From DEPARTMENT OF PUBLIC HEALTH SCIENCES
Karolinska Institutet, Stockholm, Sweden

ALCOHOL-RELATED HEALTH PROBLEMS AND CRIME

Studies on the long-term consequences of increased alcohol availability and unemployment

Emelie Thern

Karolinska Institutet

Stockholm 2018

Published by Karolinska Institutet.
Printed by Eprint AB 2018

ISBN 978-91-7831-280-1

ALCOHOL-RELATED HEALTH PROBLEMS AND CRIME: Studies on the long-term consequences of increased alcohol availability and unemployment

THESIS FOR DOCTORAL DEGREE (Ph.D.)

By

Emelie Thern

Public Defense on the 14th of December, 2018 at 09.00
Inghesalen, Floor 2, Widerströmska huset, Tomtebodavägen 18A, Karolinska Institutet, Solna Campus

Principal Supervisor:
Associate Professor Mats Ramstedt
Karolinska Institutet
Department of Clinical Neuroscience

Co-supervisor(s):
Professor Finn Rasmussen
Karolinska Institutet
Department of Public Health Sciences

Jeroen de Munter, PhD
Karolinska Institutet
Department of Public Health Sciences

Professor Tomas Hemmingsson
Stockholm University
Department of Public Health Sciences

Opponent:
Professor Per-Olof Östergren
Lund University
Department of Social Medicine and Global Health

Examination Board:
Professor Eva Vingård
Uppsala University
Department of Medical Sciences

Professor Per Carlson
Södertörn University
Department of Social Sciences

Professor Kent Nilsson
Uppsala University
Centre for Clinical Research

ABSTRACT

Background: The well-being of young people with respect to health and life opportunities is of high importance in society. This thesis examines the long-term adverse consequences of two periods in Sweden marked by high vulnerability for young people; one period with a drastic increase in alcohol availability for young people and one period with exceptionally high youth unemployment. Research has demonstrated immediate beneficial effects of restricting alcohol availability among adolescents and young adults. Less is known about the long-term consequences of exposure to increased alcohol availability during adolescence for the individual's themselves and the health and well-being of subsequent generations. Evidence suggests that youth unemployment is related to worse self-reported mental and physical health in the long-term. There remains a discussion in the literature regarding the effect of prior poor health and contextual influences on the association, especially in relation to youth unemployment.

Aims: The aim of this PhD thesis was therefore to investigate the potential effects of exposure to increased alcohol availability during adolescence and *in utero* on disability pension (Study I), alcohol-related health problems (Study II) and criminal behavior (Study III). This thesis also aimed at investigating the effects of youth unemployment on mental health during periods of high and low unemployment rates and to explore whether there was any interaction in mental health between labor force status and levels of unemployment in society (Study IV).

Methods: Studies I to III were register-based population-based longitudinal studies using a natural experiment setting of an alcohol policy experiment. During the late 1960s, strong beer became available in regular grocery stores in two regions of Sweden for adolescents under the age of 21 years, instead of being available only in the state-owned monopoly store "Systembolaget" with an age limit of 21 years. Study I investigated the effect of exposure to increased alcohol availability during adolescence on disability pension compared with same-aged unexposed adolescents (age 14–20 years). Studies II and III focused on the long-term effects of increased alcohol availability on children *in utero* during the time of the alcohol policy experiment. Study IV was a register-linked population-based cohort study based on individuals who had completed the nationwide Labour Force Survey between the ages of 17–24 years at times of high or low national unemployment rates.

Results: An increased risk of being granted disability pension due to an alcohol use disorder and a mental disorder was found among adolescents exposed to increased alcohol availability. No consistent evidence of any long-term consequences in subsequent generations was found. However, a slightly increased risk of alcohol-related health problems later in life was observed among exposed children conceived by young mothers. The results from Study IV showed a positive association between youth unemployment and mental health problems, irrespective of the overall national level of unemployment.

Conclusion: Exposure to increased alcohol availability during adolescence can have long-term health consequences, for both the individual and subsequent generations. Furthermore, youth unemployment is longitudinally related to mental health problems, independent of the overall national unemployment rate. These findings are of importance, as alcohol remains a leading cause of morbidity and mortality and youth unemployment rates are currently at a stable high level both nationally and globally.

LIST OF SCIENTIFIC PAPERS

I. **Thern E**, de Munter J, Hemmingsson T, Davey Smith G, Ramstedt M, Tynelius P, et al. Effects of increased alcohol availability during adolescence on the risk of all-cause and cause-specific disability pension: a natural experiment. *Addiction* 2017; 112(6): 1004-1012.

II. **Thern E,** Carslake D, Davey Smith G, Tynelius P, Rasmussen F. The effect of increased alcohol availability on alcohol-related health problems up to the age of 42 among children exposed in utero: a natural experiment. *Alcohol and Alcoholism* 2018; 53(1): 104-111.

III. **Thern E**, Ramstedt M, Tynelius P, Rasmussen F. Is there an increased risk of criminal behavior among children who were *in utero* when their mothers were exposed to increased alcohol availability? A register-based study using a natural experiment setting. Submitted.

IV. **Thern E**, de Munter J, Hemmingsson T, Rasmussen F. Long-term effects of youth unemployment on mental health: does an economic crisis make a difference? *Journal of Epidemiology & Community Health* 2017; 71(4): 344-349.

CONTENTS

LIST OF ABBREVIATIONS

APU	Alcohol Policy Investigation
ANDT	Alcohol, Narcotics, Doping and Tobacco
BRÅ	National Council for Crime Prevention
CAN	Swedish Council for Information on Alcohol and Other Drugs
CI	Confidence Interval
EU	European Union
FAS	Fetal Alcohol Syndrome
FASD	Fetal Alcohol Spectrum Disorders
HR	Hazard Ratio
ICD	International Statistical Classification of Disease
ILO	International Labour Organization
LFS	Labour Force Survey
LISA	Longitudinal Integration Database for Health Insurance and Labour Market Studies
MGR	Multi-Generation Register
PHC	Population and Housing Censuses
PIN	Personal Identity Number
SEI	Socioeconomic Index
SES	Socioeconomic Status
STORE	Statistics and Results

1 INTRODUCTION

The well-being of young people with respect to health and life opportunities is a high priority for most societies and their policymakers. Major goals related to this are to prevent young people from having alcohol-related problems and to enable young people to get into the workforce. This thesis examines the long-term adverse consequences of two periods in Sweden marked by high vulnerability for young people: one period with a drastic increase in alcohol availability for young people and one period with exceptionally high youth unemployment.

Although alcohol is most often associated with pleasure and is part of social life in many countries, there are also many well-established negative consequences of alcohol consumption. For instance, alcohol remains a leading cause of premature mortality and poor health globally, with negative impacts on health from embryo to old age (1). However, there are certain phases during the life course when individuals are more sensitive to alcohol exposure, such as in fetal life and during adolescence.

Within alcohol epidemiology research, availability has been found to influence alcohol consumption and, in turn, alcohol-related harm (2-4). In order to restrict alcohol availability among adolescents and young adults, several countries have limited the physical availability of alcohol through restricted outlet density and by implementing a minimum legal age limit for alcohol purchases (2). However, research is scarce with respect to the long-term health and social consequences of exposure to a more lenient alcohol policy during adolescence for the adolescents themselves and subsequent generations.

The second part of this thesis focuses on another vulnerable life phase: the transition from school to the workforce. Youth unemployment is at a high level in many countries around the world, making it a public health issue of increasing importance (5). Evidence suggests that exposure to youth unemployment can have detrimental and permanent health consequences, regardless of later labor force status (6). However, several unanswered questions remain regarding how prior poor health and contextual factors influence the association between youth unemployment and mental health status later in life.

The overall aim of this thesis is to increase knowledge on the long-term adverse effects of increased alcohol availability and unemployment among youth. More specifically, we will follow a large population of adolescents as well as their offspring in a unique natural experiment setting of an alcohol policy experiment in Sweden during the 1960s. Furthermore, to advance the existing knowledge of the long-term consequences of youth unemployment, we will follow up on a cohort of youths who were unemployed during the economic crisis in the early 1990s. The following chapters will both summarize and provide additional information on the background, methods and results of the included papers. Finally, a discussion of the results in relation to previous research will be presented and some implications of the findings are discussed along with methodological considerations.

2 BACKGROUND

The background of this thesis is divided into two main parts: alcohol and youth unemployment. In the first part I will discuss central concepts, theories and findings in relation to alcohol-related health problems, alcohol policy, prenatal alcohol exposure and adolescent alcohol consumption. I will also present a detailed description of the "strong beer experiment" that forms the empirical basis for three studies in this thesis. In the second part, I will introduce the central concepts, theories and findings in relation to unemployment, with a special focus on youth unemployment.

2.1 ALCOHOL

2.1.1 Alcohol-related harm

Alcohol consumption has long been a top public health priority, as it remains leading cause of poor health and premature death (1). Alcohol consumption is not only harmful to the consuming individual, but also to their immediate surroundings, future generations and society at large. In 2016, on a global scale, 5.3% of the deaths and 5.1% life years lost due to poor health, disability or premature death were attributable to alcohol (1). The corresponding numbers for 1990 were 4.2% and 3.0%, respectively (7). Alcohol has both medical consequences – harmful levels of consumption are a risk factor for more than 200 diseases – and social consequences, i.e., impaired work performance, relationship problems, antisocial behavior, and violent crimes (8-10). Although the alcohol consumption and alcohol-related harm in Sweden are among the lowest in Europe, the health effects and social consequences are still large (11). In 2017, the total alcohol consumption was calculated to be 9.0 liters of 100% alcohol per capita (aged 15 years and older) in the total population in Sweden (12).

2.1.2 The public health approach to alcohol-related health problems

Historically, there has been a strong individualistic perspective on alcohol consumption and alcohol-related harm. The main source of alcohol-related harm in the general population was thus found among the heavy drinkers; consequently, decreasing their problematic drinking would lead to a reduction of alcohol-related problems (4, 13). In the 1970s, a new perspective emerged: the public health approach to alcohol-related health problems, also known as the total consumption model. The total consumption model suggest that there is a strong relationship between per capita alcohol consumption and alcohol-related harm, emphasizing that the alcohol-related harm is also found in the general population, not only among heavy drinkers and individuals addicted to alcohol (4). Furthermore, Skog has proposed a theory of collective drinking within a drinking culture or population (14). The collective drinking theory argues that the entire population, including the category of heavy drinkers, move upward and downward on the consumption scale depending on the level of alcohol consumption within their society (14). Consequently, the public health approach to alcohol problems includes a shift in focus from the small proportion of heavy drinkers to the overall alcohol consumption in the general population and factors affecting this consumption.

Alcohol availability is assumed to be a key factor influencing alcohol consumption in the general population within the public health approach. Consequently, a major conclusion, which

is supported by the scientific literature, is that restricting availability is an effective tool in reducing per capita alcohol consumption and alcohol-related harm (3, 15). When liberalizing an alcohol policy, the greatest effect is most likely found among those individuals and sub-groups of the population that were restricted by the old policy. Alcohol consumption in the general population can be regulated by restricting the physical availability of alcohol (by for example limiting outlet density, having restricted hours and days of sale, and enforcing a high minimum legal age limit for alcohol purchases), having high alcohol tax, and restricting advertising (15, 16). In the general population availability and price appear to be the two most effective tools for reducing alcohol consumption and alcohol-related harm (15).

2.1.2.1 Adolescents

Comprehensive and strict alcohol policies have been shown to be related to a lower frequency and prevalence of adolescent alcohol consumption (17). The same study found that policies affecting the physical availability of alcohol were particularly important; examples of such policies include enforcement of a high minimum age limit of alcohol purchases, limited hours and days of sales and a low outlet density (17).

Enforcement of high legal minimum age limit for alcohol purchases and consumption appears to reduce the frequency and amount of alcohol consumed by youths, as well increasing the age of onset (2, 18-20). Several studies have found that lowering the minimum legal age is associated with an immediate increase of alcohol intoxication requiring emergency care, drunk driving, alcohol-related car crashes (fatal and non-fatal), and criminal behavior among young people (2, 21-24). In the long term, exposure to a lower minimum legal age limit (18 years instead of 21) during late adolescence has been associated with increased risk of binge drinking, alcohol and drug use disorder, and alcohol-related mortality later in life (19, 24-27). However, a recent study from Sweden, using the same alcohol policy experiment as in this thesis, found that the initial elevated risk of alcohol-related morbidity or mortality among adolescents exposed to increased alcohol availability diminished after including a regional level covariate, population density, in the models (28). Population density could be of importance in this research field as there is generally greater availability of alcohol in areas with high population density as an effect of more restaurants, bars, night clubs and liquor stores (2, 20).

Several studies on the physical availability of alcohol have also found that outlet density, as well as hours and days of sale can have an impact on alcohol consumption and damage from alcohol (3, 29). There has been a growing interest in the association between the physical availability of alcohol (i.e., outlet density) and alcohol use among adolescents (30). A systematic review including 21 studies shows that the current evidence indicates a positive association between outlet density and adolescent alcohol consumption (30). However, the strength of this association is dependent on if the outlet type is on-premises (bars, restaurants) or off-premises (shops) and on if the community studied is urban or rural (31-33).

Changes in public health policies can yield both intended and unintended population health effects. For example, evidence suggests that a high minimum legal age for alcohol purchases is related not only to a decrease in adolescent alcohol consumption, but also to a decrease in high school dropouts and teenage births (19). An area where research is scarce is exploration

of the possible effects of increased alcohol availability on the health and well-being of subsequent generations.

