 2001). However, the majority of evidence has been based on cross-sectional data or has been investigated in small populations. Therefore evidence from large longitudinal cohorts on the consequences of early drinking is still needed. Additionally, few studies had addressed whether the risk of experiencing unwanted consequences of early drinking onset was the same for early drinkers across for instance socioeconomic position, gender, and ethnicity. A study among young European adults found primarily that higher education and income was protective for adverse consequences of individual drinking patterns. (Kuendig et al. 2008) A study among Finnish adults found that consequences of similar drinking patterns were more severe among those from lower socioeconomic position. (Makela and Paljarvi 2008) These studies indicated that there may be different susceptibility to alcohol use in various socioeconomic groups. Our hypothesis is therefore that the association between early drinking onset and binge drinking varies between socioeconomic groups. All previous studies on social variation in the consequences of alcohol use concerned adult populations. To our knowledge no studies have previously investigated socially differential susceptibility of drinking onset among adolescents. One of the consequences of early drinking onset is binge-drinking. (Eliassen et al. 2009; Jefferis et al. 2005) Therefore, the aim of this study is to investigate whether an association between early drinking onset and binge drinking does exist in a large longitudinal adolescent cohort and whether the association varies across socioeconomic groups.

## **Methods**

### *Study population*

This study was based on data from The Danish Youth Cohort, a prospective study, which aimed at identifying risk factors for adolescents' health and health behaviour. The cohort was a nationwide and population-based study in which person-related information on socio-demographic factors, health behaviour, leisure time activities, family and school factors were collected. The adolescents were sampled in clusters of school classes with schools as sampling units. The data material consisted of internet-based questionnaires answered by students from the 7<sup>th</sup> grade in Danish schools (mean age 13.4 years). The baseline study was carried out in the spring 2005 with follow-up in the spring 2006 and 2007. At baseline 12,498 students participated, which corresponds to 18.2 % of the total population of 7<sup>th</sup> graders (N=68,764) in Danish schools in the year 2005. The participation rate was 63 %, calculated as percentage of respondents out of eligible students in the sampled school-classes. This study was based on data from the baseline in 2005 and the second follow-up in 2007 (n=3,777). All students who answered the questionnaire had informed consent from their parents. While completing the questionnaire and in all further research, the adolescents' answers were anonymous to teachers, peers and researchers. The study was approved by The Danish Data Protection Agency.(Vinther-Larsen et al. 2010)

### *Measurements*

Adolescents' early drinking onset was operationalised as to whether the adolescent had ever tried to drink more than one beer, one glass of wine, one glass of spirits or one alco-pop, when answering the questionnaire in 7<sup>th</sup> grade. The variable was dichotomised as 'no' for not having tried to drink more than one unit of alcohol, and 'yes' for having tried to drink more than one unit of alcohol. In 9<sup>th</sup> grade, the adolescents were asked how many units of beer, wine, alco-pops, and spirits, they drank at the last drinking occasion. All units for each alcohol type were summarized into one measure of drinks. This indicated how much in total the adolescents drank on the last drinking occasion. Binge-drinking was defined as drinking five or more units of alcohol. The total units of alcohol were dichotomised into binge-drinking or not binge-drinking.

The individual socioeconomic position was operationalised by use of a three-item Family Affluence Scale (FAS).(Currie et al. 2004) The scale measured the material wealth of the family: number of cars in the household (0/1/2 or more), number of holidays in the family within the last year (none/once/twice or more), and ownership of own bedroom (no=0/yes=1). The scale ranges from scores 0 to 5, where 0 represents the least affluent and 5 represents the most

affluent. In the analyses, we included the FAS score at baseline, categorized into three levels, where 0-2 constituted low affluence, 3-4 constituted medium affluence, and 5 constituted high affluence.

As suggested by Greenland and colleagues,(Greenland et al. 1999) for selection of confounders a causal diagram on the relation between early drinking onset and binge drinking was produced with inclusion of prior knowledge from the literature and logical reasoning about the relation of interest.(See supplementary material for the causal diagram used in this study). The following set of potential baseline confounders was identified and adjusted for: smoking (ever tried smoking), family structure (number of adults and siblings in the household), ethnicity (Danish origin, immigrants or descendants), peer pressure (frequency of experiencing peer pressured related to alcohol), parents alcohol consumption (frequency of mother's and father's alcohol consumption), academic performance (own perception of academic performance), and social relations with friends (frequency of seeing friends, and age of friends). Information on all the potential baseline confounders was obtained at baseline.

### *Statistical methods*

In this study, data were collected in clusters of school classes, which make the assumption of independence between individuals invalid. The intraclass correlation coefficient (ICC) for binge drinking between schools was ICC=0.03 and between school classes ICC=0.06. As a consequence, multilevel modelling was used. We performed the statistical analyses using a multilevel logistic regression model with random effects on both school classes and schools. We examined the association between early drinking onset at baseline and binge-drinking two years later. To analyse if the odds of early drinking onset on binge-drinking were different for different socioeconomic groups, we further stratified the relation by FAS measured at baseline. We made an exposure variable combining early drinking onset with family affluence, a variable with six categories (1: non early drinking + low affluence, 2: non early drinking + medium affluence, 3: non early drinking + high affluence, 4: early drinking + low affluence, 5: early drinking + medium affluence, 6: early drinking + high affluence). Non early drinkers from families with low affluence were chosen as reference. Each analysis was performed sex specifically. To test for significant effects a Wald-test was applied where significance was indicated with a p-value <0.05. All analyses were performed using SAS version 9.1.

As sensitivity analyses, other measures of early drinking onset (had tried to feel an effect of drinking alcohol earlier than 7<sup>th</sup> grade and had tried to be drunk earlier than 7<sup>th</sup> grade) were analysed. Furthermore, to examine the possible, separate effect of the low follow-up rate, we used multiple imputations (MI) with monotone missing method. We imputed missing values of

our outcome (binge-drinking), which was the only variable measured at follow-up, based on baseline characteristics. We repeated the imputation five times. Hereafter we did the main analyses in each of the imputed data sets and combined these results by using the PROC MIANALYZE procedure.

## **Results**

At baseline in 7th grade, 39% of the boys and 30% of the girls is drinking more than one unit of alcohol.(See Table 1) Early drinking among both boys and girls is more prevalent among adolescent with Danish origin, who has tried smoking, who lives with only one parent or with others than their parents, who sometimes or often feels pressured by peers, whose father drink weekly, who has poor academic performance, who frequently see their friends, and who mostly se older friends. Early drinking is also more prevalent among boys who come from families with high affluence, and whose mother drinks weekly. The proportion of binge-drinking boys and girls at follow-up two years later is 67% and 59%, respectively.

Table 1: Characteristics of 1844 boys and 1933 girls participating in the Danish Youth Cohort at baseline and 2. follow-up according to sex and frequency of early drinking onset

	Boys		% Early drinking	P-value	Girls		% Early drinking	P-value
	%	N			%	N		
Total (mean age)	13.5	(1844)	39.1		13.4	(1933)	29.5	
Ethnicity								
Danish	97.0	(1695)	40.6	<0.0001	96.1	(1768)	30.5	0.0031
Desc. and immig.	3.0	(52)	13.5		3.9	(71)	14.1	
FAS (Family affluence scale)								
Low	12.4	(227)	35.7	0.0301	13.4	(257)	28.0	0.6981
Medium	65.1	(1194)	38.0		66.7	(1282)	29.4	
High	22.5	(413)	44.7		19.9	(382)	31.1	
Smoking (Ever tried smoking)								
No	81.7	(1492)	33.5	<0.0001	85.9	(1652)	25.1	<0.0001
Yes	18.3	(334)	62.9		14.1	(271)	56.3	
Family structure								
Living with two adults	79.5	(1413)	36.0	<0.0001	77.3	(1441)	26.4	<0.0001
Living with only one adults	17.6	(313)	48.8		18.5	(344)	38.4	
Living with others	2.9	(52)	50.0		4.2	(79)	39.2	
Family structure								
Living w. no siblings	52.7	(972)	42.0	0.0107	40.7	(786)	31.2	0.0003
Living w. younger siblings	23.5	(434)	32.6		28.4	(548)	22.6	
Living w. young. and elderly	9.0	(165)	39.4		10.6	(205)	35.6	
Living w. elderly siblings	14.8	(273)	39.0		20.4	(394)	32.7	
Peer pressure (alcohol)								
Never	88.9	(1631)	36.5	<0.0001	88.3	(1718)	26.9	<0.0001
Sometimes/often	6.3	(116)	58.3		6.2	(119)	58.5	
Do not know	4.7	(87)	58.6		4.5	(87)	42.5	
Frequencies of mothers alcohol consumption								
Seldom/never	35.4	(648)	32.7	0.0004	36.0	(692)	28.9	0.9236
Monthly	19.1	(350)	41.4		22.0	(423)	28.8	
Weekly or more	39.7	(728)	42.0		34.5	(663)	30.4	
Do not know	5.8	(106)	48.1		7.5	(144)	29.9	
Frequencies of fathers alcohol consumption								
Seldom/never	19.6	(359)	30.1	0.0005	19.8	(381)	23.4	0.0084
Monthly	21.0	(385)	37.4		22.5	(432)	29.6	
Weekly or more	52.9	(969)	42.4		47.7	(917)	32.6	
Do not know	6.6	(120)	43.3		10.1	(194)	26.8	
Academic performance								
Really good/good	80.0	(1462)	36.7	0.0001	78.4	(1506)	27.2	0.0001
Average	18.3	(335)	47.0		19.4	(373)	36.6	
Poor	1.7	(31)	61.3		2.2	(42)	45.2	
Frequency of seeing friends								
Never/seldom	14.7	(269)	25.8	<0.0001	14.7	(282)	20.2	0.0002
More often	85.3	(1530)	41.2		85.3	(1636)	31.1	
Age of friends								
Mostly younger	4.9	(90)	35.6	<0.0001	1.8	(35)	11.4	<0.0001
Mostly same age	84.8	(1550)	37.3		84.5	(262)	24.1	
Mostly elderly	10.3	(188)	54.3		13.5	(1618)	64.9	