Previous research from the United States has studied the effects on birth outcomes of different minimum legal drinking ages (18, 19, 20 and 21 years), before it was nationally increased to 21 years in the late 1980s (34-36). Results from these studies suggested that a lower minimum legal drinking age (18 years) was associated with an increased risk of preterm birth and fetal loss, and a higher rate of low birthweight (34-36). As regards the longer term, evidence from a recent Swedish study, using the same alcohol policy experiment as in this thesis, suggests that children exposed *in utero* to the effects of a lower legal minimum age for alcohol purchases (16 years instead of 21 years) and who had young mothers had lower wages and educational attainment, and a higher welfare dependence at age 30 compared with unexposed children of same-aged mothers (37). A recent study from Canada found a positive association between alcohol outlet density and maternal alcohol consumption (38). However, it did not find any evidence that high accessibility to alcohol had a negative effect on birth outcomes (low birth weight and preterm birth) (38).

2.1.3 Swedish alcohol policy – a historical perspective

Sweden has a long history of having a relatively strict alcohol policy. In 1919, the Bratt system (motboksystemet), a rationing system, was introduced in Sweden in order to reduce the high alcohol consumption levels (39). This was an alternative to alcohol prohibition. The system was built on the notion that each man should not be allowed to buy more than he "needed," which was defined as 4 liters per month until 1942, when it was reduced to 3 liters. Not everyone was entitled to a motbok; certain criteria determined the alcohol allocation, such as income, sex, criminal records and socioeconomic position (39). It was very uncommon for females to have their own motbok, as was the case for young unmarried men and unemployed individuals. The system was a serious threat to the individual's integrity and infuriated not only the individuals who were denied a motbok, but also those who were managing the system, as it was very complex and time-consuming. The temperance movement was strongly against the system from the very beginning, as they believed it was an obstacle to complete prohibition of alcohol and it would increase rather than decrease alcohol consumption, as individuals might be reluctant not to use their alcohol ration (40). Due to strong influence from the temperance movement, the system was abolished in 1955 and the state-owned Swedish alcohol monopoly Systembolaget was established in its current form, where everyone 21 years or older was entitled to purchase alcohol (today, the age limit is set at 20 years) (39). Consequently, there was an increase in alcohol consumption (especially among heavy drinkers) and alcohol-related harm (40).

After 1955, taxes on alcohol were gradually introduced in order to decrease the general level of alcohol consumption and this became a key tool in alcohol policy, albeit without profit-making interests (16). The price of spirits, the most common alcoholic beverage, was increased by almost 50% at the end of the 1950s (16). Furthermore, a range of beverage-specific policy measures were implemented to encourage consumption of beverages with lower alcohol content (41, 42). One example is the introduction at a national level, in 1965, of medium-

strength beer (maximum alcohol content of 4.5% by volume) on the Swedish market, in regular grocery stores (43).

The new public health perspective on alcohol harm, i.e., the total consumption model, became very influential on the formulation of the Swedish alcohol policies in the late 1970s. For example, sales of medium strength beer were moved from regular grocery stores to Systembolaget in 1977 and from 1982 to 2000 the monopoly stores were closed on Saturdays (16). Ever since Sweden joined the European Union (EU) (1995), the Swedish alcohol policy has been under pressure to harmonize with the EU alcohol policy by having fewer restrictions and lower taxes on alcohol (16). A major change that put pressure on Sweden was that travelers' alcohol allowance from other EU-countries were gradually increased and by 2004 the quotas were practically abolished (16).

In 2016, the Swedish Government adopted a new cohesive alcohol, narcotics, doping and tobacco policy (ANDT strategy). Similar to the previous ANDT strategy, the overarching objective is "A society free from narcotics and doping, with lower medical and social injuries caused by alcohol and reduced tobacco use" (44). The strategy aims to facilitate a long-term perspective and stresses the importance of children and adolescents being protected from the negative effects of, alcohol and other substances. For example, major goals are to reduce the number of individuals with an early alcohol debut and reducing the number of children who are harmed by others' use of alcohol, for instance through alcohol consumption during pregnancy (44).

2.1.4 The strong beer experiment

An alcohol policy trial was carried out in 1967–1968 by the APU (Alcohol policy investigation) where sale of strong beer (maximum alcohol content 5.6% by volume) was allowed in regular grocery stores instead of the state-owned Systembolaget (41). The experiment was carried out in two regions, Gothenburg and Bohus county and Värmland county (denoted "the intervention area"), in order to represent both the city and the countryside (Figure 1).

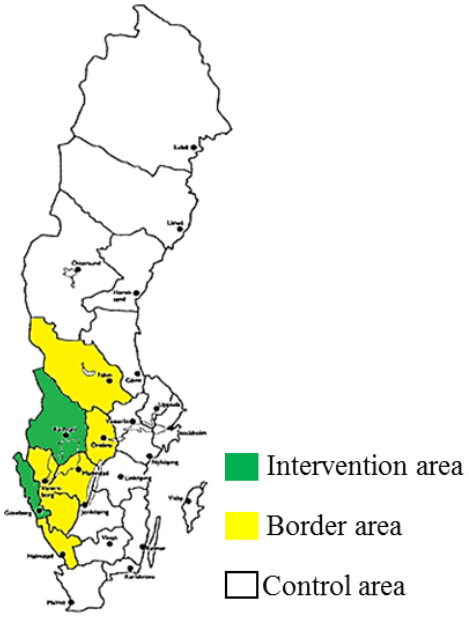

Figure 1. Map of Sweden showing where the strong beer experiment was implemented.

The age limit of purchasing medium strength beer on-premises (restaurants, bars) was set at 16 years during this time period, while it was up to the individual salesman to enforce this age limit in grocery stores (45). The main reason for this was that children were often sent to purchase beer from the shops for adults. Thus, the minimum legal age limit for strong beer purchases was most likely set at 16 years in the intervention area (46), while it was 21 years in the rest of Sweden, where strong beer could be purchased only at Systembolaget (41). During the experiment, sales of strong beer were moved from the 37 outlets of Systembolaget to approximately 2180 regular grocery stores within the intervention area (47). This trial was heavily regulated by the state: on a monthly basis, the amount of strong beer produced, delivered and sold had to be reported by breweries, grocery stores, and restaurants. Although there was very little advertisements regarding the introduction of strong beer in grocery stores, there was a ten-fold increase in sales already during the first six months (Figure 2) (41), while there was a minor decrease in wine and spirit sales in the intervention area.

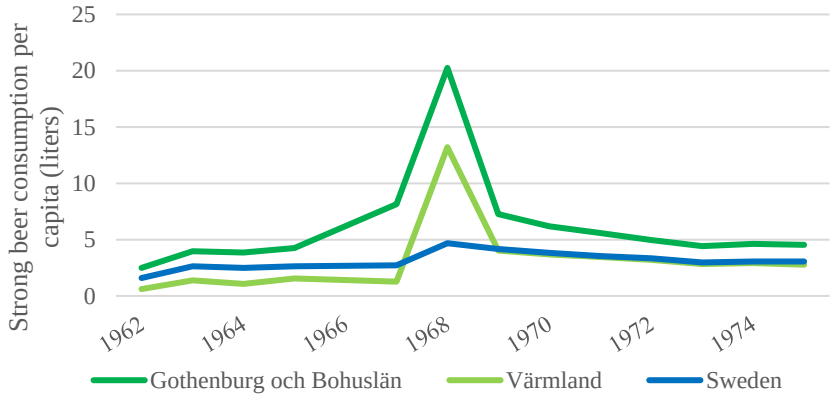

Figure 2: Strong beer consumption per capita (in liters) between 1962 and 1975. Source: Statistics Sweden 1962– 1975.

In order to monitor the alcohol experiment for any occurrence of alcohol abuse, the supervisors of the experiment had access to monthly police reports on individuals detained for public intoxication. During June 1968, questionnaires regarding experiences from the strong beer experiment were sent out to all the relevant local authorities: temperance boards (nykerhetsnämnder), child welfare commissions (barnavårdsnämnder), school boards, and police. Overall, a general negative experience of the strong beer experiment was reported by the local authorities (41, 46). The questionnaire also included a free-text section where the respondents were asked to provide a more detailed description of their opinion on the impact of the strong beer experiment on society (their responses have been translated from Swedish into English to be included in this thesis) (46). The majority of the temperance boards reported that the experiment had a negative impact on the community's sobriety state; similar reports came from both the city and countryside. The temperance boards stressed that with the strong beer being sold in grocery stores, it was much easier for both alcohol abusers and youths to obtain alcohol (46).

> "Grocery stores appear to sell strong beer without any restrictions. Alcohol abusers are more likely to buy strong beer, because the intoxication effect is so good that it has become an easily accessible substitute for stronger drinks." (Temperance board, Gothenburg and Bohus County)

> "Strong beer is sold without determining if the product is intended for alcohol intoxication. It has been identified that younger teens have been able to buy 5 to 10 liters of strong beer at a time. Even heavy alcoholics have been able to purchase unlimited quantities. The most common form of alcohol intoxication for the latter group is strong beer nowadays." (Temperance board, Värmland County)

The child welfare commissions and schoolboards were somewhat more positive towards the strong beer experiment and around half reported that they did not experience that the experiment had a negative impact on the adolescents (41). Around half of the municipalities' child welfare commissions reported receiving complaints regarding drunkenness among youths. Complaints occurred regarding all age groups (below 15, 15–17, 18–20 years), but the majority of complaints were about adolescents aged 15–17 years.

In the city there were reports of, e.g., strong beer consumption during school hours, increased absenteeism on Monday mornings, and cancellation of school dances as a result of the strong beer experiment (46).

> "Children were taken into custody at school, school dances no longer exist and there has been a lack of information about strong beer and its effects." (Child welfare commission, Gothenburg and Bohus County)

> "No direct effect has been seen. An increase in absenteeism on Monday mornings among boys in 8th grade could be due to an increase in strong beer consumption." (School board, Gothenburg and Bohus County)

Meanwhile, on the countryside, the general perception was that the majority of adolescents tried strong beer out of curiosity. Unfortunately, this resulted in children as young as 12–13 years trying and consuming larger quantities of strong beer (46).

> "Many adolescents have tried strong beer out of curiosity, some have not continued drinking, and another group have continued consuming strong beer to a small extent. A third group consumes strong beer to a greater extent." (Child welfare commission, Värmland County)

> "According to incoming information, young people of all ages, as young as 12–13 years, within the municipality, have been intoxicated from strong beer consumption and behaved offensively toward older people. There are also examples of damage caused by littering with empty strong beer cans." (School board, Värmland County)

All of the police in Gothenburg and Bohus County and about half of the police in Värmland County reported a negative impact of the strong beer experiment (41). The police in the city reported an increase in burglaries, an increase in groups of adolescents gathering to consume strong beer for intoxication, and an increase in drunk driving (46). Almost all police reports, from both city and countryside, reported an increase of empty strong beer cans littering the streets.

> "Burglary takes place to steal strong beer or money to be able to buy strong beer. The more characterless youths gather indoors and outdoors consuming strong beer for intoxication. Moped drivers drink strong beer and get caught drunk driving. Older people quench their thirst with strong beer and then get caught drunk driving." (Police, Gothenburg and Bohus County)

> "Alcoholics now have greater opportunities to drink themselves to death, an opportunity they are using diligently. Empty strong beer cans can be found on the city's streets and roads, especially in areas around schools." (Police, Värmland County)

Questionnaires were also sent out to the restaurants in the intervention area. The majority of the restaurant owners did not report a problem with the strong beer experiment, which is not surprising as the age limit for strong beer purchases at restaurants (18 years) remained the same throughout the experiment. Restaurants owners were worried that the amount of strong beer cans on the street, as well as the increased drunkenness among adolescents and adults, would have a negative impact on tourism (46).

Because of the reports from the relevant authorities and the high amount of strong beer being sold, there was some concern that problems would increase during the summer. Consequently, the majority voted for an early termination of the strong beer experiment, which thus lasted only 8.5 months, instead of the 14 months that were originally planned (41). It has been estimated that the total alcohol consumption (liters of 100% alcohol consumed per capita) increased by around 5% in the intervention area during the strong beer experiment (41). Although no alcohol consumption data is available for sub-populations in the intervention area, a nationwide survey among 15–25-year-olds was carried out during the summer of 1968, which revealed that adolescents and young adults generally consumed more beer and less strong spirits compared with the older population (41). Furthermore, around 90% of both males and females reported that they had consumed alcohol prior to turning 21 years (41). In general, men reported a higher level of strong beer consumption compared with females (41). Against this background, it is of interest to investigate if the exposure to the strong beer experiment could have any long-term consequences for the adolescents exposed as well as their offspring, as these two phases during the life course could be more sensitive to alcohol exposure (48, 49).

2.1.5 Life course and alcohol

Life course epidemiology is defined as the longitudinal study of effects of physical or social exposures during the life course (e.g., during gestation, childhood, adolescence, young adulthood, and adulthood) on later health (48). Life course epidemiology studies how certain risk factors experienced during the life course can influence health and disease in the long term; either independently, cumulative or interactively (Figure 3) (48).

The timing of an exposure can be crucial in relation to the long-term impact. For example, a critical period is a limited time window during an individual's development (i.e., gestation) when an exposure can have an protective or adverse effect on subsequent disease risk and no additional risk is associated with this exposure outside of the time window (48). There can also be sensitive periods, which occur during times of rapid individual development (i.e., gestation,

childhood, adolescence), when the effects of an exposure on subsequent disease risk are stronger compared with in other time periods (48). The accumulation of risk model is based on the notion that long-term health consequences are explained by an accumulation of exposures or insults over the life course, irrespective of their timing (48). The chain of risk model is a special version of the accumulation of risk model and postulates that it is a chain of exposures that increases the risk of disease, such that one negative exposure leads to another negative exposure and so on (48).

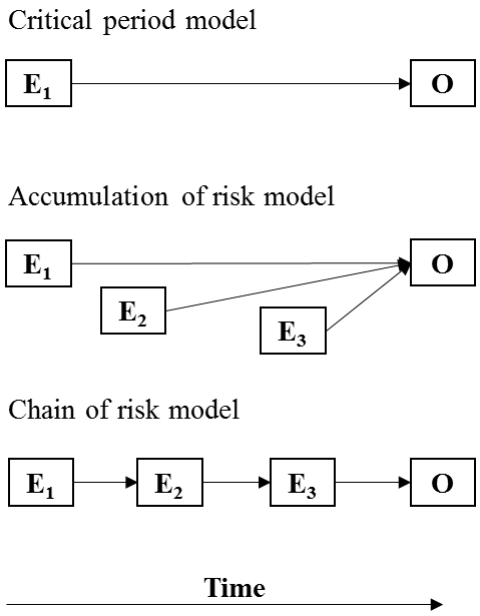

Figure 3. Life course models of the relationship between exposures (E) and an outcome measure (O)

Research suggests that alcohol can impair people's health throughout the lifespan, from embryo to old age. However, there are certain phases during the life course when individuals are more sensitive to adverse exposures, such that it may influence health permanently. Two such phases, which might be more sensitive in relation to alcohol exposure, and which will be discussed in this thesis, are fetal life and adolescence (48, 49).

Furthermore, drinking patterns tend to vary during the life course. Adolescents and young adults most commonly consume large amounts of alcohol at a small number of occasions (binge drinking), while adults tend to have a more continuous and stable drinking pattern (50, 51).

2.1.6 Prenatal alcohol exposure

Recommendations and guidelines regarding alcohol consumption during pregnancy vary historically, as well as between countries (52). The main discussion and debate revolve around the question of lower levels of alcohol consumption during pregnancy. A perfect illustration of this issue is a recently published book in Sweden "Praktika för blivande föräldrar: Gravidfakta och barnkunskap på vetenskaplig grund" written by Professor Agnes Wold and pediatrician Cecilia Chrapkowska (53). This book presents parents-to-be with facts surrounding pregnancy and children based on the scientific literature, with an aim of dispelling many of the myths in this area. In the discussion on alcohol during pregnancy, the authors claim that there is no

convincing evidence suggesting that consuming small amounts of alcohol (defined as 5–6 glasses per week and less than 3 glasses per occasion) while pregnant would harm the fetus, which is in conflict with the general recommendation in Sweden. As research has been unable to establish any "safe" amount of alcohol consumed during pregnancy, the general recommendation in many countries, including Sweden, is total abstinence (54).

2.1.6.1 Prevalence of alcohol consumption during pregnancy

A systematic review estimated the prevalence of alcohol use during pregnancy at national, regional and global levels in 2012 (52). At a global level, around 9.8% of females continued consuming alcohol after pregnancy recognition with above 40% doing so in some countries (52). Based on several studies from Sweden, it was estimated that around 10% of females continue drinking after pregnancy recognition; however, in previous studies, up to 30% have reported alcohol consumption during pregnancy (52, 55, 56). Alcohol intake can vary from an occasional social drink to weekly binge drinking or a high level of alcohol consumption throughout pregnancy.

A majority of women consume alcohol in the year before becoming pregnant (55). Pregnancies, especially among the young, might be unplanned, which increases the risk of prenatal alcohol exposure during the earlier stages of a pregnancy. In addition, alcohol consumption is still prevalent among females trying to conceive; only a small proportion change their drinking habits prior to a positive pregnancy test (55, 57). Thus, the majority of women keep drinking until they know they are pregnant.

2.1.6.2 The link between prenatal alcohol exposure and later health problems

In the 1950s, it was strongly believed by epidemiologists that the placenta could protect the fetus against almost all harmful substances, which might be used by the pregnant woman, such as alcohol and tobacco. In 1957, a medical student concluded, after studying development abnormalities of 100 children born to alcoholic parents, that drinking during pregnancy might have adverse consequences for the child (58). This knowledge became more widely spread in the general public in 1973, when Fetal Alcohol Syndrome (FAS) was first diagnosed (59).

Several hypotheses have been constructed regarding how prenatal alcohol exposure affects the fetus. The fetal origin hypothesis, originally introduced by Barker, proposes that the nine months *in utero* are the most vulnerable period in terms of long-term health consequences (60). This hypothesis combines several key ideas, including that the effects of fetal exposure are persistent and sometimes have latent health effects (58). Evidence from clinical research and research on rodents has shown that prenatal alcohol exposure affects numerous areas of the developing brain of the fetus, such as the cerebral cortex (frontal and parietal cortex), the hippocampus and cerebellum, which could result in cognitive and behavioral deficits (58, 61, 62). Furthermore, studies from animal models suggest that exposure to alcohol during fetal life increases the responsiveness to alcohol, as rodents exposed to alcohol prenatally acquired a preference for alcohol postnatally (61). Similar results has been found with newborn babies, where a preference for ethanol (alcohol) odor has been detected among children exposed to alcohol prenatally (61). Furthermore, the field of epigenetics suggests a link between epigenetic alterations in how genes are expressed (by DNA methylation and histone modification) and

development of alcohol dependence later in life (63, 64). Nonetheless, it remains unclear how much of the association between prenatal alcohol exposure and later health problems can be explained by the prenatal alcohol exposure versus other important factors such as socioeconomic, environmental, genetic, and epigenetic influences (58, 61, 62).

2.1.6.3 Short- and long-term consequences of prenatal alcohol exposure

A vast amount of literature has demonstrated that prenatal alcohol exposure can lead to a range of developmental, cognitive, and behavioral problems (61, 65-67). To what extent prenatal alcohol exposure has effects on the offspring depends on the quantity, frequency, and timing of the maternal alcohol consumption. Today, it is widely understood that excessive amounts of alcohol consumption during pregnancy can have detrimental consequences for the exposed fetus, i.e., FAS (67, 68). Several decades of research have identified some less severe effects of prenatal alcohol exposure. Thus, the umbrella term fetal alcohol spectrum disorders (FASDs) has been created to describe the full range of cognitive, behavioral, and physical consequences of alcohol consumption during pregnancy (68). FAS is the most severe FASD. Individuals with FAS can have a variety of problems, such as, impaired fetal growth and abnormal facial appearance, short height in childhood and in later life, low body weight, learning difficulties, low intelligence, and behavior problems (67). Children with a less severe form of FASD appear healthy at birth as the effects are latent, and their disorders are recognized only in later childhood or even in adulthood. Furthermore, FASDs are often misdiagnosed for other disorders (e.g., Attention Deficit Hyperactivity Disorder). Therefore, the prevalence of FASD is most likely underestimated in many populations.

However, inconsistency remains in the literature with regard to the short- and long-term effects of lower levels of alcohol consumption during pregnancy. Several systematic reviews have found no consistent evidence that light-to-moderate alcohol consumption has an adverse effect on a range of pregnancy outcomes, for example, miscarriage, growth restriction, birthweight, and features of FAS (69, 70). Similar results emerged in a systematic review including a range of neuropsychological outcomes such as academic performance, attention, behavior, cognition, language and verbal development in relation to light-to-moderate prenatal alcohol exposure (67). Studies vary on their operational definition of alcohol use; there is no universally established definition of light, moderate or heavy alcohol use, which could be part of the explanation of the differences in findings (71).

A few studies have focused on the link between prenatal alcohol exposure and later alcohol-related health problems. Professor Ann Streissguth and colleagues have done extensive work within this area by following families from mid-pregnancy until the offspring is aged 25 years (72-74). Results suggest that prenatal alcohol exposure is associated with alcohol problems at age 14, 21 and 25 years, independent of the effects of maternal demographic characteristics, family history of alcohol problems, prenatal nicotine exposure, and maternal alcohol problems after pregnancy (72-74). The mothers from the birth cohort reported a range of alcohol consumption during pregnancy, from abstinence to heavy drinking, but with the majority around moderate or social drinking as defined by the authors (74). A similar study was conducted in Australia, where families were followed from a child's birth to child age 21 years, with mothers asked to report the amount and frequency of alcohol consumed in early and late

pregnancy (75). The results suggest that three or more glasses of alcohol a few times per month in early pregnancy increased the risks of both early onset (between age 13 to 17 years) and later onset (between age 18 and 21 years) of alcohol disorders, after adjusting for several maternal characteristics such as cigarette smoking during pregnancy, sociodemographic position, and mental health status (75). These findings are strengthened by more recent studies where moderate levels of prenatal alcohol exposure were associated with increased risk of drinking alcohol between the age of 11 and 17 years (76).

Several studies have also addressed the relationship between prenatal alcohol exposure and externalizing behavior problems (i.e., delinquency, behavioral difficulties and conduct disorders) in offspring. A few studies have found a positive association between low-to-moderate prenatal alcohol exposure and behavioral problems during childhood, adolescence, and early adulthood (71, 77-79). However, research by O'Leary and colleagues, suggests an association between moderate and higher levels of prenatal alcohol exposure and child behavioral problems, which was not found at low levels of prenatal alcohol exposure (defined as less than 7 standard drinks per week and no more than 1–2 standard drinks per occasion) (80). Similar results have been seen in other research (81, 82).

2.1.7 Adolescent alcohol consumption

2.1.7.1 Recent alcohol trends among youths in Sweden

Alcohol is the most common drug among adolescents (83). During the past decade, there has been a general decrease in alcohol consumption among adolescents in many countries, including Sweden. According to a yearly nationwide survey conducted by the Swedish Council for Information on Alcohol and Other Drugs (CAN), 40% of the pupils in the 9th year of primary school (15–16 years of age) and 74% of the pupils in the second year of upper secondary school (17–18 years of age) have consumed alcohol during the last twelve months (83). In 1971, when the yearly monitoring began, around 90% of the pupils, both males and females, in the 9th grade reported having consumed alcohol during the last 12 months (83). Today, it is estimated that students aged 15–16 years and 17–18 years consume on average 1.2 liters and 3.1 liters of 100% alcohol per year, respectively (83). Also, in 2017, around 8% of the younger students and 25% of the older students reported consuming a large amount of alcohol at least once a month, defined as intensive alcohol consumption (e.g., binge drinking) (83).

2.1.7.2 The link between adolescent alcohol consumption and later health problems

Adolescence is a transition period from childhood to adulthood, when individuals are experimenting with adult aspects of life. It is normal for adolescents to experiment with alcohol use, and their drinking patterns are often characterized by heavy episodic drinking, also known as binge drinking (51).

Although adolescent alcohol consumption is a strong risk factor of later alcohol-related health problems, the underlying mechanisms of this association are still not fully understood (61, 84-86). According to a vast amount of research, there appears to be a complex interplay of genetic, neurobiological, individual, and environmental factors that may explain the association. Taking

a life course perspective, adolescence is characterized as a phase of rapid development and can be considered a sensitive period when the effects of alcohol exposure on subsequent disease risk are stronger than in other periods (48, 49). Some evidence indicates that there might be specific periods within adolescence when the individual is more vulnerable, such that initiation of alcohol use in early adolescence can be more detrimental than later initiation (85, 87, 88). Studies in the field of developmental neuroscience suggest that due to the rapid brain development occurring during adolescence, this age group is particularly sensitive to the effects of alcohol on brain development, which may in turn increase the risk of alcohol abuse (89, 90).

A recent meta-analysis of twin and adoption studies found that approximately 50% of the variance in alcohol abuse disorders could be explained by genetic factors (91). Two studies based on twin pairs discordant on adolescent drinking patterns and adult alcohol outcomes, while partially or completely adjusting for familial background and shared genetic influences by design, found that these factors explained a part of but not the entire association between adolescent alcohol consumption and adverse adult outcomes (92, 93). Adolescents are also influenced by the alcohol consumption of their peers and parents (94). Although it is clear that genetic and social factors in adolescence are important, it remains unclear if adolescent alcohol consumption is causal, a tracked behavior or merely a marker of vulnerability of later alcohol-related health problems (49, 61, 93).

2.1.7.3 Short- and long-term health consequences of adolescent alcohol consumption

Numerous epidemiological studies have demonstrated several short- and long-term consequences related to adolescent alcohol consumption. Acute consequences of heavy adolescent alcohol consumption include risky sexual behavior, injuries, criminal and aggressive behavior, attempted and successful suicide, alcohol intoxication, and accidental death (95, 96). In the long term, heavy alcohol consumption during adolescence has been associated with alcohol consumption in adulthood, alcohol abuse and dependence, all-cause mortality, and alcohol-related mortality (84, 86, 97, 98).

Evidence for alcohol-related social consequences of heavy adolescent alcohol consumption has also been documented in literature, for instance, increased risk of lower socioeconomic status, lower educational attainment, unemployment, mental health issues and violent offending (84, 99-101). A few studies have also found an increased risk of being granted disability pension – leaving the labor market prematurely and permanently – due to risky alcohol use during adolescence (102-104). Leaving the labor market prematurely has substantial consequences for the individual and their family, along with considerable costs for society. Using conscription data (males only), studies have documented a positive association between risky alcohol use during adolescence and increased risk of receiving disability pension due to all-cause, alcohol abuse, and drug abuse, but not due to other psychiatric diagnoses (102-104). No association was found for female adolescents' alcohol consumption patterns and increased risk of getting disability pension (105).