We find that early drinking onset is associated with higher odds of binge drinking two years after for both boys (OR= 3.33, CI 95%: 2.53-4.39) and girls (OR= 2.49, CI 95%: 1.89-3.27).(See Table 2) For non-early drinking boys a pattern is seen of binge drinking two years later: boys with higher affluence have higher risk of binge drinking. Among early drinking boys no clear pattern with family affluence is observed. Among non-early drinking girls no clear pattern with family affluence is seen, while a clear pattern in the risk of binge drinking is observed with family affluence for early drinking girls. Overall, for both boys and girls the highest risk of binge drinking two years after baseline is among early drinking adolescents from families with high affluence. Interaction between early drinking onset and family affluence was however not present ( $p_{\text{boys}}=0.69$ ,  $p_{\text{girls}}=0.68$ ).

Table 2: Odds ratio for binge-drinking according to early drinking onset separately for boys and girls and stratified on Family Affluence Scale (FAS) (OR (CI 95%))

OR for binge-drinking	OR, crude <sup>a</sup>						OR, adjusted <sup>b</sup>		
	FAS						FAS		
		Low	Medium	High		Low	Medium	High	
<b>Boys</b>									
Early drinking onset									
No	1		1.61 (1.09-2.38)	2.05 (1.29-3.27)	1	1	1.32 (0.84-2.08)	1.56 (0.92-2.65)	
Yes	4.32 (3.37-5.53)	5.51 (2.79-10.91)	6.50 (4.16-10.15)	8.57 (4.84-15.17)	3.33 (2.53-4.39)	4.63 (2.15-9.99)	4.07 (2.46-6.75)	5.30 (2.82-9.96)	
<b>Girls</b>									
Early drinking onset									
No	1	1	1.61 (1.14-2.28)	1.35 (0.89-2.03)	1	1	1.37 (0.93-2.03)	1.10 (0.69-1.73)	
Yes	3.31 (2.61-4.20)	3.08 (1.65-5.76)	5.11 (3.40-7.69)	5.47 (3.08-9.70)	2.49 (1.89-3.27)	1.95 (0.97-5.08)	3.21 (2.02-5.08)	4.04 (2.15-7.61)	

<sup>a</sup> Adjusted for age

<sup>b</sup> Adjusted for: age, ethnicity, smoking, family structure (number of adults), family structure (number of siblings), frequency of parents alcohol consumption, academic performance, peer pressure, frequency of seeing friends, and age of friends.

It is also of interest looking at the absolute prevalence level of binge drinking in different family affluence categories according to early drinking or non-early drinking. (See table 4) Among both boys and girls, the highest prevalence of binge drinking was among early drinkers from families with high affluence, and the lowest prevalence of binge drinking was among non-early drinking boys and girls coming from families with low affluence backgrounds. (See table 3)

Table 3: Prevalence of binge-drinking in each early-drinking category separately for boys and girls and stratified on Family affluence scale (FAS)

% Binge-drinker			
	FAS		
	Low	Medium	High
Boys			
Early drinking onset			
No	45.2	56.2	63.9
Yes	80.8	83.1	86.5
Girls			
Early drinking onset			
No	39.8	54.0	50.6
Yes	70.2	78.4	80.4

### Sensitivity analyses

Separate analyses were performed with other measurements of early drinking onset (had tried to feel an effect of drinking alcohol earlier than 7<sup>th</sup> grade and had tried to be drunk earlier than 7<sup>th</sup> grade). The results of these analyses showed the same results: that early drinking onset was associated with binge drinking at age 15 and that the highest risk of binge-drinking was for the group that both had have an early drinking onset *and* came from families with high affluence.

Multiple imputation analyses revealed no difference in prevalence of binge-drinkers between the imputed data set and the original data set. When executing our logistic regression in the imputed data sets stratified for family affluence the same tendencies were observed: the odds of binge-drinking with early drinking onset were highest among adolescents from high affluence families. However, the odds ratios were not as high as in the original data set. (See table 4).

Table 4: Odds ratio for binge-drinking according to early drinking onset separately for boys and girls and stratified on Family Affluence Scale (FAS) (OR (CI 95%)) in the imputed data set.

OR for binge-drinking		OR, adjusted**		
		FAS		
		Low	Medium	High
<b>Boys</b>				
Early drinking onset				
No	1	1	0.83 (0.68-1.02)	1.21 (0.95-1.54)
Yes	1.74 (1.48-2.04)	0.83 (0.71-1.33)	1.21 (1.05-1.40)	1.32 (0.88-1.98)
<b>Girls</b>				
Early drinking onset				
No	1	1	0.89 (0.79-1.00)	1.05 (0.90-1.22)
Yes	1.64 (1.46-1.85)	0.93 (0.72-1.19)	1.22 (0.99-1.51)	1.32 (0.94-1.86)

## Discussion

In this study, we observed higher odds of binge-drinking for early drinkers. This finding was consistent across all strata of family affluence. Moreover, for both boys and girls the highest risk of binge drinking two years after baseline was among early drinking adolescents from families with high affluence.

Many studies have previously found negative consequences of early drinking,(Pitkanen et al. 2005;Pedersen and Skrondal 1998;Fergusson et al. 1995;Kuntsche et al. 2009;Warner and White 2003;Hawkins et al. 1997;Grant et al. 2001) however only few were conducted in large longitudinal study cohorts.(Grant et al. 2001;Fergusson et al. 1995) Therefore, our finding that early drinking onset is associated with an elevated risk of binge-drinking measured two years later provides more evidence of the consequences of early drinking onset. Additionally, only few studies have investigated social differentiation in the consequences of alcohol behaviour. The studies found that alcohol has different consequences according to different socioeconomic strata: adults with low socioeconomic position experienced more alcohol-related consequences given the same drinking pattern as adults with higher socioeconomic positions.(Kuendig et al. 2008;Makela and Paljarvi 2008) However, not all studies found evidence that socioeconomic position plays a role in the experience of alcohol-related consequences.(Eliassen et al. 2009) We find that adolescents who had had an early drinking onset had the highest odds ratio of binge-drinking if they came from high affluent backgrounds. Our finding indicates that socially differential vulnerability to alcohol may exist in adolescence, however it is the high affluence groups who is at highest risk of experiencing binge-drinking. Diderichsen et al. had suggested pathways in which socioeconomic circumstances affect health and health behaviour.(Diderichsen et al. 2001) Both pathways “differential exposure”, which suggests that the determinants are socially patterned, and “differential vulnerability”, which suggest that individuals may be more or less vulnerable to the effect of determinants depending on their other resources, may be mechanisms that contribute to the explanation of social differences in consequences of alcohol intake among adults.(Schmidt et al. 2010) We find opposite social differences in binge-drinking given early drinking onset among adolescents, than other studies among adults have found for more health-related consequences of a given alcohol intake. This could be explained by the choice of outcome used. In our study we focused on binge-drinking which is a consumption measure representing tracking of risky alcohol use, while the studies among adults focused on more health-related consequences such as mortality rates and injuries.(Kuendig et al. 2008;Makela and Paljarvi 2008) When focusing on a consumption measure as outcome among adolescents financial resources, and hereby availability to drink excessively, might be the explanation for our findings: that it is adolescents from high affluent family backgrounds that is at highest risk of binge-drinking given early drinking onset. Another factor in explaining our finding might be

age span under investigation: there may be different socioeconomic gradients in alcohol related consequences in different age groups. Additionally, drinking context may also be a factor in explaining our finding. A study implied that the risk of problem drinking for early drinkers was relatively greater when early drinking occurred outside the family context compared to at family gatherings.(Warner and White 2003) If drinking in a family context is more common in families of lower affluence, it may also contribute to explain our findings. However, the latter explanation depends on the association between family affluence and the family arena as drinking context, of which we do not have any information.