2.2 YOUTH UNEMPLOYMENT

2.2.1 Definition

The working age population (aged 15–64 years) can be divided into two main groups: people in the labor force (i.e., employed or unemployed) and people outside of the labor force, i.e., conscripts, pensioners, individuals with long-term illness, and students without work (excluding full-time students who have applied for work and are able to start working). In accordance with the International Labour Organization (ILO), unemployment is broadly defined as doing less than one hour of paid work per week, actively applying for work and being able to start a new job within two weeks (106, 107). Unemployment rates are calculated as the ratio of unemployed people in relation to all individuals in the labor force. In line with the ILO definition changes, Sweden in 2007 included full-time students who have applied for work (and are able to start working) in the unemployed category (5), which resulted in an increase in unemployment rates, especially among youths. In Sweden, youth unemployment is defined as being unemployed at the age of 15–24 years.

The official statistics on unemployment are collected via Statistics Sweden's Labour Force Survey (LFS) (106, 107). This is a nationwide survey where about 20 000 individuals who are registered in Sweden are randomly sampled to participate each month. The participating individuals are interviewed regarding labor force status every three months for a total of two years, resulting in eight interviews per person. Statistics Sweden cooperates with Eurostat (an authority under the European Commission) in order to measure and produce statistics on unemployment rates that can be used for international comparisons (5).

2.2.2 Theory of unemployment and mental health

Unemployment or involuntary job loss is a critical life event often accompanied by loss of income, social network, valuable labor experience, social status, and personal identity, and lowered psychological well-being. There is no generally accepted theory on unemployment and mental health. Several theories have been proposed as theoretical frameworks for understanding the association between unemployment and mental health (6, 108).

Jahoda's model of latent functions is based on the idea that work represents a number of functions important to mental well-being (109). Specifically, work fulfills five different needs: time structure, social contacts, personal identity, regular activity, and having a collective purpose. Warr has expanded this model by developing the "vitamin theory," which emphasizes nine specific environmental factors that influence mental health (110). These are: opportunity for control, opportunity for use of skill, externally generated goals, variety, availability of money, environmental clarity, physical security, opportunity for interpersonal contact, and valued social position. Thus, becoming unemployed will result in absence of these "vitamins", lowering levels of mental health. Ezzy draws from the identity theory and suggests that unemployment is rather a process, a status change, which could influence mental health (111).

2.2.3 Unemployment and health – selection or causation

Unemployment and health are associated by a bidirectional relationship, as poor health is both a consequence of and a risk factor for unemployment. Unemployment and health can be connected through three hypothetical pathways (112):

1. Unemployment causes poor health (causation).
2. Poor health causes job loss or prolongs unemployment (direct health selection).
3. Some underlying factor (e.g., personality characteristics or low social resources) increases the risk of unemployment, and also makes people more susceptible to health problems (indirect health selection).

Today, it is widely accepted that health selection, i.e., prior poor health, confounds the causal relationship between unemployment and disease (113). Although there is a fairly good understanding of the health selection mechanism, a debate remains on how much of the association between youth unemployment and mental health is explained by health selection (6). Bias due to health selection has been proposed to be less of a methodological limitation when a large proportion of the population becomes unemployed, for example during an economic crisis (114). Several longitudinal studies in Sweden and Finland have used the economic crisis during the early 1990s to study the effect of unemployment on various health outcomes (114-121).

There are several theoretical frameworks discussing how the context in which unemployment occurs can affect the association between unemployment and health. During a time of low unemployment, health selection could have a stronger effect on the association, or being unemployed could lead to more stigmatization (114, 122). Conversely, becoming unemployed during a period of high unemployment makes it easier to attribute one's current situation to external causes, which might buffer against the negative consequences of unemployment. However, high levels of unemployment in society create uncertainty about the possibility of re-entering the labor market, which could also influence the association (122-124). Furthermore, these contextual influences could potentially be different for youths and adults, as they are in different stages of their careers. In periods of high unemployment in society, youths experience increased difficulties in entering the labor market for the first time, while adults are at increased risk of being expelled from the labor market prematurely.

2.2.4 The economic crisis in the 1990s

Historically, Sweden and many other countries have been hit by economic downturns that have had heavy impacts on society at large. The economic crisis in the early 1990s had a large impact on unemployment levels in Sweden, which increased drastically from 1.7% in 1990 to 8.3% in 1993 (125). Young adults were one of the most disadvantaged groups during and after the crisis, with a drastic decrease in full- and part-time jobs and an increase in unemployment from 3.4% in 1990 to 19% in 1993 (125, 126). Prior to the crisis, the youth unemployment rate was at a comparatively low stable level, with a peak at 8% in 1983 (127). Large groups of young inexperienced people who were not eligible for unemployment benefits struggled to enter the labor market. The age of establishment, i.e., the age at which 75% of the same birth cohort has employment, increased from 21 years to 26 years for males and to 31 years for females within

a ten-year period (125). Also, the number of temporary employments, a more insecure employment form, more than doubled during the decade after the economic crisis (125).

2.2.5 Trends of youth unemployment in Sweden

In relation to other age groups, youths have a higher unemployment rate in general, irrespective of the economic situation in the country (127). Youth unemployment was at a low stable level prior to the crisis in the 1990s. After the dramatic increase in unemployment during the crisis, youth unemployment has never returned to the previous low levels. Today, youth unemployment is at a stable rate (around 18%) in Sweden, which is relatively high compared with other countries in the EU (128).

2.2.6 Life course, unemployment and scarring

The transition from school to work may be considered a difficult and sensitive period for young people (49). Young adults who have recently entered the labor market are more vulnerable than adults who have been established for a longer time, as they lack both work experience and social security benefits in case of unemployment. Not only are unemployed youths at risk of a range of short- and long-term consequences, but exposure to unemployment at a young age can produce multiple scarring effects. Studies suggest that youth unemployment can have a "mental scarring" effect on the individual, as the effect of youth unemployment on mental health appears to remain above the age of 40 years, independent of unemployment experiences after age 25 years (129, 130). Individuals unemployed when young may also be "scarred" on the labor market, in terms of lower pay and higher risk of repeated periods of unemployment (126, 131). Furthermore, research suggests an accumulation of poorer mental health among individuals who have experienced more than one unemployment spell, which lends support to the life course accumulation of risk model described earlier (48, 129).

2.2.7 Short- and long-term health consequences of youth unemployment

Numerous epidemiological studies have examined the effects of youth unemployment on later health. Unemployment during youth increases the risk of unhealthy habits (132-136), mental health problems (6), attempted suicide (6, 137), and all-cause mortality (138, 139). Several studies also suggest that unemployment at a young age can have a long-term negative health effect, such as worse mental and physical health (121, 129, 130, 136). Moreover, unemployed youths are at increased risk of experiencing future unemployment spells (140) and at increased risk of later sickness absence and disability pension (138).

2.3 KNOWLEDGE GAP

Previous research suggests that increased alcohol availability is associated with increased alcohol consumption and alcohol-related health problems in the general population. As regards the short term, several studies have shown that restricting adolescents' alcohol availability by enforcing a high minimum legal age limit for alcohol purchases decreases youths' alcohol use and traffic accidents. Only a few studies have investigated the long-term consequences of decreasing the minimum legal age limit for alcohol purchases. Another area in which research

is scarce and the potential costs are high, is the long-term consequences of such a policy change on the health and well-being of subsequent generations.

As described above in Section 2.2.7, there is evidence suggesting that youth unemployment is related to worse self-reported mental and physical health in the long term. However, a debate remains in the literature regarding the effects of prior poor health and contextual influences on the association, especially in relation to youth unemployment.

3 AIMS

The overall aim of this thesis was to examine the long-term adverse consequences of two periods in Sweden marked by high vulnerability for young people: one period with a drastic increase in alcohol availability for young people and one period with exceptionally high youth unemployment.

3.1 SPECIFIC AIMS

1. To test if being exposed to increased alcohol availability during adolescence is associated with an increased risk of receiving disability pension due to all-cause, alcohol use disorders, and mental disorders. (Study I)

2. To examine if increased alcohol availability is associated with alcohol-related health problems later in life among those exposed *in utero*. (Study II)

3. To examine whether a mother's exposure to increased alcohol availability while pregnant is associated with criminal behavior in the next generation. (Study III)

4. To investigate the effects of youth unemployment on mental health during periods of high and low unemployment rates and to explore whether there is any interaction in mental health between labor force status and level of unemployment in society. (Study IV)

4 METHODS

Table 1. Overview of the four studies

	Study I	Study II	Study III	Study IV
Aim	To test if being exposed to increased alcohol availability during adolescence is associated with an increased risk of receiving disability pension due to all-cause, alcohol use disorders, and mental disorders.	To examine if increased alcohol availability is associated with alcohol-related health problems later in life among those exposed *in utero*.	To examine whether a mother's exposure to increased alcohol availability while pregnant is associated with criminal behavior in the next generation.	To investigate the effects of youth unemployment on mental health during periods of high and low unemployment rates and to explore whether there is any interaction in mental health between labor force status and level of unemployment in society.
Design	Register-based population-based study using a natural experiment setting.	Register-based population-based study using a natural experiment setting.	Register-based population-based study using a natural experiment setting.	A register-linked population-based cohort study.
Study population	518 810 individuals (70 761 intervention group, 448 049 control group).	363 286 children (47 987 born in an intervention area, 315 299 born in a control area).	363 207 children (47 981 born in an intervention area, 315 226 born in a control area).	14 572 individuals (6410 crisis cohort, 8162 non-crisis cohort).
Inclusion criteria	Aged 14–20 years during policy experiment, registered in PHC 1965 and 1970, living in an intervention or control area, alive and registered in Sweden from 1994.	Born in Sweden between 1 Nov 1965 and 15 April 1971, with their biological mother registered in PHC 1965 and 1970/ 1970 and 1975, registered in an intervention or control area, alive after age 14 years.	Born in Sweden between 1 Nov 1965 and 15 April 1971, with their biological mother registered in PHC 1965 and 1970/ 1970 and 1975, registered in an intervention or control area, alive after age 15 years.	Participated in LFS between ages 17–24 years. Crisis cohort completed the LFS between 1991 and 1994 and non-crisis between 1983 and 1986.
Data sources	MGR, PHC, STORE, LISA, National Patient Register, Cause of Death Register	MGR, PHC, National Patient Register, Cause of Death Register	MGR, PHC, National Patient Register, Cause of Death Register, National Criminal Conviction Register	MGR, PHC, LFS, National Patient Register, Cause of Death Register
Exposure	Increased alcohol availability	Increased alcohol availability	Increased alcohol availability	Employment status
Outcome measure	Disability pension due to all-cause, alcohol use disorders, and mental disorders	Alcohol-related health problems	All crime, violent crime, theft, and drunk driving	Mental diagnosis
Statistical analyses	Descriptive, Pearson's $\chi 2$ test, Cox proportional hazard regression models	Descriptive, Pearson's $\chi 2$ test, Poisson regression, Cox proportional hazard regression models, between-cohort comparison	Descriptive, Pearson's $\chi 2$ test, Poisson regression, Cox proportional hazard regression models, between-cohort comparison	Descriptive, Pearson's $\chi 2$ test Cox proportional hazard regression models, interaction analysis

Note: Abbreviations and acronyms are defined in the list of abbreviations earlier in this thesis.

All four studies were population-based longitudinal studies based on Swedish nationwide register data (Table 1). Studies I–III used a natural experiment setting, the strong beer experiment conducted in two regions of Sweden during the late 1960s, to investigate the effects of increased alcohol availability on disability pension, alcohol-related health problems, and criminal behavior. Study IV used the economic crisis that hit Sweden in the early 1990s to obtain a sample of individuals unemployed at a time of high unemployment and compare them with individuals unemployed prior to the economic crisis (in a period of low unemployment), to investigate the effects of youth unemployment on mental health problems.

4.1 STUDIES I–III: LONG-TERM EFFECTS OF INCREASED ALCOHOL AVAILABILITY

4.1.1 Design and study population

4.1.1.1 Setting: Natural experiment setting of an alcohol policy experiment

In current literature there is no agreed upon definition of the term "natural experiment" (141, 142). There is, however, a general consensus that a natural experiment occurs when individuals are exposed to an intervention and control condition exogenously, as opposed to being manipulated by a researcher (141). Thus, it is an observational study as opposed to an experimental study. A natural experiment is a kind of quasi-experiment. One main advantage of using natural experiment data is that the researcher can make more credible claims of an "as if" random assignment to the intervention and control conditions, which allows for stronger causal inference compared with other observational studies (141, 142). Natural experiments can be employed as study designs when it is impossible, for practical or ethical reasons, to manipulate the exposure experimentally, as is the case with alcohol (141). An alcohol policy change or alcohol policy experiment can be considered to be a good natural experiment (141).

An extensive description of the alcohol policy experiment that took place in Sweden during the late 1960s has been given in Chapter 2 of this thesis. Briefly, strong beer (4.5% to 5.6% alcohol by volume) was made available to individuals including those under the age of 21 years, in regular grocery stores in two regions of Sweden, Gothenburg and Bohus County and Värmland County ("the intervention area") during an 8.5 month trial period. Prior to and after the experiment, and in all other regions, strong beer was available only at the Swedish alcohol retail monopoly Systembolaget for everyone 21 years or older (41). There was a 10-fold increase in strong beer sales during the first six months of the experimental period as compared with the same months the preceding year (41).

4.1.1.2 Study population

The study populations of Studies I–III were obtained using the nearest available, in time, Population and Housing Censuses (PHC) to identify individuals' residence information, subsequently determining their exposure status (see Figure 1 in Chapter 2 for a map of Sweden showing the intervention, control and border area). Individuals who lived in the intervention area in both 1965 and 1970 were identified as the intervention group and individuals who lived

in an area unexposed to the alcohol policy experiment in both 1965 and 1970, excluding a border area (Halland, Älvsborg, Skaraborg, Örebro and Kopparberg, to avoid spillover effects) were identified as the control group. For Studies II and III, PHC 1975 was also used to identify children born after 1970.

The study population of Study I included all non-adopted individuals born between 1948 and 1953, who were still alive and resident in Sweden in 1965 and had at least one biological parent identified in the Multi-Generation Register (MGR) (n = 666 639). Excluded individuals lacked information on residence (n = 4500), lived in an area bordering the intervention area in either 1965 or 1970 (n = 126 976), moved between the intervention and control area (n = 6166), emigrated from Sweden (n = 615) or died (n = 48) between 1965 and 1970.

Due to register constraints, an additional 9524 individuals (1349 in the intervention group, 8175 in the control group) who had died before 1994 were also excluded in Study I, since we did not have any information regarding their potential disability pension status prior to 1994. The final analytical sample for Study I consisted of 518 810 individuals (70 761 in the intervention group, 448 049 in the control group).

Studies II and III included all non-adopted children born in Sweden between 1 November 1965 and 15 April 1971 with their biological mother known in the MGR (n = 572 293). To identify where the child was born, the biological mother's residence information was extracted from the PHCs. The mother had to be registered in the intervention area or in the control area in both PHC 1965 and 1970 if the child was born before 1970 and in both PHC 1970 and 1975 if the child was born after 1970. A child was excluded if the mother lacked residence information (n = 4725), emigrated (n = 1570), not seasonally matched (n = 9076), moved between the intervention and control area (n = 8083) or lived in an adjacent area (n = 98 335).

Follow up in Study III was from age 14 to 42 years; thus, if a child died before the age of 14 years he/she was also excluded (n = 5529). The final analytical sample for Study II consisted of 366 178 children, 48 380 born in an intervention area and 317 798 born in a control area.

As the age of criminal responsibility is 15 years in Sweden, children who died before their 15th birthday were excluded in Study III (n = 5608). Thus, the final analytical sample for Study III consisted of 367 207 children, 47 981 born in an intervention area and 315 226 in a control area.

The analytical sample in Studies II and III was divided into four groups based on the exposure to the policy experiment: cohort A included all children born before the alcohol policy experiment was initiated, between 1 November 1965 and 15 April 1967. Cohorts B and C included those born between 1 November 1967 and 15 April 1969, thus all children exposed to the policy experiment *in utero*. Cohort B was those conceived prior to the alcohol policy experiment and cohort C was those conceived during the time of the alcohol policy experiment. Cohort D included all children conceived after the alcohol policy experiment had terminated and born between 1 November 1969 and 15 April 1971.

4.2 STUDY IV: LONG-TERM CONSEQUENCES OF YOUTH UNEMPLOYMENT

4.2.1 Design and study population

4.2.1.1 Setting: The economic crisis of the 1990s

Prior to the deep economic crisis in Sweden in 1991, youth unemployment was at a comparatively low stable level, around 5% (106). During the years 1991–1994, youth unemployment drastically increased from 3.4% in 1990 to 19% in 1993 (125, 126).

4.2.1.2 Study population

The study base in Study IV included all individuals between the ages of 17 and 24 years who had participated in the LFS. The LFS is a telephone-supported interview in which individuals are asked about their labor force status every three months over a two-year period, resulting in a total of eight interviews. The study population was divided into two cohorts. The first cohort, the "crisis cohort" included all individuals born between 1969 and 1974 who had completed the LFS during the period 1991–1994 (n = 7208). The second cohort, the "non-crisis cohort" included all individuals born between 1961 and 1966 who had completed the LFS during 1983–1986 (n = 9076). Individuals were excluded if they had taken part in less than five out of the eight interviews or if there was missing data on the variable labor force status in more than three out of the eight interviews. The final analytical sample consisted of 14 572 individuals (6410 in the crisis cohort, 8162 in the non-crisis cohort).

4.3 DATA SOURCES

In 1947, the Swedish personal identity number (PIN) was introduced. A PIN is assigned to everyone residing in Sweden on a permanent basis (143). This unique PIN allows linkage between several national registers kept by Statistics Sweden, the National Board of Health and Welfare and the National Council for Crime Prevention (BRÅ) (Figure 4) (143, 144).

4.3.1 The Multi-Generation Register

The MGR is part of the total population register (145). The register includes everyone who has been registered in Sweden at some point from 1961 and who was born 1932 or later. These individuals are referred to as index persons and have been linked to their biological parents, as well as their adoptive parents, if relevant. The register also includes information on for example date of birth, sex and place of birth for each index person. The register has a high coverage, especially for index persons born in Sweden, with over 95% having data on both parents (145). For index persons born outside Sweden, 26% have data on their mother and 21% on their father (145).

4.3.2 National Population and Housing Censuses

Everyone above the age of 15 years and registered in Sweden was required to complete the PHC, which was administered every five years between 1960 and 1990. The register is kept by Statistics Sweden and includes information on, for example, education, income, socioeconomic status, and population density of locality (146).

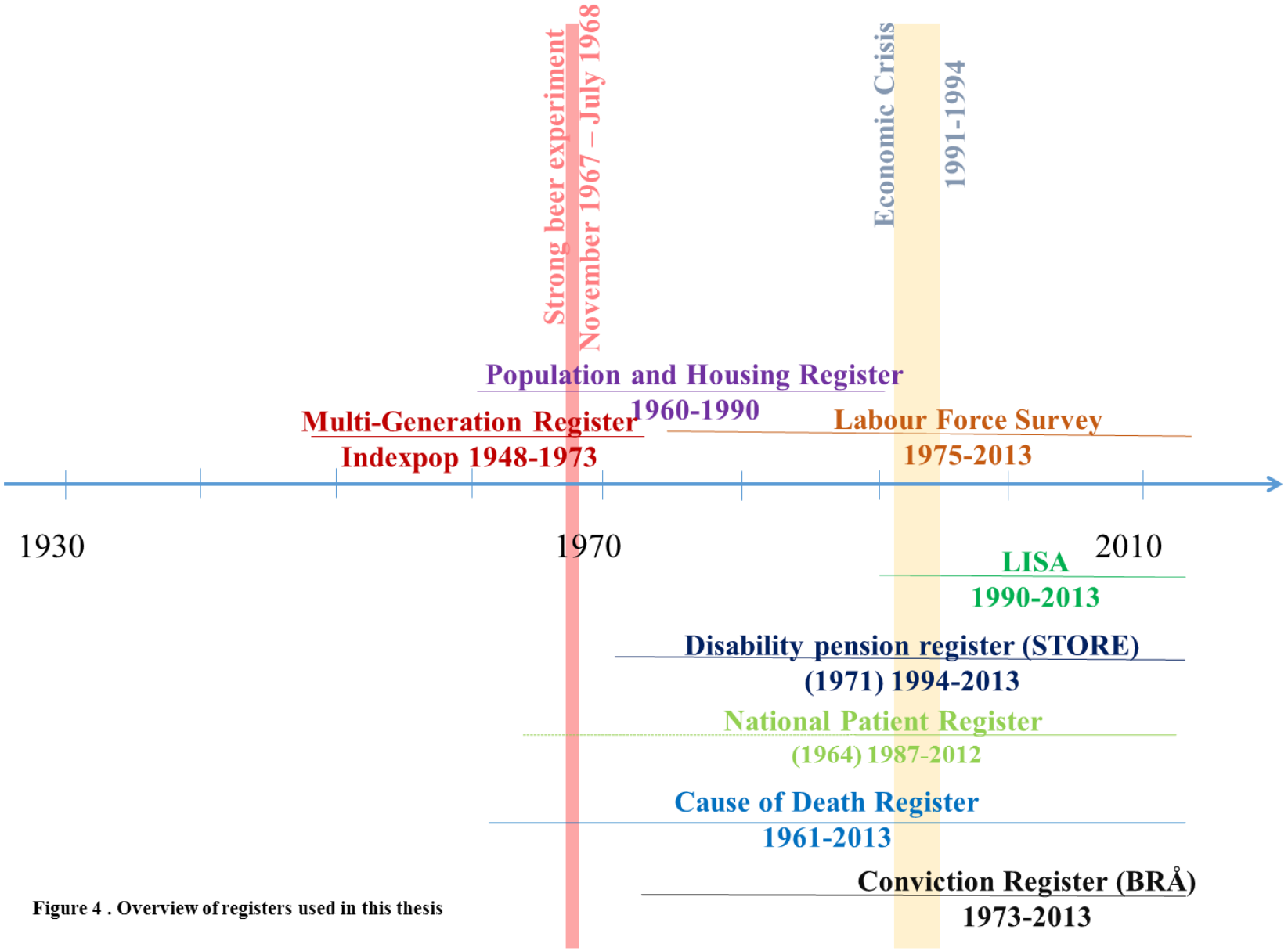

Figure 4 . Overview of registers used in this thesis

4.3.3 Longitudinal Integration Database for Health Insurance and Labour Market Studies

The Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA) is kept by Statistics Sweden since the 1990s and updated annually (147). Individuals 15 years or older registered in Sweden are included in the register, which contains information on, for example, employment, income and educational qualifications.

4.3.4 Swedish National Social Insurance Agency database

The Swedish National Social Insurance Agency database STORE (STatistik Och REsultat, Statistics and results) includes information on sickness absence and disability pension (148). Regardless of labor force status, all citizens registered in Sweden who are between the ages of 19 to 64 years (from age 16 years prior to 2003) and have a medically confirmed disease or injury that impairs their work capacity permanently by at least 25% (50% prior to 1993) are entitled to disability pension (149). Since 1977, alcohol abuse has been permitted as an underlying disability pension diagnosis (150, 151).

Although STORE was created 1994, the register has been extended backward and includes all disability pensioners from 1 January 1971 who were still alive and receiving disability pension in 1994. The register includes the date of the disability pension and one main diagnosis (sometimes two) included in the Swedish versions of the International Statistical Classification of Disease (ICD) versions 8 (1969–1986), 9 (1987–1996) or 10 (from 1997). The validity of the disability pension diagnoses is largely unexamined.

4.3.5 The National Patient Register

The National Patient Register (also known as the Hospital Discharge Register), kept by the National Board of Health and Welfare, contains information on inpatient care and specialized outpatient care (152, 153). The register was launched in 1964 for somatic diagnoses and 1973 for psychiatric diagnoses, complete national coverage was reached by 1987, as it became mandatory for both publicly and privately funded physicians to report data to the register (153). Diagnosis is coded according to the Swedish versions of the ICD versions 8, 9 or 10. A primary diagnosis is listed in 99% of all hospital discharges, including both somatic and psychiatric diagnoses (152). A validation study on the Swedish patient register found a high proportion of valid diagnoses, around 85–95% (152).

4.3.6 The Cause of Death Register

The Cause of Death Register, kept by the National Board of Health and Welfare, covers information on all deceased persons registered in Sweden, regardless of if the death took place in Sweden or abroad (154). The register, which is updated yearly, was established in 1961 (154). Information on both underlying and contributing causes of death, coded according to the Swedish version of the ICD, are included in the register (154). In less than 1% of all deaths, there is no cause of death registered (154).

4.3.7 The National Register of Criminal Convictions

The National Register of Criminal Convictions kept by the National Council for Crime Prevention (BRÅ), includes information on all individuals who have been found guilty of committing a crime, either by a Swedish court or by prosecutors (summary imposition of a fine or waivers of prosecution) (155). Sweden began registering individuals who had been convicted of a crime already in the 1830s, but it was not until 1970s that the official statistics were reproduced in accordance with a governmental regulation which allowed the statistics to be used for research (155). In Sweden, all crimes committed on a single occasion are included under the same conviction in the register; the principal offence is usually the crime with the most severe penalty on the sentencing scale. In the register, only information on the penalty for the principal offence is included (155).

4.3.8 Labour Force Survey

The LFS is a nationwide survey based on a random sample of the Swedish population, aged 15-74 years (16-64 years before 2001) (156). The first Swedish labor market survey was conducted in 1959 by the Swedish Labour Market Board (156). Since 1961, Statistics Sweden has been conducting the survey on a quarterly basis (156). In 1970, Statistics Sweden began conducting the survey on a monthly basis, with a sample of approximately 20 000 individuals (156). Participating individuals are interviewed with regard to their current labor force status (during a specific week of the reference month) every three months for a two-year period.

The LFS categorizes the working age population into two main groups: individuals who are active in the labor force (i.e., employed or unemployed) and individuals who are economically inactive (i.e., students, conscripts, pensioners or individuals with long-term illness). To be defined as employed you have to perform at least one hour of work per week, while people who are working less than one hour per week, are actively seeking work, and would be able to start a new job within two weeks are defined as unemployed (156).