To our knowledge, the present study is the first investigating the effect of early drinking onset on binge-drinking according to different socioeconomic background. Our work was based on data with thorough measurements of relevant covariates. This implied that we were able to include almost all known important covariates for the investigated association. Further, the findings of the present study were strengthened by the prospective design, which is sparse in the evidence of alcohol use among adolescents. This design provided information on the sequence of events allowing for conclusions on causality, assuming proper confounding control. Potential confounders of the association between early drinking onset and binge-drinking were carefully selected on the basis of a causal diagram. However, we cannot exclude that the association can be affected by residual confounding. For instance, smoking might not be adequately adjusted for due to the lack of differentiation in measurement categories (have tried smoking/have never tried smoking). Further, several risk factors for binge drinking were not available in data, and the association may be affected by unmeasured confounding. Covariates such as adverse childhood experiences, and level of maturity, are some of the factors that might be potential confounders, that we, unfortunately, not could get adequate information on.

Other limitations of this study should also be addressed. The response rate of our study is low (63%), hence, caution should be taken when generalizing our findings. Adolescents, who chose to participate were more likely to be higher socioeconomic position.(Vinther-Larsen et al. 2010) Furthermore, only 30% of the participants at baseline were followed up two years later. We performed multiple imputations to investigate the effect of this high attrition and executed the analysis in the imputed data. This reduced the size of the risk of binge-drinking among high affluent early drinking boys and girls. However, the conclusion still stays: that both boys and girls from families with high affluence have a relative higher risk of binge-drinking when drinking at an early age, compared to boys and girls from families with lower affluence. However, due to the high attrition we cannot conclude how enhanced the risk is. We only had a two years follow-up period. And as stated earlier, the consequences of early drinking onset cannot only be seen in later adolescence but also in adulthood. Therefore, despite our findings

with a two year period of follow-up, we are unable to inform on the long-term evidence of social patterning in consequences of early drinking onset.

Our measurements of early drinking onset and binge-drinking may be subject to misclassification. Due to the Danish alcohol culture, drinking alcohol is more accepted than abstaining. This may lead to over reporting. Further, the measurement of binge-drinking is a sum of four variables (measuring units of beer, wine, spirits and alco-pops), which may lead to misunderstandings, when asking about *one* drinking occasion. This would influence the prevalence of binge-drinkers, and if adolescents from families with low affluence have more difficulties understanding the configuration of the questionnaire this may cause differential misclassification. Another problem of this measure is that adolescents' alcohol use fluctuates from occasion to occasion. Therefore one drinking occasion may not be representative for their normal alcohol intake. Better information of their usual intake should have been collected, for instance if they answer to a question of alcohol intake at a *usual* drinking occasion and not, as was done in this study, *last* drinking occasion. Further, we measured the adolescent's socioeconomic position by the affluence of the family, using the Family Affluence Scale (FAS). The validity of this measurement is documented.(Currie et al. 2008) A great number of adolescents are unable to give sufficient information about their parents' occupation and income, which render it impossible to place the parents in a social group. But almost all children can answer a number of questions concerning the family's number of cars, holidays etc.(Currie et al. 1997) Further, previous studies have found good correspondence between the adolescents' answers and their parents' answers to the FAS questions. Only for the question concerning number of family holidays poor agreement has been documented.(Andersen et al. 2008) This indicates no serious misclassification of the reporting of the measure.

We find that early drinking onset is strongly associated with binge-drinking two years later. This implies that postponing the onset of alcohol use may prevent later adolescent binge-drinking, which is an important public health goal, especially in Denmark, as Danish adolescent has the highest prevalence of binge-drinking in Europe.(Currie C et al. 2008) We find that early drinking onset is even stronger related to binge-drinking for adolescents from families of high affluence. This suggests an early opposite social vulnerability to alcohol intake, which adds to the evidence that postponement of drinking alcohol should be given high priority.

We conclude that early drinking is associated with binge drinking, and that the relative risk varies across groups of family affluence. This means that there may be social differentiation in the consequences of early drinking onset, though with a positive gradient.

**Acknowledgement**

The European Research Advisory Board and the Danish Health Insurance Fund funded the study.

## References

Andersen, A., Due, P., Holstein, B.E., and Iversen, L., 2003 Tracking drinking behaviour from age 15-19 years. *Addiction* 98, 1505-1511.

Andersen, A., Krolner, R., Currie, C., Dallago, L., Due, P., Richter, M., Orkenyi, A., and Holstein, B.E., 2008 High agreement on family affluence between children's and parents' reports: international study of 11-year-old children. *J.Epidemiol.Community Health* 62, 1092-1094.

Currie C, Nic Gabhain S, Godeau E, Roberts C, Smith R, Currie D, Pickett W, Richter M, Morgan A, and Barnekow V, 2008 Inequalities in young people's health: HBSC international report from the 2005/2006 Survey. World Health Organisation, Copenhagen

Currie, C., Roberts, C., Morgan, A., Smith, R., Settertoboulte, W., and Rasmussen, O.S.V.B., 2004 Young people's health in context. Health Behaviour in School-aged Children (HBSC) study: international report from the 2001/2002 survey. In: Candace Currie, C.R.A.M.R.S.W.S.O.S.V.B.R. (Ed.) WHO Regional Office for Europe, Copenhagen

Currie, C., Molcho, M., Boyce, W., Holstein, B., Torsheim, T., and Richter, M., 2008 Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. *Soc.Sci.Med.* 66, 1429-1436.

Currie, C.E., Elton, R.A., Todd, J., and Platt, S., 1997 Indicators of socioeconomic status for adolescents: the WHO Health Behaviour in School-aged Children Survey. *Health Educ.Res.* 12, 385-397.

Diderichsen, F., Evans, T., and Whitehead, M., 2001 The Social Basis of Disparities in Health. in: Evans, T., Whitehead, M., Diderichsen, F., Bhuiya, A., and Wirth, M. (Eds.), *Challenging inequities in health. From ethics to action* Oxford University Press, Oxford, pp. 13-23.

DuRant, R.H., Smith, J.A., Kreiter, S.R., and Krowchuk, D.P., 1999 The relationship between early age of onset of initial substance use and engaging in multiple health risk behaviors among young adolescents. *Arch.Pediatr.Adolesc.Med* 153, 286-291.

Eliassen, M., Kaer, S.K., Munk, C., Nygard, M., Sparen, P., Tryggvadottir, L., Liaw, K.L., and Gronbaek, M., 2009 The relationship between age at drinking onset and subsequent binge drinking among women. *Eur.J.Public Health* 19, 378-382.

Fergusson, D.M., Horwood, L.J., and Lynskey, M.T., 1995 The prevalence and risk factors associated with abusive or hazardous alcohol consumption in 16-year-olds. *Addiction* 90, 935-946.

Grant, B.F., Stinson, F.S., and Harford, T.C., 2001 Age at onset of alcohol use and DSM-IV alcohol abuse and dependence: a 12-year follow-up. *J Subst.Abuse* 13, 493-504.

Greenland, S., Pearl, J., and Robins, J.M., 1999 Causal diagrams for epidemiologic research. *Epidemiology* 10, 37-48.

Gruber, E., DiClemente, R.J., Anderson, M.M., and Lodico, M., 1996 Early drinking onset and its association with alcohol use and problem behavior in late adolescence. *Prev.Med* 25, 293-300.

Hawkins, J.D., Graham, J.W., Maguin, E., Abbott, R., Hill, K.G., and Catalano, R.F., 1997 Exploring the effects of age of alcohol use initiation and psychosocial risk factors on subsequent alcohol misuse. *J Stud.Alcohol* 58, 280-290.