4.4 STUDY VARIABLES AND DEFINITIONS

4.4.1 Exposures

4.4.1.1 Increased alcohol availability (Studies I–III)

The nearest available PHC (PHC 1965, 1970 and 1975) was used to obtain individuals' residence information, which was used in turn to determine if the individual was exposed to the alcohol policy experiment.

4.4.1.2 Employment status (Study IV)

Employment status was obtained from the LFS. In line with the LFS definitions of the various labor force statuses the study population was categorized into six mutually exclusive groups (Figure 5).

1. Unemployed less than 3 months: Individuals reporting unemployment in one interview.
2. Unemployed 3 to 6 months: Individuals reporting unemployment in two consecutive interviews.
3. Unemployed more than 6 months: Individuals reporting unemployment in three or more consecutive interviews.
4. Economically inactive: Individuals reporting studying, conscription or being medically ill in at least five of the eight interviews.
5. Unstable labor force status: Individuals reporting a mix of different labor force statuses or working part-time (< 35 hours/week).
6. Full-time employed: Individuals reporting working 35 hours/week or more in at least five of the eight interviews (reference group).

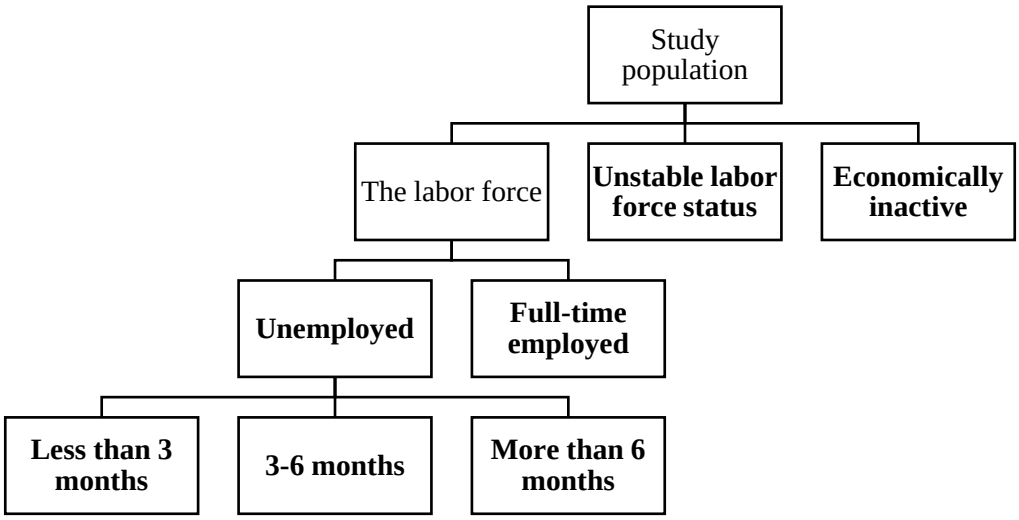

Figure 5. Schematic overview of the six exposure groups in Study IV.

4.4.2 Outcomes

4.4.2.1 Disability pension (Study I)

The outcome of interest, disability pension due to all-cause, alcohol use disorders, or mental disorders (excluding alcohol use disorders), was extracted from STORE. Alcohol use disorders included alcoholic psychoses (ICD-8 and ICD-9: 291), alcoholism (ICD-8 and ICD-9: 303), misuse of alcohol (ICD-9: 305), and mental and behavioral disorders due to alcohol abuse (ICD-10: F10). Mental disorders included for example schizophrenia, mood disorders, and stress-related disorders (ICD-8: 290, 292–302, 304–315; ICD-9: 290, 292–302, 304, 306–320; ICD-10: F00–F09, F20–F99). A person's first time being granted disability pension, regardless of if it was full- or part-time, was included.

4.4.2.2 Alcohol-related health problems (Study II)

The outcome of interest, alcohol-related health problems, was obtained from the National Patient Register. The Swedish index of alcohol-related inpatient care was used to define the outcome (Table 2) (157). The event of interest was the person's first alcohol-related inpatient care diagnosis, recorded as either a principal or contributory discharge diagnosis.

Table 2. Swedish index of alcohol-related inpatient care.

ICD 8 and 9 (1969–1986) (1987–1996)		ICD 10 (from 1997)	
291	Alcoholic psychoses	E 24.4	Alcohol-induced pseudo-Cushing's syndrome
303	Alcoholic dependence syndrome	F10	Mental and behavioral disorders due to alcohol abuse
305.0*	Nondependent alcohol abuse	G 31.2	Degeneration of nervous system due to alcohol
357.5*	Alcoholic polyneuropathy	G 62.1	Alcoholic polyneuropathy
425.5*	Alcoholic cardiomyopathy	G 72.1	Alcoholic myopathy
535.3*	Alcoholic gastritis	I 42.6	Alcoholic cardiomyopathy
571	Alcoholic liver disease	K 29.2	Alcoholic gastric
E860 or E980+980	Alcohol poisoning	K70	Alcoholic liver disease
		K 85.2	Alcohol-induced acute pancreatitis
		K 86.0	Alcohol induced chronic pancreatitis
		R 78.0	Alcohol in blood
		T 51.0	Toxic effect of alcohol
		Y 90.0	Evidence of alcohol involvement determined by blood alcohol level
		Y 91.0	Evidence of alcohol involvement determined by intoxication
		Z71.4	Alcohol abuse counselling and surveillance
		Z72.1	Alcohol use

*Only available in ICD 9

4.4.2.3 Crime (Study III)

Information on the outcome of crime was obtained from the National Register of Criminal Convictions and categorized into four groups: any crime, violent crime, theft, and drunk driving, in accordance with previous research (158, 159). If the crime was homicide, robbery, assault, arson, any sexual offence, illegal threats or intimidation, it was defined as a violent crime. For theft, the full spectrum from shop-lifting to burglary was included. Drunk driving included anyone who had been found driving a vehicle while under the influence of alcohol. First-time offences of the specified type of crime was used.

4.4.2.4 Mental diagnosis (Study IV)

The outcome of mental diagnosis was collected from the National Patient Register. Four categories of discharge diagnosis were used to define the outcome: alcohol or drug use disorders (ICD-9: 291, 292, 303–305; ICD-10: F10–F19), mood disorders (ICD-9: 296, 311; ICD-10: F30–F39), nervous or stress-related disorders (ICD-9: 300, 306, 308, 309; ICD-10: F40–F48), and self-harm (ICD-9: E950–E959, E980–E989; ICD-10: X60–X84, Y10–Y34). If an individual had any of the diagnoses as either a principal or secondary discharge diagnosis, he/she was considered as having the outcome of interest.

4.4.3 Covariates

4.4.3.1 Individual level covariates

The individual level covariates used in all studies, which were obtained from the MGR, included sex, year of birth, and country of birth (Sweden or outside of Sweden).

In Study I, the highest level of own attained education (primary, secondary or university and above), which was extracted from LISA, was also included.

In Study IV, a measure of prior mental health problems obtained from the National Patient Register was included, as mental health problems are a risk factor of unemployment. In addition to the mental diagnoses that were used to define the outcome, diagnoses of organic psychosis, schizophrenia, other non-affective disorders, personality disorders, childhood mental disorders, and mental retardation were also included as covariates (ICD 8: 292, 293, 294.0–2, 294.4, 294.8–9, 295, 297, 298, 301, 302, 306, 308–315 and the corresponding ICD-9 codes).

4.4.3.2 Family level covariates

From the PHC 1970, information on parents' level of attained education (primary, secondary, or university and above) and parents' socioeconomic index (SEI), which was based on each individual's occupation (High non-manual, Middle non-manual, Low non-manual, Self-employed/farmer, Skilled workers, Unskilled workers, Others not classified), was extracted. Either the maternal or paternal information was used, whichever the highest.

The date of birth of the mother was obtained from the MGR to calculate maternal age at conception, which was included as a covariate in Study II.

Indicators of any disability pension (Study I), alcohol-related morbidity and mortality (Studies I–III), criminal behavior (Study III), and mental health problems (Study IV) for both parents were extracted from the same registers used to obtain information on the outcomes of interest as described above.

4.4.3.3 Regional level covariate

A regional measure of population density of locality extracted from the PHC 1970 was included in Studies I–III, coded from one (low density) to ten (high density). Statistics Sweden defines a locality as an urban area where houses are no more than 200 meters apart and with at least 200 inhabitants, regardless of municipal or regional boundaries (160) (95). In 1970, there was a total of 1775 localities in Sweden (161).

4.5 STATISTICAL ANALYSIS

4.5.1 Study I

Pearson's chi-squared test ($\chi 2$) was used to test for differences in baseline characteristics in the intervention and control areas. The association between exposure to increased alcohol availability during adolescence and disability pension was estimated using Cox proportional hazard regression analysis to obtain hazard ratios (HR) with 95% confidence intervals (CI).

Log-log plots and plots of Schoenfeld residuals were used to verify the proportional hazard assumption.

In Study I, person-time was calculated from 1 January 1971 until the date of receiving disability pension, date of emigration, date of death, or the end of follow-up (31 December 2013), whichever came first.

Several individual, family and regional-level covariates were included in the analyses. The Wald test was used to test for an interaction between increased alcohol availability and sex, as well as between availability and age, categorized into three age groups (14–15 years, 16–17 years, 18–20 years). Also, evidence of an interaction between increased alcohol availability and childhood socioeconomic status (SES) and adulthood SES, defined as parental and own level of attained education, was assessed.

In Study I, a sensitivity analysis was performed including an outcome of disability pension due to any diagnosis excluding alcohol use disorders and mental disorders. Further, as the intervention area had generally higher alcohol consumption compared with the control area prior to the alcohol policy experiment, an additional analysis was performed comparing Gothenburg (part of the intervention group) with an area within the control area with higher prior alcohol consumption on average, in this case Stockholm.

4.5.2 Studies II and III

Pearson's chi-squared test ($\chi 2$) and t tests were used to estimate differences in the study populations' baseline characteristics. The association between being born in the intervention area and alcohol-related health problems (Study II), or between being born in the intervention area and crime (Study III), was estimated using Cox proportional hazard regression analysis to obtain HR with 95% CI. The proportional hazard assumptions were verified using log-log plots and plots of Schoenfeld residuals.

In Study II, person-time was calculated from age 14 years until first alcohol-related diagnosis, emigration, death, or end of follow-up (age 42 years), whichever came first.

For Study III, person-time was calculated from age 15 years instead, as this is the age of criminal responsibility in Sweden (162), until first criminal offence of any specific crime of interest, emigration, death or end of follow-up (age 42 years), whichever came first.

For both studies, between-cohort comparisons were performed to test if the hazard ratios obtained for cohorts B, C, and D were relatively different from cohort A. This allowed us to detect any potential effect of the policy change on the outcomes of interest, while allowing for pre-existing differences between the areas. This was done by including an interaction term between area and cohort in the Cox model and estimating the ratio of cohort-specific hazard ratios, derived through exponentiation of the difference in log-hazards. Adjusted incidence rates (per 10 000 person-years) were obtained from a Poisson regression model by averaging across all covariates included in the model to verify if the baseline incidences of all cohorts' control areas were comparable. As similar results were obtained in the Poisson model and

adjusted Cox model, the latter was used for the between-cohort comparisons and the results were presented as hazard ratios between cohorts.

For both studies, analyses were stratified by maternal age at conception, which was crudely estimated by subtracting 280 days from maternal age at birth. Mothers below the age of 21 years were defined as young mothers and mothers 21 years or older were defined as older mothers. In the first model, adjustments were made for sex, month of birth, and year of birth. In the second model, additional adjustments were made for parents' SEI, education, alcohol-related health problems, and criminal behavior (only Study III). In the final model, a stratified Cox repression model was used to additionally adjust for population density of birth locality; this allows for a unique baseline hazard for each stratum.

Evidence of an interaction between being born in the intervention area and sex in relation to the outcomes was assessed using the Wald test.

Several additional analyses were conducted in Study II. First an additional analysis was conducted excluding individuals with missing data on covariates (n = 5230). In addition, a sensitivity analysis was conducted excluding individuals who had moved between regions within the same area (intervention or control) between 1965 and 1970, since more mobile individuals might differ in terms of factors associated with alcohol use (n = 67 447). Lastly, the outcome of any health problem requiring inpatient care was included in an additional analysis, since prenatal alcohol exposure is associated with a range of health problems (65)

Numerous sensitivity analyses were performed in Study III, to investigate if imprisonment as well as a criminal history influenced the main results. First, being imprisoned impedes individuals from committing further crimes, thus analyses were conducted including the date of imprisonment as censoring in the Cox model, as well as excluding individuals at baseline who were sentenced to jail during follow-up (n = 10 169). Date of first imprisonment was included as a competing risk in a competing risk analysis, a specific type of survival analysis, in accordance with the method of Fine and Gray (163). Furthermore, date of prior criminal offending was included as a competing risk, as criminal offending can be a risk factor of committing more crimes.

4.5.3 Study IV

All analyses were stratified by cohort. The association between labor force status and mental diagnosis was estimated by Cox proportional hazard regression analysis to obtain crude and adjusted HR with 95% CI. Person-time was calculated from the end of the exposure window (crisis cohort: 1 January 1995; non-crisis cohort: 1 January 1986) until the first date of a mental diagnosis, emigration, death, or until end of follow-up (crisis cohort: 31 December 2012; non-crisis cohort: 31 December 2004), whichever came first.

A likelihood ratio test was performed to test for evidence of an interaction between labor force status and sex, as well as between labor force status and level of unemployment. As prior mental health problems are a risk factor for unemployment, a sensitivity analysis was performed excluding individuals with prior mental health problems. Additional analysis was conducted to explore the association between labor force status and specific mental diagnoses.