Hingson, R., Heeren, T., Levenson, S., Jamanka, A., and Voas, R., 2002 Age of drinking onset, driving after drinking, and involvement in alcohol related motor-vehicle crashes. *Accid.Anal.Prev.* 34, 85-92.

Hingson, R., Heeren, T., Winter, M.R., and Wechsler, H., 2003a Early age of first drunkenness as a factor in college students' unplanned and unprotected sex attributable to drinking. *Pediatrics* 111, 34-41.

Hingson, R., Heeren, T., Zakocs, R., Winter, M., and Wechsler, H., 2003b Age of first intoxication, heavy drinking, driving after drinking and risk of unintentional injury among U.S. college students. *J Stud.Alcohol* 64, 23-31.

Hingson, R.W., Assailly, J.P., and Williams, A.F., 2004 Underage drinking: frequency, consequences, and interventions. *Traffic.Inj.Prev.* 5, 228-236.

Hingson, R.W., Heeren, T., and Edwards, E.M., 2008 Age at drinking onset, alcohol dependence, and their relation to drug use and dependence, driving under the influence of drugs, and motor-vehicle crash involvement because of drugs. *J.Stud.Alcohol Drugs* 69, 192-201.

Hingson, R.W., Heeren, T., Jamanka, A., and Howland, J., 2000 Age of drinking onset and unintentional injury involvement after drinking. *JAMA* 284, 1527-1533.

Jefferis, B.J., Power, C., and Manor, O., 2005 Adolescent drinking level and adult binge drinking in a national birth cohort. *Addiction* 100, 543-549.

Komro, K.A., Tobler, A.L., Maldonado-Molina, M.M., and Perry, C.L., 2010 Effects of alcohol use initiation patterns on high-risk behaviors among urban, low-income, young adolescents. *Prev.Sci.* 11, 14-23.

Kraus, L., Bloomfield, K., Augustin, R., and Reese, A., 2000 Prevalence of alcohol use and the association between onset of use and alcohol-related problems in a general population sample in Germany. *Addiction* 95, 1389-1401.

Kuendig, H., Plant, M.L., Plant, M.A., Kuntsche, S., Miller, P., Gmel, G., Ahlstrom, S., Bergmark, K.H., Olafsdottir, H., Elekes, Z., Csemy, L., and Knibbe, R., 2008 Beyond drinking: differential effects of demographic and socioeconomic factors on alcohol-related adverse consequences across European countries. *Eur.Addict.Res.* 14, 150-160.

Kuntsche, E., van, d., V, and Engels, R., 2009 The earlier the more? Differences in the links between age at first drink and adolescent alcohol use and related problems according to quality of parent-child relationships. *J.Stud.Alcohol Drugs* 70, 346-354.

Kypri, K., Paschall, M.J., Langley, J., Baxter, J., Cashell-Smith, M., and Bourdeau, B., 2009 Drinking and alcohol-related harm among New Zealand university students: findings from a national Web-based survey. *Alcohol Clin.Exp.Res.* 33, 307-314.

Makela, P. and Paljarvi, T., 2008 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* 62, 728-733.

O'Grady, K.E., Arria, A.M., Fitzelle, D.M., and Wish, E.D., 2008 Heavy Drinking and Polydrug Use among College Students. *J Drug Issues* 38, 445-466.

Pedersen, W. and Skrondal, A., 1998 Alcohol consumption debut: predictors and consequences. *J Stud.Alcohol* 59, 32-42.

Pitkanen, T., Lyyra, A.L., and Pulkkinen, L., 2005 Age of onset of drinking and the use of alcohol in adulthood: a follow-up study from age 8-42 for females and males. *Addiction* 100, 652-661.

Prescott, C.A. and Kendler, K.S., 1999 Age at first drink and risk for alcoholism: a noncausal association. *Alcohol Clin Exp Res.* 23, 101-107.

Rothman, E.F., DeJong, W., Palfai, T., and Saitz, R., 2008 Relationship of age of first drink to alcohol-related consequences among college students with unhealthy alcohol use. *Subst.Abus.* 29, 33-41.

Schmidt, L.A., Mäkelä, P., Rehm, J., and Room, R., 2010 Alcohol: equity and social determinants. in: Blass, E. and Kurup, A.S. (Eds.), Equity, social determinants and public health programmes

Tennant, F.S., Jr. and Detels, R., 1976 Relationship of alcohol, cigarette, and drug abuse in adulthood with alcohol, cigarette and coffee consumption in childhood. *Prev.Med* 5, 70-77.

Vieira, D.L., Ribeiro, M., and Laranjeira, R., 2007 Evidence of association between early alcohol use and risk of later problems. *Rev.Bras.Psiquiatr.* 29, 222-227.

Vinther-Larsen, M., Riegels, M., Rod, M.H., Schiøtz, M., Curtis, T., and Gronbaek, M., 2010 The Danish Youth Cohort: Characteristics of participants and non-participants and determinants of attrition. *Scand.J.Public Health.*

Wagner, F.A., Velasco-Mondragon, H.E., Herrera-Vazquez, M., Borges, G., and Lazcano-Ponce, E., 2005 Early alcohol or tobacco onset and transition to other drug use among students in the state of Morelos, Mexico. *Drug Alcohol Depend.* 77, 93-96.

Warner, L.A. and White, H.R., 2003 Longitudinal effects of age at onset and first drinking situations on problem drinking. *Subst.Use.Misuse.* 38, 1983-2016.



## Paper IV



# Author's Accepted Manuscript

Area level deprivation and drinking patterns among adolescents

Mathilde Vinther-Larsen, Taisia Huckle, RuQuan You, Sally Casswell



[www.elsevier.com/locate/healthplace](http://www.elsevier.com/locate/healthplace)

PII: S1353-8292(12)00168-2  
DOI: <http://dx.doi.org/10.1016/j.healthplace.2012.09.014>  
Reference: JHAP1243

To appear in: *Health & Place*

Received date: 24 November 2011  
Revised date: 14 September 2012  
Accepted date: 14 September 2012

Cite this article as: Mathilde Vinther-Larsen, Taisia Huckle, RuQuan You and Sally Casswell, Area level deprivation and drinking patterns among adolescents, *Health & Place*, <http://dx.doi.org/10.1016/j.healthplace.2012.09.014>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting galley proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

**AUTHORS:** Cand.scient.san.publ Mathilde Vinther-Larsen<sup>a</sup>, MA(Hons) Taisia Huckle<sup>b</sup>,  
MSc(Hons) RuQuan You<sup>b</sup>, PhD Sally Casswell<sup>b</sup>

**AUTHOR AFFILIATIONS:**

<sup>a</sup> National Institute of Public Health, University of Southern Denmark, Copenhagen, Denmark

<sup>b</sup> SHORE and Whariki Research Centre School of Public Health, Massey University, Auckland,  
New Zealand

**CORRESPONDENCE TO:**

Mathilde Vinther-Larsen

National Institute of Public Health,

Øster Farimagsgade 5A, DK-1353 Copenhagen K

Telephone +45 65 50 77 77

E-mail: mvl@niph.dk

**TITLE:** Area level deprivation and drinking patterns among adolescents

**TOTAL PAGE COUNT: 21**

**WORD COUNT (text excluding abstract, references, tables, max 4000-6000): 3954**

**WORD COUNT (abstract, about 100): 126**

**ABSTRACT**

**Objective:** To assess relationships between area level deprivation and drinking patterns among adolescents.

**Method:** This study uses data from the national New Zealand Alcohol Survey 2004 comprising 1828, age range 12-19 years. A multilevel linear regression was conducted using NZDep2001 (a composite deprivation measure) as the exposure and alcohol use (quantity and frequency) as outcome.

**Results:** A J-shaped association was observed between area level deprivation and quantity of adolescents' alcohol use after controlling for age, sex, ethnicity, and individual socioeconomic position; where adolescents living in the most deprived areas consumed the heaviest quantities of alcohol. No association was found for frequency of drinking.

**Conclusion:** This study found a J-shaped relationship between area-level disadvantage and increased quantities consumed, where adolescents living in the most deprived areas typically consumed the heaviest quantities of alcohol. However, our study has also highlighted that future research may better isolate an independent relationship between deprivation and consumption in adolescents by accounting for structural variables related to both deprivation and consumption, such as alcohol outlet density

**KEY WORDS:** Area level deprivation, drinking patterns, adolescents, New Zealand

## INTRODUCTION

Researchers have increasingly recognised the importance of community characteristics, such as area level socioeconomic position, in shaping health outcomes and behaviours (Galea et al. 2007a;Galea et al. 2007b;Karriker-Jaffe 2011;Macintyre et al. 2002;Marmot 2005;Pickett and Pearl 2001;Stimpson et al. 2007). The teenage years are especially important when focusing on health behaviours, as this is when lifestyles and habits develop and future lifestyles are established (Kleinert 2007;Masten et al. 2008). However, little attention has been given to how area level socioeconomic position relates to adolescent risk behaviours, including alcohol use.

Studies assessing relationships between area level socioeconomic position and drinking patterns among young people are relatively rare and a key limitation within the existing literature is that no clear picture emerges as to whether area level disadvantage is related to

increased adolescent drinking behaviour .(Karriker-Jaffe 2011). Many of the studies, which have been carried out in North America or Europe, have found no association between area level socioeconomic position and quantity of alcohol intake.(Breslin and Adlaf 2005;Ecob and Macintyre 2000;Song et al. 2009) For example, a study from Scotland found no association between area level deprivation and number of units drunk on the last occasion among those aged 15 years.(Ecob & Macintyre 2000) A recent review on area level deprivation and substance use highlighted that the effect of area level deprivation on alcohol behaviour was less likely to be significant among youth samples compared with adult samples, and questioned whether this was due to small samples or simply no associations among adolescents.(Karriker-Jaffe 2011)

However, other studies have found relationships. A study from North America found that living in an area with low deprivation was associated with greater frequency of alcohol intake among adolescents.(Lo CC et al. 2006) Another study from North America compared children of alcoholics (COAs) and non-children of alcoholics (non-COAs). Among non-COAs, higher neighbourhood socioeconomic status predicted higher volume but among COAs lower neighbourhood socioeconomic status predicted increased volume. .(Trim and Chassin 2008) Another North American study found that higher area level income was associated with greater frequency of drunkenness, but that living in an area with high percent below the poverty level was associated with greater frequency of drunkenness.(Reboussin et al. 2010)

Mixed findings among studies of adolescents may be due the different contexts assessed, be related to lower power in adolescent samples (as mentioned above), but may also be related to differences in measures of area level socioeconomic position used across studies. In the majority of previous studies among adolescent populations(excluding for example Ecob et

al(2000) and Lo et al,(2006)) single item measures of area level socioeconomic position such as percentage with low income or percentage below the poverty level have been used.(Breslin & Adlaf 2005;Karvonen and Rimpela 1996;Reboussin, Preisser, Song, & Wolfson 2010;Song, Reboussin, Foley, Kaltenbach, Wagoner, & Wolfson 2009) However as single item measures only measure one aspect of community socioeconomic position, results may vary depending on the aspect measured. Using a composite measure, that captures many aspects of community socioeconomic position rather than a single item measure might better reflect the underlying concept of a neighbourhood's socioeconomic position.(Pickett & Pearl 2001)

Studies have found that socioeconomic position at an individual level is associated with adolescents' alcohol behaviour. However, as with the area level studies, findings have not been consistent,(Bahr et al. 1995;Droomers et al. 2003;Due and Holstein 1991;Goodman and Huang 2002;Kuntsche et al. 2004;Marmot 1997;Richter et al. 2006) which might be explained by the use of different socioeconomic measures and consumption outcome measures. This is supported by the study by Casswell et al. that found that individual level socioeconomic position measured by both income, occupation, and education were related to different aspects of drinking pattern differently among young adults.(Casswell et al. 2003) As socioeconomic position at the individual level seems to be associated with drinking patterns among adolescents and since area level socioeconomic position is affected by the socioeconomic position of the individuals living in the areas, it is necessary to include the socioeconomic position of the individual when conducting analyses of the influence of area level socioeconomic position. This is supported by Karriker-Jaffe, that highlights that socioeconomic position at an individual level is likely to be an important variable to consider when conducting socioeconomic area level analyses.(Karriker-Jaffe 2011)

Area level socioeconomic position or the socioeconomic profile of an area may be related to health and behaviour in different ways:(Stimpson, Ju, Raji, & Eschbach 2007) *a social exchange pathway*, which means that behaviour is influenced by the culture and behaviours of others in the area; *a stress induced pathway*, which means living in a deprived area activates stress and in turn results in risky health behaviours; and *a structural pathway*, which means the physical environment can affect behaviour, by, for example, access to and availability of alcohol. Relevant to this last point, New Zealand has experienced liberalising alcohol policy changes increasing the physical availability of alcohol including: proliferation of alcohol outlets with longer trading hours. .

Relatively few studies have assessed relationships between area level socioeconomic position and drinking patterns among adolescents and fewer have used composite area level measures of socio-economic position to assess these relationships. Therefore the aim of this study is to explore if the deprivation of the area in which adolescents live is related to increased alcohol consumption (over and above the influence of individual socioeconomic position on alcohol behaviour).

#### **METHODS**

The study population was 12-19 year olds, nationally, living in households with access to a landline telephone (and who had lived in New Zealand for at least one year). A representative sample of 1828 respondents aged 12-19 years was obtained. Contact and interviewing were undertaken using an in-house computer assisted telephone interviewing (CATI) system. A high level of quality control was achieved using this CATI system (for further explanation see Casswell et al.,2002).(Casswell et al. 2002) The response rate was 60%. Ethics approval for the surveys was obtained (Massey University).

A stratified sample design was used and within each stratum random digit dialling was used to select a household (including listed and unlisted phone numbers). The strata, when combined, covered the whole of New Zealand (strata were based on geographical areas, similar to territorial authorities, defined by Statistics New Zealand). Landline telephone coverage in New Zealand was high in 2004 (93%) when compared with international figures. Certain sectors of the population are underrepresented among telephone surveys. However, this did not affect population estimates of alcohol consumption.(Wyllie et al. 1994)

A further random selection was then made to determine which individuals in the household would be interviewed. Respondents aged 12-19 years were enumerated and independently and randomly selected by computer based on the number of eligible individuals living in the household. All potential respondents had an equal probability of being selected. Data were collected in 2004. An oversample of Maori (the indigenous people of New Zealand) was also collected and then weighted back down to match the corresponding population estimates obtained from Statistics New Zealand.(Statistics New Zealand 2009) The sample demographics matched the census well. The sample demographics matched the census on gender, age, socioeconomic status (education, employment, and income), ethnicity, and geographic region.(Huckle et al. 2011)

## **Measures**

### **Individual level**

#### *Typical occasion quantity and frequency of drinking in the last 12 months*

Drinkers in the past 12 months were asked at which of a number of mutually exclusive locations, plus any additional locations, they had drunk. For each place respondents drank in they were asked how often they drank there and how much they would drink on a typical occasion at that location.

Respondents reported the quantities of alcohol they consumed in their own terms and these were coded by interviewers using the wide range of containers commonly used to serve and sell alcoholic beverages in New Zealand. Numerous container coding options were available specific to different beverage types.(Casswell, Huckle, & Pledger 2002) Beverage conversions were based on container sizes and standard alcohol content beverages as documented by Statistics New Zealand.

From these data, the continuous variables: typical occasion quantity (millilitres of pure alcohol) and frequency of drinking were derived (count in previous 12 months) were derived. These consumption measures have been found to have good validity and give a very good approximation to alcohol available for consumption in New Zealand. For further description see.(Casswell, Huckle, & Pledger 2002)

The individual socioeconomic position of each 12-19 year old was obtained from a question they answered in the survey about the occupation of the main earner in their household. Occupations were asked about in the following categories: professional with university or other qualifications, director/managerial, clerical/sales/service, craftsman/skilled tradesman/ manual worker/labourer, and others (which we combined as homemaker, pensioner/retired, student, beneficiary/ unemployed, no main income earner; due to small numbers in these categories). This measure was used, as there was no information from the adolescents regarding household income or educational level of their parents due to the fact that they have difficulties answering such questions.(Currie et al. 2008) We compared the distribution of the variable measuring occupation of main earner of the household in the youth sample with the distribution of the same variable in the total population sample (age range 12-65) and they were in good agreement.

Respondents also reported which ethnic group they belonged to (NZ European, Maori, Asian, and Pacific) and their age.

#### **Area level measure**

To examine the effect of the area level deprivation on adolescents' alcohol consumption, a variable that described the level of deprivation for different areas in New Zealand, the NZDep2001 index of deprivation was used. (Salmond et al. 2006) Each phone number/household in the survey had Census Area Unit (CAU) information attached. A CAU is the second smallest geographical area utilised by Statistics New Zealand roughly the size of a suburb (with a median of 2,000 people). This allowed us to match respondent's geographical location to the NZDep Index (that was also calculated at the CAU level).