All analyses in Studies I to IV were computed using StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP.

4.6 ETHICAL CONSIDERATIONS

Ethical approval for all studies was obtained from the Stockholm Regional Ethical Review Board (Ref: 2016/112–31).

All data received were handled in accordance with the Personal Data Act and Public Access to Information and Secrecy Act (164, 165). Statistics Sweden had de-identified all the individuals prior to delivering the data, thus it was not possible to identify anyone from the data. Consequently, no informed consent was obtained from the study population. When working with sensitive data, such as criminal data, it is important that the results cannot be traced back to the individual. Furthermore, when using a specific alcohol policy experiment in Sweden, some of the study participants might experience a violation of their privacy. It was a governmental decision to make strong beer more readily available to the public and the knowledge on long-term health consequences of increased alcohol availability was limited at the time. During the alcohol policy experiment, alcohol consumption increased dramatically, along with the alcohol-related harm among adolescents. The Swedish Government acted accordingly and terminated the experiment early, decreasing any further potential harm caused by the experiment.

5 RESULTS

In the following section, a summary of the main results for each study will be presented. The results are presented in more detail in Articles I to IV.

5.1 LONG-TERM EFFECTS OF EXPOSURE TO INCREASED ALCOHOL AVAILABILITY DURING ADOLESCENCE (STUDY I)

During follow-up, a total of 104 475 individuals were granted disability pension, of which 2476 (2.4%) were due to alcohol use disorders and 26 699 (25.6%) due to mental disorders. The results showed that adolescents exposed to the alcohol policy experiment were at an increased risk of being granted disability pension due to alcohol use disorders and mental disorders later in life compared with same-aged individuals who were not exposed. This increased risk remained after including several important individual, family, and regional level covariates. The interaction analyses demonstrated that sex, age, childhood SES or later SES did not influence the association between alcohol availability and disability pension.

5.2 LONG-TERM EFFECTS OF EXPOSURE TO INCREASED ALCOHOL AVAILABILITY *IN UTERO* (STUDIES II AND III)

In Studies II and III, the main focus was on the offspring who were *in utero* when their mothers were exposed to an increased alcohol availability, to examine if they were at an increased risk of alcohol-related health problems (Study II) or criminal behavior (Study III) later in life. The study sample was divided into four separate cohorts: cohort A was born before the policy experiment and thus not exposed, cohort B was conceived before the policy experiment but exposed to it, cohort C was conceived during the policy experiment and cohort D was conceived after termination of the strong beer experiment and therefore not exposed. The main focus was placed on cohort B, as this cohort was less likely impacted by the positive association between alcohol consumption and unplanned pregnancies (cohort C) (35).

During the 28-year follow-up in Study II, a total of 8417 individuals were treated in a hospital for an alcohol-related diagnosis, of whom 1214 (2.4%) were born in the intervention area and 7203 (2.3%) in the control area. The main results suggest that children conceived by young mothers in cohort B were at a slight increased risk of alcohol-related health problems compared with the unexposed children, after adjusting for several individual, family and regional level covariates. Children conceived by older mothers in the same cohort were at a lower risk of alcohol-related health problems compared with children not exposed to the policy change. No clear evidence of an association was found in any of the other cohorts among children conceived by either young or older mothers.

In Study III, a total of 74 234 (20.4%) individuals had been convicted for committing a crime during the 27-year follow-up, of which 10 085 (21.0%) were born in the intervention area and 64 149 (20.4%) were born in the control area. A total of 18 359 (24.7%) crimes were defined as violent, 31 352 (42.2%) as theft and 17 088 (23.0%) as drunk driving.

Compared to the children born in the control area, no strong evidence was found of an increased risk of being convicted of any crime, violent crime, theft or drunk driving among the children

born in the intervention area in cohort B, whether conceived by young or older mothers. A slight increased risk of being convicted of theft among children conceived by young mothers in cohorts C and D was found in the between-cohort analysis.

Similar results as in the main analysis were obtained in the sensitivity analyses when censoring individuals who were sentenced to prison during follow-up and when treating imprisonment as a competing event. Furthermore, prior criminal offences did not appear to influence the results.

5.3 LONG-TERM EFFECTS OF YOUTH UNEMPLOYMENT (STUDY IV)

During the 19-year follow-up, a total of 557 individuals received inpatient care due to a mental diagnosis, of whom 252 (3.9%) were in the crisis cohort and 305 (3.7%) in the non-crisis cohort. The results suggest a positive gradient between the length of unemployment and a mental diagnosis in both the crisis and non-crisis cohort. Although the effect estimate was slightly larger in the non-crisis cohort for all three unemployed groups, the CI overlapped the estimates obtained in the crisis cohort. No clear evidence of an association between either being economically inactive or having an unstable labor force status and receiving inpatient care for a mental diagnosis was found in either cohort. Results from the additional analysis, where the outcome of mental diagnosis was split into four groups (affective disorders, stress, alcohol/drug use, and self-harm), suggest that unemployment is associated with alcohol and drug use disorders in both cohorts.

6 DISCUSSION

As discussed above, the current thesis has been conducted in the framework of two periods in Sweden, hypothesized to influence the long-term health of young people and subsequent generation. The first is a natural experiment setting of an alcohol policy experiment which increased the availability of strong beer among youth during a distinct 8.5-month period. The second is a severe economic crisis which markedly increased unemployment rates in Sweden, especially among young people. The goal of this thesis was to advance the understanding of the long-term effects of exposure to increased alcohol availability during two sensitive phases of life: fetal life and during late adolescence. In the second part of this thesis, the goal was to advance knowledge of the long-term consequences of youth unemployment in settings with high and low national unemployment rates.

In this chapter, I will summarize the main findings and discuss them in relation to previous research. Then, I will discuss the main methodological considerations of the studies, public health implications, and touch on possible future research with regard to both alcohol availability and unemployment.

6.1 MAIN FINDINGS AND PREVIOUS RESEARCH

1. Exposure to increased alcohol availability during adolescence was associated with an increased risk of receiving disability pension due to alcohol use disorders and mental disorders later in life (Study I).
2. Being *in utero* when mothers were exposed to increased alcohol availability may have enhanced the risk of alcohol-related health problems later in life among children conceived by young mothers (Study II).
3. There was no strong evidence that exposure *in utero* to the effects of increased alcohol availability increased the risk of being convicted of violent crime, theft, or drunk driving in the subsequent generation (Study III).
4. Youth unemployment increased the risk of mental health problems requiring inpatient care (Study IV).
5. National unemployment rates did not influence the association between youth unemployment and health (Study IV).
6. Youth unemployment was associated with an increased risk of alcohol and drug use disorders (Study IV).

6.1.1 Long-term effects of increased alcohol availability (Studies I to III)

The main aim of the alcohol policy experiment that took place in Sweden during the late 1960s was to decrease the consumption of strong spirits (41). The underlying rationale was that the general population would shift their consumption to alcoholic beverages with a lower percentage of alcohol if those became more readily available. However, in contrast to expectations, there was only a minor decrease in wine and strong spirit sales in the intervention area during the experiment, while medium strength beer sales decreased considerably (41). The strong beer experiment was terminated earlier than originally intended due to a sharp increase in strong beer sales and reports from several authorities indicating a large increase in strong beer consumption, especially among adolescents (41). Against this background, it is of interest

to investigate if the exposure to increased alcohol availability could have any long-term consequences for the adolescents exposed or their offspring.

6.1.1.1 Study I

Study I found an increased risk of being granted all-cause and cause-specific disability pension among the adolescents exposed to increased alcohol availability compared with a same-aged comparison group. These findings are in line with previous research that investigated the short- and long-term consequences of increasing alcohol availability by having a minimum age limit for alcohol purchases set at 18 years instead of 21 years (2, 19, 25-27). On the other hand, this contradicts other research that used data from the same alcohol policy experiment with the outcome of alcohol-related morbidity and mortality (28). Previous research using self-reported data on alcohol consumption has found a positive association between adolescent alcohol use and later alcohol abuse and dependence, as well as alcohol-related mortality (84, 86). Furthermore, risky use of alcohol during adolescence, among men, has been linked to an increased risk of being granted all-cause disability pension or disability pension with an alcohol- or drug-related diagnosis (102, 104). Then again, an increased risk of being granted disability pension due to mental diagnosis (excluding alcohol use) was found in Study I, contradicting previous research (104). However, due to differences in definitions of exposure and follow-up time, it is difficult to compare the results of Study I with previous research.

Diseases that are severe enough to lead to work incapacity would most likely result in a high degree of healthcare use, especially since a doctor's certificate is required to be able to apply for disability pension. A recent study by Rahman et al. found that individuals who received disability pension due to common mental disorders were more likely to receive outpatient care than inpatient care for both psychiatric and somatic diagnosis before being granted disability pension (166). Thern et al. were unable to include the outpatient register due to coverage constraints, thus their outcome of alcohol-related morbidity was based only on the inpatient care register (28), which could in part explain the differences in findings. Furthermore, there are regional differences in granting disability pension in Sweden that cannot be explained solely by differences in unemployment rates, population composition, work environment or important changes in disability pension regulations (167). Other important factors that appear to contribute are an individual's ambition to be granted disability pension, actions of all the relevant authorities in the process, and local norms (168). In Sweden, disability pension appears to be most common in semi-rural or rural areas (168). Including a covariate of population density of locality in the models most likely reduced any potential bias this regional difference could have on the associations.

Given the current literature, it remains unclear if the link between adolescent alcohol consumption and later alcohol-related problems is causal, a tracked behavior or merely a marker for alcohol abuse vulnerability (61, 84-86). One hypothesis is that the adolescents exposed to the strong beer experiment formed a habit of consuming larger quantities of beer than the control group, thus getting an increased risk of alcohol-related health problems. This habit could be kept up after the strong beer experiment was terminated, as medium strength beer was still available in grocery stores throughout the nation for those over the age of 16 years (43). Alternatively, perhaps the adolescents exposed to the strong beer experiment

performed worse in school due to their increased alcohol consumption, which in turn resulted in them obtaining jobs where a disability pension is more common; this would be an example of the life course chain of risk model described in Section 2.1.5 (48, 49).

6.1.1.2 Studies II and III

Studies II and III aimed at investigating the potential unintended consequences of increased alcohol availability on the health and well-being of subsequent generations, an important area where potential costs are high, but research is very scarce. The strong beer experiment took place during a time period before knowledge of the consequences of alcohol consumption for the fetus was common in the general population (59). Furthermore, results from a nationwide survey administered in 1968 showed that around 90% of females in Sweden reported consuming alcohol before the age of 21 years (41).

Research into the short-term consequences of increased alcohol availability suggests an increased risk of several adverse birth outcomes, such as increased risk of preterm birth and fetal loss, and a higher rate of low birthweight (34-36). A limitation of previous studies is that they were unable to isolate a birth cohort conceived prior to a policy change that increased alcohol availability. Therefore these studies have only investigated the indirect effects of such policy changes on subsequent generations, since alcohol consumption is linked to an increased risk of unplanned pregnancies. Unplanned pregnancies is more prevalent among mothers with lower educational attainment and socioeconomic status, factors which also have an effect on the health of the offspring (169). This limitation was overcome in a recent study from Sweden by Nilsson, using the same strong beer experiment as in this thesis (37). The author followed children conceived by young mothers prior to the initiation of the policy change but still exposed to it *in utero* and found that these children were worse off on several economic outcomes in early adulthood compared with unexposed children (37). Studies II and III aimed at extending these findings by examining the outcomes of alcohol-related health problems and criminal behavior.

Results from Study II were not consistent, as some evidence of an increased risk of alcohol-related health problems was found among children conceived by young mothers prior to the policy change but exposed to it later in pregnancy (cohort B), while a reduced risk was found among older mothers in the same cohort. These results are in line with what was expected if the policy experiment had an effect. Since alcohol increases the risk of unplanned pregnancies, it was expected, that children conceived during the time of the strong beer experiment would be more vulnerable (169), especially considering the first trimester appear to be the most sensitive to prenatal alcohol exposure in relation to the outcome of alcohol dependence (75). However, the findings of Study II were not in line with this. Previous research has found a positive association between heavy episodic or frequent alcohol consumption (more than 3 glasses per occasion) throughout pregnancy and alcohol-related health problems in early adulthood (73, 75, 76, 170). A potential reason for not finding a strong effect of the alcohol policy experiment could be that the study population was too young at the end of follow-up (42 years); the majority of individuals in Sweden needing inpatient care for an alcohol-related health problem are above the age of 50 years (171).

Results from Study III showed no consistent evidence of an increased risk of being convicted of a crime among those who had been *in utero* when their mothers were exposed to increased alcohol availability. Some studies have found that low to moderate alcohol consumption during pregnancy could increase the risk of behavior problems and conduct disorders in adolescence and early adulthood (71, 77-79), while other research has not (81, 82). Previous research has to a great extent focused on less severe behavioral delinquencies compared with the outcome of criminal conviction, which could be a potential explanation for not finding an effect. Furthermore, there is a lack of research that extends beyond early adulthood, as research into the long-term effects of prenatal alcohol exposure in the middle-aged population is scarce (74). Previous research has found an increased risk of criminal behavior among youths with FASD/FAS (172, 173). We were unable to find out if any of the children born during the studied time period were diagnosed with FAS, the most severe form of FASD, as the Swedish Medical Birth Register was not established until 1973 (174). A recent report estimated that the prevalence of FAS per 10 000 in the general population of Sweden is 13.9, which is substantially lower than in many other countries (52). It is estimated that FAS accounts for about 10% of the prevalence of FASD (52). Most likely, the prevalence of FAS and FASD was slightly higher in the late 1960s, as this was a time period before knowledge of the harms related to alcohol use was common in both the medical profession and the general population (59).