The index consists of nine deprivation-related dimensions derived from Census 2001 data: income (proportions receiving a means tested benefit), income (proportions living in household with income below and income threshold), owned home (proportions of people not living in own home), support (proportions of people living in a single-parent family), employment (proportions of people unemployed), qualifications (proportions of people without any qualifications), living space (proportions of people living in households below a bedroom occupancy threshold), communication (proportions of people living with no access to a telephone), and transport (proportions of people living with no access to a car). NZDep2001 scores areas from 1 to 10 where 1 = areas of least deprivation and 10 = areas of most deprivation.

### Statistical analysis

The analysis was based on drinkers and individuals with full information on covariates, which left a sample on 1144 individuals. Multi-level modelling was used to model the hierarchical structures present, and thereby account for the individuals in this study being nested within spatial units (CAU's median of 2,000 people). Multi-level modelling was also applied to investigate the impact of area level data on our individual variable of interest. The intraclass correlations (ICC) for quantity and frequency of alcohol intake, respectively, were small but significant:  $ICC_{Quantity}=0.006$ , p-value: 0.0074 and  $ICC_{Frequency}=0.005$ , p-value:  $<0.0001$ . This means that the between area variations only attribute a little to the overall variation of alcohol intake, though the variances are significant which indicates the use of multilevel models. Multilevel models were used to analyse the association of area level deprivation with adolescents' drinking patterns. Multilevel linear regressions (random intercept) were conducted with quantity at typical drinking occasion and frequency of alcohol consumption in separate models, NZDep2001, individual socioeconomic position, ethnicity, age and sex as fixed effects. To optimize the choice of statistical model, we checked for quadratic effects of NZDep2001. It was not significant for frequency, but it was significant for quantity of alcohol consumption. Therefore, NZDep2001 was included as a quadratic linear effect in the model with quantity of alcohol as outcome. Further, outcome variables were not normally distributed, and as a result we included the outcome variables as log-transformed, but back log-transformed for the final results. Significance was indicated with a p-value  $<0.05$ . All analyses were performed using SAS version 9.2.

## RESULTS

Table 1 describes the study population's mean age, distribution by gender, area level deprivation, individual socioeconomic position, and ethnicity. The mean age of the study population was 16.6 years. Fifty three percent of the sample were female, 60% of the sample lived in more deprived areas (NZDEP index 6-10), and the participants were primarily Maori (46.5%) and European (46.5%).

On a typical drinking occasion boys consumed 69 mls of pure alcohol (or 4.6 drinks – a drink defined here as 15ml pure alcohol) and females drank on average 3.5 drinks. Males drank, on average, once a week and females a bit less frequently. The estimates show that, in general, participants living in the most deprived areas had higher typical occasion quantities. Typical occasion quantity was higher among lower occupation levels (in particular manual workers and the other category). The estimates show that Maori and Pacific peoples consumed a higher amount of alcohol on a typical drinking occasion. Adolescents of Pacific origin also drank frequently however, relatively speaking, adolescents with Asian origin did not. (Table 1)

Table 2 shows the fixed effects from the multilevel linear regression. Area level deprivation was significantly associated with typical occasion quantity in a J-shaped relation after controlling for age, sex, ethnicity and individual socioeconomic position (Table 2). The  $\beta$ -estimates decreased slightly with an average decrease on -0.0267 until NZDep2001-category 4, and increased at an average rate of about 0.0658 after NZDep2001-category 4. The difference in  $\beta$ -estimates between NZDep2001-category 1 and NZDep2001-category 4 was 0.0802 and the difference between NZDep2001-category 4 and NZDep2001-category 10 was 0.3948. This means that adolescents living in areas with the least deprivation (NZDep2001-category 1) consumed 8% more alcohol on a typical drinking occasion than adolescents living

in medium deprived areas (NZDep2001-category 4), and that that adolescents living in areas with the highest deprivation (NZDep2001-category 10) consumed 48% more alcohol on a typical drinking occasion than adolescents living in medium deprived areas (NZDep2001-category 4). At the individual level adolescents who reported that the main income earner in their household was a 'Craftsman/skilled tradesman' or a 'Manual worker' (both lower occupation levels) were significantly associated with increased typical occasion quantity. Increased age was associated with significantly higher typical occasion quantity. Boys had significantly higher typical occasion quantity compared to girls. Adolescents of Maori ethnicity consumed significantly more on a typical occasion while adolescents reporting Asian ethnicity consumed less (compared to European adolescents).

We did not find a significant association between area level deprivation and frequency of alcohol intake (Table 2). At the individual level, adolescents who reported that the main income earner was in the 'other' category had significantly lower frequency of drinking in the last 12 months. Increased age was associated with significantly higher frequency; males had higher frequency of drinking compared to females; and young Asian people drank less frequently (compared to European adolescents).

## DISCUSSION

This study examined the relationship between area level deprivation and drinking patterns among adolescents. We found a J-shaped association between area level deprivation and quantity of adolescents' alcohol consumption, which means that adolescents' living in the highest deprived areas consumed the most alcohol on a typical occasion but that those living in the least deprived area consumed slightly more than those in the medium deprived areas.

We did not find an association between area level deprivation and frequency of alcohol consumption.

To the best of our knowledge, no previous studies among adolescents have found a J-shaped relation between area level deprivation and quantity of alcohol consumption but several factors may help to explain this relationship. There is some evidence to suggest that living in affluent areas is associated with more substance use among adolescents. In particular, higher disposable income among these adolescents may enable greater use.(Karriker-Jaffe 2011) It could be possible that, in the New Zealand context, community advantage was generally protective but that greater disposable income may have allowed for a modest increase in typical occasion quantity among adolescents living in the least deprived areas (over those living in medium deprived areas). It is also possible that the J-shaped relationship is due to its association with factors other than those measured and adjusted for (however a J –shaped relationship between deprivation and hazardous alcohol use (as measured by AUDIT) has been found previously in New Zealand for males aged 15 – 75+.(Ministry of Health 2008)

Our finding that adolescents living in the highest deprived areas are the ones that consume the most alcohol is supported by an earlier large US study in an adult population where living in a deprived area was found to be associated with high quantity alcohol intake.(Stimpson, Ju, Raji, & Eschbach 2007) A regional sample in New Zealand has also observed a similar association with higher quantities of alcohol consumed among adolescents living in areas with high deprivation.(Huckle et al. 2008)

Deprivation was not associated with frequency of drinking among adolescents in this sample. Perhaps the lack of association among adolescents is related to other factors

holding drinking frequency constant across deprivation groups; such as living with parents likely to prevent drinking on days other than the weekends. It may also reflect the possibility that deprivation may have varying effects according to different drinking patterns.

Although the aim of this study was not to test the pathways in which area level socioeconomic position may influence adolescent's behaviour; the finding that greater quantities were consumed in the most deprived areas could be consistent with several explanatory pathways. Including, the social exchange pathway, where behaviour is influenced by others behaviour in the area, or the stress induced pathway, where the stress of living in a deprived area leads to risky behaviour. For example lack of recreational facilities for activity and other sources of stress such as racism. However, the New Zealand policy context may also be relevant. These data were observed in New Zealand following a period of significant alcohol policy liberalisation that resulted in considerable increases in the physical availability of alcohol, particularly for young people. Increases in the quantities of alcohol consumed by young people were also found over the time of the policy changes.(Habgood et al. 2001) As suggested by the structural pathway hypothesis, where the physical environment can influence behaviour, a New Zealand study found that people living in more deprived areas did have greater access to alcohol outlets,(Hay et al. 2009) and another study found that density of alcohol outlets increased the quantity of alcohol intake among adolescents.(Huckle, Huakau, Sweetsur, Huisman, & Casswell 2008) A previous study from New Zealand found that the liberalising policy changes may have had more effects on consumption among people with lower socioeconomic position.(Huckle et al. 2010)

The fact that alcohol outlets cluster in more deprived areas in New Zealand raises an important issue however, it is possible that our finding of increased quantities consumed in more deprived areas is, in part, explained by increased alcohol outlet density in more

deprived areas. A limitation of this current study (and of the literature more generally among adolescents, deprivation and consumption) is that structural variables such as outlet density that may be related to both deprivation and consumption are not generally controlled for. Although we were not able to do this in this study, we recommend that future studies consider doing so in order to better identify the independent effect of deprivation on consumption.

In the majority of previous studies among adolescent populations only single item measures such as percentage with low income or percentage below the poverty level have been used.(Breslin & Adlaf 2005;Karvonen & Rimpela 1996;Reboussin, Preisser, Song, & Wolfson 2010;Song, Reboussin, Foley, Kaltenbach, Wagoner, & Wolfson 2009) We have used the NZDep2001 index of deprivation, which is a robust composite measure of area level socioeconomic position.(Blakely and Pearce 2002) It measures nine different aspects of an area's socioeconomic position. Pickett et al., in their review of effects of neighbourhood context on health outcomes, highlight that using a composite measure rather than a single item measure might better reflect the underlying concept of a neighbourhood's socioeconomic position.(Pickett & Pearl 2001) In our study the composite measure consisted of nine items, which, however, render the assumption that all nine items has equal weight in the overall measure. This assumption, however, may be too strong to make.

We cannot preclude that confounding effects are not, in part, explaining the association although we have tried to eliminate the effect of the composition of the individuals in the area units by adjusting for individual socioeconomic position, age, and ethnicity confounding might still be present and hereby explain some of the association (for example alcohol outlet density). We do not claim that there is a causal link between deprivation and quantities consumed among adolescents.

We cannot rule out the possibility that our finding still reflects the effects of individual socioeconomic position. We have controlled for individual socioeconomic position by using one variable measuring occupation of main earner of the household. More variables of the individual socioeconomic position, such as income and educational background, would have been useful. However, due to the limitations of the data we only had one variable to include in the analysis. The validity of adolescents' reports of their parents' occupations have also been questioned.(Currie, Molcho, Boyce, Holstein, Torsheim, & Richter 2008) However, others have found good accordance between adolescents' and parents' reports.(Lien et al. 2001) Further, as mentioned previously we did compare the distribution of the variable in the youth sample with the distribution in an adult sample and found no differences.

The multilevel model incorporated only two levels (individuals within neighbourhoods). Future studies would benefit from examining additional levels, such as individuals within peer groups or families and peer groups or families within neighbourhoods. This will provide the opportunity to explore more complex models of youth and the areas' effect on their alcohol use. However Jayne et al states quantitative methods while "produce broad insights, do not fully explain the ways in which practices are deeply embedded in specific national social and cultural contexts" (Jayne et al. 2008)(pp. 87). Using more integrated methods and/or in-depth qualitative investigations of the drinking-related practices and experiences of youth living in diverse social and cultural contexts would be a useful direction for future research.

Our measurements of alcohol also require further explanation. Alcohol surveys usually underestimate consumption when compared to taxable alcohol. However, comparison of the 2004 survey data with taxable alcohol in New Zealand (calculated by Statistics New

Zealand) has shown that the volume accounted for by the survey data, when scaled to a population level, accounted for 91% of the taxable alcohol. (Social and Health Outcomes Research and Evaluation (SHORE) 2006) We therefore believe our measurements of alcohol intake are not subject to serious misclassification. However, young people might tend to over report intake of alcohol if they perceive the behavior to be desirable. (Hagger-Johnson 2011)

### **Conclusion**

This study found a J-shaped relationship between area-level disadvantage and increased quantities consumed, where adolescents living in the most deprived areas typically consumed the heaviest quantities of alcohol. However, our study has also highlighted that future research may better isolate an independent relationship between deprivation and consumption in adolescents by accounting for structural variables related to both deprivation and consumption, such as alcohol outlet density. Also, utilising more integrated methods and/or in-depth qualitative investigations to reveal the culturally and socially embedded nature of drinking-related practices of adolescents would be of value.

### **ACKNOWLEDGEMENTS**

The National New Zealand Alcohol Survey 2004 was carried out by the SHORE and Whariki Research Centre, School of Public Health, Massey University and was funded by Public Health Intelligence, Ministry of Health in New Zealand. The Danish Health Insurance Fund, funded this analysis.

**HIGH LIGHTS**

- Association between area level deprivation and adolescents' alcohol use is investigated
- A J-shaped association between area level deprivation and quantity of alcohol is seen
- No association between area level deprivation and frequency of alcohol consumption is observed

Accepted manuscript

## References

- Bahr, S.J., Marcos, A.C., & Maughan, S.L. 1995. Family, educational and peer influences on the alcohol use of female and male adolescents. *J Stud.Alcohol*, 56, (4) 457-469 available from: PM:7674682
- Blakely, T. & Pearce, N. 2002. Socio-economic position is more than just NZDep. *N.Z.Med.J.*, 115, (1149) 109-111 available from: PM:11999223
- Breslin, F.C. & Adlaf, E.M. 2005. Part-time work and adolescent heavy episodic drinking: the influence of family and community context. *J.Stud.Alcohol*, 66, (6) 784-794 available from: PM:16459940
- Casswell, S., Huckle, T., & Pledger, M. 2002. Survey data need not underestimate alcohol consumption. *Alcohol Clin.Exp.Res.*, 26, (10) 1561-1567 available from: PM:12394290
- Casswell, S., Pledger, M., & Hooper, R. 2003. Socioeconomic status and drinking patterns in young adults. *Addiction*, 98, (5) 601-610 available from: PM:12751977
- Currie, C., Molcho, M., Boyce, W., Holstein, B., Torsheim, T., & Richter, M. 2008. Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. *Soc.Sci.Med.*, 66, (6) 1429-1436 available from: PM:18179852
- Droomers, M., Schrijvers, C.T., Casswell, S., & Mackenbach, J.P. 2003. Occupational level of the father and alcohol consumption during adolescence; patterns and predictors. *J Epidemiol Community Health*, 57, (9) 704-710 available from: PM:12933777
- Due, P. & Holstein, B. 1991. Alcohol Consumption and Social Factors among 11-15 year old [Alkoholforbrug og sociale faktorer blandt 11-15 årige]. *Nordisk Psykologi*, 43, (4)
- Ecob, R. & Macintyre, S. 2000. Small area variations in health related behaviours; do these depend on the behaviour itself, its measurement, or on personal characteristics? *Health Place.*, 6, (4) 261-274 available from: PM:11027952
- Galea, S., Ahern, J., Tracy, M., Rudenstine, S., & Vlahov, D. 2007a. Education inequality and use of cigarettes, alcohol, and marijuana. *Drug Alcohol Depend.*, 90 Suppl 1, S4-15 available from: PM:17129684
- Galea, S., Ahern, J., Tracy, M., & Vlahov, D. 2007b. Neighborhood income and income distribution and the use of cigarettes, alcohol, and marijuana. *Am.J.Prev.Med.*, 32, (6 Suppl) S195-S202 available from: PM:17543711
- Goodman, E. & Huang, B. 2002. Socioeconomic status, depressive symptoms, and adolescent substance use. *Arch.Pediatr.Adolesc.Med*, 156, (5) 448-453 available from: PM:11980549

Habgood, R., Casswell, S., Pledger, M., & Bhatta, K. 2001, Drinking in New Zealand: National Surveys Comparison 1995 & 2000, Alcohol and Public Health Research Unit, University of Auckland, Auckland.

Hagger-Johnson, G. 2011, Alcohol in Use in Youth (Survey Question Bank, Topic Overview 3), UK Data Archive, University of Leeds, United Kingdom.

Hay, G.C., Whigham, P.A., Kypri, K., & Langley, J.D. 2009. Neighbourhood deprivation and access to alcohol outlets: a national study. *Health Place.*, 15, (4) 1086-1093 available from: PM:19540790

Huckle, T., Huakau, J., Sweetsur, P., Huisman, O., & Casswell, S. 2008. Density of alcohol outlets and teenage drinking: living in an alcogenic environment is associated with higher consumption in a metropolitan setting. *Addiction*, 103, (10) 1614-1621 available from: PM:18821871

Huckle, T., You, R.Q., & Casswell, S. 2010. Socio-economic status predicts drinking patterns but not alcohol-related consequences independently. *Addiction*, 105, (7) 1192-1202 available from: PM:20456295

Huckle, T., You, R.Q., & Casswell, S. 2011. Increases in quantities consumed in drinking occasions in New Zealand 1995-2004. *Drug Alcohol Rev.*, 30, (4) 366-371 available from: PM:21355906

Jayne, M., Valentine, G., & Holloway, S. 2008. Fluid Boundaries—British Binge Drinking and European Civility: Alcohol and the Production and Consumption of Public Space. *Space and Polity*, 12, (1) 81-100

Karriker-Jaffe, K.J. 2011. Areas of disadvantage: a systematic review of effects of area-level socioeconomic status on substance use outcomes. *Drug Alcohol Rev.*, 30, (1) 84-95 available from: PM:21219502

Karvonen, S. & Rimpela, A. 1996. Socio-regional context as a determinant of adolescents' health behaviour in Finland. *Soc.Sci.Med*, 43, (10) 1467-1474 available from: PM:8923619

Kleinert, S. 2007. Adolescent health: an opportunity not to be missed. *Lancet*, 369, (9567) 1057-1058 available from: PM:17398287

Kuntsche, E., Rehm, J., & Gmel, G. 2004. Characteristics of binge drinkers in Europe. *Soc.Sci.Med*, 59, (1) 113-127 available from: PM:15087148

Lien, N., Friestad, C., & Klepp, K.I. 2001. Adolescents' proxy reports of parents' socioeconomic status: How valid are they? *J.Epidemiol.Community Health*, 55, (10) 731-737 available from: PM:11553657

Lo CC, Anderson AS, Minugh PA, & Lomuto N 2006. Protecting Alabama Students From Alcohol and Drugs: A Multi-Level Modeling Approach. *J Drug Issues*, 36, 687-718

Macintyre, S., Ellaway, A., & Cummins, S. 2002. Place effects on health: how can we conceptualise, operationalise and measure them? *Soc.Sci.Med.*, 55, (1) 125-139 available from: PM:12137182

Marmot, M. 1997. Inequality, deprivation and alcohol use. *Addiction*, 92 Suppl 1, 13-20 available from: PM:9167283

Marmot, M. 2005. Social determinants of health inequalities. *Lancet*, 365, (9464) 1099-1104 available from: PM:15781105

Masten, A.S., Faden, V.B., Zucker, R.A., & Spear, L.P. 2008. Underage drinking: a developmental framework. *Pediatrics*, 121 Suppl 4, S235-S251 available from: PM:18381492

Ministry of Health 2008, A Portrait of Health: Key results of the 2006/07 New Zealand Health Survey., Ministry of Health, Wellington.

Pickett, K.E. & Pearl, M. 2001. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *J.Epidemiol.Community Health*, 55, (2) 111-122 available from: PM:11154250

Reboussin, B.A., Preisser, J.S., Song, E.Y., & Wolfson, M. 2010. Geographic clustering of underage drinking and the influence of community characteristics. *Drug Alcohol Depend.*, 106, (1) 38-47 available from: PM:19740611

Richter, M., Leppin, A., & Nic, G.S. 2006. The relationship between parental socioeconomic status and episodes of drunkenness among adolescents: findings from a cross-national survey. *BMC.Public Health*, 6, 289 available from: PM:17132161

Salmond, C., Crampton, P., King, P., & Waldegrave, C. 2006. NZiDep: a New Zealand index of socioeconomic deprivation for individuals. *Soc.Sci.Med.*, 62, (6) 1474-1485 available from: PM:16154674

Social and Health Outcomes Research and Evaluation (SHORE) 2006, Comparing survey data with taxable alcohol, SHORE, Massey University, Auckland.

Song, E.Y., Reboussin, B.A., Foley, K.L., Kaltenbach, L.A., Wagoner, K.G., & Wolfson, M. 2009. Selected community characteristics and underage drinking. *Subst.Use.Misuse.*, 44, (2) 179-194 available from: PM:19142820

Statistics New Zealand. Household Economic Survey: Year ended 30 June 2004. [http://www.stats.census2006.govt.nz/browse\\_for\\_stats/people\\_and\\_communities/Households/HouseholdsEconomicSurvey\\_HOTPYJun04](http://www.stats.census2006.govt.nz/browse_for_stats/people_and_communities/Households/HouseholdsEconomicSurvey_HOTPYJun04) . 2009.

Ref Type: Electronic Citation

Stimpson, J.P., Ju, H., Raji, M.A., & Eschbach, K. 2007. Neighborhood deprivation and health risk behaviors in NHANES III. *Am.J.Health Behav.*, 31, (2) 215-222 available from: PM:17269911

Trim, R.S. & Chassin, L. 2008. Neighborhood socioeconomic status effects on adolescent alcohol outcomes using growth models: exploring the role of parental alcoholism. *J.Stud.Alcohol Drugs*, 69, (5) 639-648 available from: PM:18781238

Wyllie, A., Black, S., Zhang, J., & Casswell, S. 1994. Sample frame bias in telephone-based research in New Zealand. *NZ Statistician*, 29, 40-53

Accepted manuscript

Table 1: Sample description and mean ml. of pure alcohol consumed on typical drinking occasion and frequency of drinking alcohol

<sup>a</sup>Geometric means are used, because measurement variables are skewed

	<i>N</i>	%	<i>MI .alcohol</i>	<i>Frequency</i>
Age (mean)	1144	16.6	-	-
Sex				
Girls	607	53.1	53.4	40.5
Boys	537	46.9	68.9	54.7
Area level deprivation (NZdep index)				
1	85	7.4	50.6	44.6
2	101	8.8	48.6	42.2
3	71	6.2	47.3	34.4
4	93	8.1	53.2	34.4
5	104	9.1	56.0	51.6
6	122	10.7	52.0	50.7
7	117	10.2	62.8	50.0
8	152	13.3	66.6	48.8
9	152	13.3	75.3	50.7
10	147	12.9	96.2	40.2
Individual SEP (occupation of main earner in household)				
Professional w. uni. or other qualification	174	16.6	48.6	46.6
Director/managerial	217	20.7	59.8	53.9
Clerical/sales/service	254	24.2	57.6	47.6
Craftsman/skilled tradesman	174	16.6	61.3	45.7
Manual work/labourer	176	16.8	72.0	38.8
Others	53	5.1	83.9	32.5
Ethnicity				
NZ European/European	531	46.5	47.7	48.4
Asian	31	2.7	35.2	21.1
Pacific	26	2.3	74.3	58.2
NZ Maori	553	46.5	81.3	46.3

Table 2: Area level deprivation and individual effects on quantity of alcohol consumed at typical drinking occasion and on frequency of alcohol intake: results from multilevel linear regression. Both crude estimates and estimates adjusted for individual covariates are presented

	<i>Quantity of alcohol intake</i>					<i>Frequency of alcohol intake</i>				
	<i>Estimate</i> <i>e</i> <i>(Crude)</i>	<i>p-value</i>	<i>Estimate</i> <i>(adjusted)</i>	<i>Log back-</i> <i>transformed</i> <i>change in %</i>	<i>p-value</i>	<i>Estimate</i> <i>e</i> <i>(Crude)</i>	<i>p-value</i>	<i>Estimate</i> <i>(Adjusted)</i>	<i>Log back-</i> <i>transformed</i> <i>change in %</i>	<i>p-value</i>
<b>Fixed effects</b>										
Area level deprivation NZDep	-0.0868	0.1190	-0.0781	1.24	0.1052	0.02931	0.1530	0.0253	1.60	0.1592
Area level deprivation NZDep <sup>2</sup>	0.0135	0.0074	0.0103		0.0187		-		-	-
Age			0.2151	1	<0.0001			0.4675	1	<0.0001
Sex				1.31					1.46	
Girls			-	-	-			-	1.03	-
Boys			0.2759	-	<0.0001			0.3796	-	<0.0001
<b>Individual SEP</b>										
Professional w.uni. or other quali.			-	1	-			-	1	-
Director/managerial			0.1044	1.11	0.2046			0.0179	1.02	0.8911
Clerical/sales/service			0.0572	1.05	0.4652			-0.0593	0.94	0.6333
Craftsman/skilled tradesman			0.1987	1.21	0.0168			-0.0932	0.91	0.4792
Manual work/labourer			0.1955	1.21	0.0358			-0.1354	0.87	0.3585
Others			0.0493	1.05	0.5852			-0.3684	0.69	0.0103
<b>Ethnicity</b>										
NZ European/European			-	1	-			-	1	-
Asian			-0.4528	0.65	<0.0001			-1.2249	0.29	<0.0001
Pacific			0.0184	1.05	0.8983			-0.2909	0.75	0.2035
NZ Maori			0.4483	1.59	<0.0001			-0.1518	0.86	0.1635

#### HIGH LIGHTS

- Association between area level deprivation and adolescents' alcohol use is investigated
- A J-shaped association between area level deprivation and quantity of alcohol is seen
- No association between area level deprivation and frequency of alcohol consumption is observed.