Although evidence suggests that prenatal alcohol exposure is a risk factor for later health problems, it remains unclear how much of the association can be explained by prenatal alcohol exposure versus other important factors, such as socioeconomic, environmental, genetic, and epigenetic influences (58, 61, 62). Research suggests that prenatal alcohol exposure is a risk factor of later alcohol-related health problems, since fetal life is a sensitive time period, during which the effects of alcohol on subsequent disease risk are greater than during other time periods (48). On the other hand, Nilsson's research, using almost the same analytical sample and the same alcohol policy experiment as in this thesis, found that the exposed children were at increased risk of lower wages, educational attainment and cognitive ability (37), which are all risk factors of later alcohol-related health problems (175). Therefore, taking the life course perspective and the chain of risk model into account, one could speculate that the children *in utero* during the policy experiment were worse off from the start in relation to cognitive ability, which resulted in poorer school performance and a lower occupational level, which in turn led to higher alcohol consumption in young adulthood and adulthood, increasing the risk of being hospitalized for an alcohol-related diagnosis.

6.1.2 Long-term effects of youth unemployment (Study IV)

The results of Study IV suggest that unemployment at a young age is associated with an increased risk of receiving a mental diagnosis requiring inpatient care, irrespective of overall national rates of unemployment. These findings strengthen and extend previous research that has shown an association between youth unemployment and impaired mental health and well-being (6). The results suggest that the long-term effects of youth unemployment might be more severe and detrimental than previously thought as this is one of the first studies on youth unemployment using hospital discharge registers to obtain information on the outcome. Previous research on middle-aged workers has found an increased risk of receiving a mental health diagnosis requiring inpatient care following unemployment (113, 176, 177).

Furthermore, research suggests that unemployment at a young age can lead to mental health scarring such that the negative effects remain after the age of 40, irrespective of later unemployment spells (129, 130).

We found no strong evidence that the effects of unemployment at a young age on inpatient care for mental diagnoses change when the national levels of unemployment fluctuate, which is in line with some results (120, 123, 178, 179), but contradicts others (114). Martikainen and Valkonen found that the effects of unemployment were stronger during a time period of low unemployment, which could be due to stronger influence of prior health problems biasing the association or stigmatization, as the unemployment experience is not shared by many (114). Previous research on the contextual influence of national unemployment rate has to a great extent focused on adults experiencing involuntary job loss (123). Young adults are trying to enter the labor market, as opposed to involuntarily leaving it, which could involve other psychological and social processes. Specifically, being unemployed during a period of high unemployment might be more stressful and have more adverse health consequences, as the employment opportunities available are more limited compared with a period of low unemployment (123, 124).

Prior poor health is a risk factor of unemployment, which can be an example of the life course model of accumulation of risk described earlier (48, 112), in that exposure to unemployment does not happen at random, as prior health or social problems increase the risk of becoming unemployed. The results of Study IV did not, however, lend much support to this model as including a measure of prior mental health problems had very little or no influence on the association between youth unemployment and later mental health problems. This suggests that youth unemployment might be a separate risk factor for later health problems or perhaps the first step in a life course chain of risk model.

6.2 METHODOLOGICAL CONSIDERATIONS

Major strengths of the four studies in the thesis are that they are all population-based with long-term follow-up, have large sample sizes, and include information on several factors derived from high-quality Swedish nationwide registers. Below is a more detailed discussion of the main methodological issues and limitations of the four studies included in this thesis.

6.2.1 Natural experiment (Studies I to III)

Using a natural experiment setting has many strengths, foremost among them being that researchers can make more credible claims of random assignment compared with other observational studies, as the exposure is exogenously introduced (180) This as-if random assignment to an intervention and control group, similar to a randomized control trial, overcomes several limitations of other observational studies and therefore allows for stronger causal inferences (180, 181).

Random allocation to alcohol exposure among adolescents and pregnant women is impossible for practical and ethical reasons (141), but can to some extent be achieved by using data from a natural experiment setting of an alcohol policy change. This natural experiment approach also allows for escaping problems with self-reported data on alcohol consumption, e.g., biased

responses due to social desirability issues and recall bias (182). The strong beer experiment took place in a restricted time window (8.5 months) and delimited geographical area (only two regions of Sweden), which allowed us to use the rest of Sweden (excluding a bordering area) as a control area, unexposed to the strong beer experiment. This is a major strength, as the associations are less likely to be biased by any natural temporal trends or other unmeasured variables (142). In addition, we were able to compare the results of same-aged mothers and were not limited to comparing younger and older mothers' offspring in Studies II and III, which might differ in regard to other factors related to poor infant health (i.e., lack of resources and poor health) (35).

Causal pathways in public health are complex and often unknown (183). The ability to draw causal conclusions from a natural experiment setting depends on several factors (180). Firstly, as there is no randomization of treatment/intervention in a natural experiment, there needs to be a plausibility of an as-if random assignment. In Studies I to III, we chose to use the rest of Sweden (excluding a border area) as the control group, since the results could vary depending on what regions in Sweden were chosen as a comparison group. The assumption of as-if randomization was partially validated as the individual and family level baseline characteristics between the intervention and control group/area were fairly similar in all three studies. However, at a regional level, the intervention area was to a larger extent made up with high population density areas compared with the control area, 47.9% and 21.2%, respectively. Areas with high population density tend to have higher alcohol availability than areas with lower population density, as an effect of having more restaurants, bars, and liquor stores (2, 20). Most of the strong beer was sold in Gothenburg during the time of the policy experiment, subsequently there was a connection between population density and strong beer sales (41). As this could have an influence on the associations, a covariate of population density of locality was included in the final model in all three studies. We decided to use a stratified Cox regression model when adjusting for population density instead of including population density as a covariate in the Cox regression analyses, as this model had a better fit according to the Alkaike's Information Criterion.

The results of a natural experiment can also be influenced by prior conditions, such as pre-existing alcohol norms in the areas (183). Due to a history of troublesome alcohol problems in Gothenburg, there was some hesitation toward implementing the alcohol experiment there (41). According to alcohol statistics in Sweden, the intervention area had a slightly higher alcohol consumption on average in 1965 than the control area (184). Such pre-existing differences between the intervention and control group can be handled in various ways. Due to register constraints we were unable to include a cohort of adolescents (aged 14–20 years) from before the alcohol experiment was initiated to follow for the same time-period in Study I. Consequently, a sensitivity analysis was performed comparing adolescents living in Gothenburg during the time of the strong beer experiment with adolescents living in Stockholm, a part of the control group with a known higher alcohol consumption than Gothenburg (184). The initial elevated estimates remained, suggesting that these pre-existing conditions did not bias our estimates. In Studies II and III, two negative control cohorts (cohorts A and D) not directly exposed to the alcohol policy experiment were included to enable detection of differences between the intervention and control areas that were unrelated to the intervention (181, 185). In Study III, all children born in the intervention area were at an

increased risk of being convicted of drunk driving compared with the children born in the control area, irrespective of exposure to the alcohol policy experiment, suggesting that there were other unmeasured factors influencing this association.

Due to alarming reports of increased alcohol consumption, especially among youths, and a worry about further increase in problems during the summer of 1968, the alcohol policy experiment was terminated early (41). Consequently, the policy change lasted only 8.5 months, instead of the intended 14 months. Furthermore, from 1965, medium strength beer (up to 4.5% alcohol by volume) was available in grocery stores nationally for those over 16 years (43). While there was a 10-fold increase in strong beer sales during the time of the alcohol policy experiment, these factors raise doubts regarding if the alcohol policy experiment was extreme enough to warrant an effect in the outcomes of interest (142, 180). Based the life course model of sensitive time periods it was anticipated that exposure during fetal life and adolescence to an alcohol policy experiment would have a greater effect on subsequent disease risk compared to other phases during the life course (48, 49).

Another methodological limitation is the risk of misclassification of exposure, as we did not have exact residence information during the experiment and the PHC registers were only administered every five years (146). Consequently, we used the nearest available PHCs, 1965 and 1970, to be able to determine the area of residence. In addition, to minimize the issue of misclassification of exposure, we excluded anyone who had moved between the intervention and control area between 1965 and 1970, as we were unable to determine their exact moving date, as well as individuals who moved from Sweden between those years. Furthermore, as there was a potential issue of a spill-over effect due to cross-border shopping (41), individuals living in a region bordering the intervention area were excluded. For Studies II and III, analyses were stratified by maternal age at conception; this was important as strong beer availability increased substantially more for individuals under the age of 21 years. Exact maternal age at conception was unknown and was roughly estimated by subtracting 280 days from maternal age at birth, which is close to the average registered pregnancy length in the Swedish Medical Birth Register, 281.1 days ± 14 days in 1973. The age at conception was used to reduce misclassification of exposure, especially among young mothers who turned 21 years during their pregnancy.

A further limitation of the study design in Studies I to III is that we do not have individual level information on alcohol consumed during the strong beer experiment. Thus, we lack information on alcohol consumption during adolescence and of the prenatal magnitude of alcohol exposures in relation to the outcomes of disability pension, alcohol-related health problems, and crime. Consequently we cannot examine the role of specific drinking patterns in relation to the outcomes of interest, which appear to matter more than age at onset of alcohol consumption among adolescents in relation to long-term consequences (85). The same limitation applies to the analysis of prenatal alcohol exposure where timing, frequency, and quantity of the alcohol consumed by mothers during pregnancy are all important for the extent to which prenatal alcohol exposure affects offspring health and well-being (186).

6.2.2 Register-based research

In all of the studies included in this thesis, individual-level datasets linking data between the individuals and their biological parents were created through record-linkage of several high-quality nationwide registers. Although this is a major strength, there are several important caveats to keep in mind when working with register-based research.

In Study I, the STORE register was used to obtain information on the outcomes of disability pension. The registers include the underlying diagnoses for disability pension, which adds valuable information, although the diagnoses were only reported at the three-digit level. The older versions of the ICD codes (version 8 and 9) require at least the four-digit level to specify if a diagnosis is alcohol-related and we were therefore unable to include a wider spectrum of alcohol-related disorders. Furthermore, there could be some degree of misclassification of the outcome disability pension due to an alcohol use disorder. Although alcohol abuse is legally permitted as the underlying diagnosis for being granted a disability pension, more socially acceptable diagnoses, such as mental diagnoses, are often found on the disability pension certificates (104, 187). This could have attenuated the association with the outcome of disability pension due to alcohol use disorders, as there might have been more cases than reported of disability pensions due to alcohol use disorders.

A limitation of the STORE register was the left-truncation of the register; it was established in 1994, but has been extended backward to include anyone who was still alive in 1994 and received disability pension from 1971. In order to reduce the possibility of introducing bias, we excluded anyone who died before 1994, as it was unknown if they had received disability pension during follow-up. Using other registers not connected to the database used in Study I, it was estimated that about 2% of the disability pension cases were lost due to this truncation in the STORE register. Similar results as in the main analysis were obtained if the excluded individuals were included as well as if follow-up began at 1994; thus, this did not appear to bias our results.

In Study II, the outcome of alcohol-related health problems were defined in accordance with the National Board of Health and Welfare index of alcohol-related inpatient care, which encompasses all diagnoses that include the word “alcohol” (157). A limitation of the index is that it captures only a small proportion of the health problems attributable to alcohol, e.g., no cardiovascular diseases or cancers are included, in spite of significant evidence that alcohol is a risk factor for them (188). Subsequently, an additional analysis with the outcome of any health problems requiring inpatient care was included, which found no strong evidence of an increased risk among the children born in the intervention area.

Due to register constraints, we were unable to include the outpatient register in Studies II and IV, which is a limitation as inpatient care for both alcohol-related diagnoses and mental health problems is relatively rare in Sweden (189, 190). Furthermore, there was some degree of lack of coverage of registered parents’ alcohol-related health problems and mental health problems in the registers, as the National Patient Register reached full coverage only in 1987(157). This limitation could have biased our results, as family history of alcoholism and mental health problems are important risk factors for developing problems. This lack of coverage also applies to the covariate of prior mental health problems included in Study IV and since prior poor

health is a risk factor for unemployment, the association between unemployment and mental health in Study IV might be slightly overestimated. Still, there is extensive evidence in the current literature suggesting a link between unemployment and mental health, over and above the influence of prior mental health problems. This suggests that the increased risk found among the unemployed in both the crisis and non-crisis cohort would remain, even if a better measure of prior mental health problems was included (113, 123).

The outcome of criminal behavior in Study III was defined in accordance with previous research and derived from a high-quality register. An important caveat of that register is that it covers only a fraction of all the crimes committed and convicted in Sweden (155, 162). The ratio between reported and unrecorded crimes is highly dependent on police work, prioritization of different types of offences, available resources, and public willingness to report crimes, which could all vary between areas and over time (162). Furthermore, using the conviction date instead of the date of the criminal offence if this was missing in the register could introduce bias, as it can take several years for a reported crime to lead to a conviction (155).

In Study IV, data on exposure were obtained from a survey that is conducted regularly by Statistics Sweden. One advantage of surveys is the ability to gather more in-depth information on a subject, while limitations include the risk of missing data and attrition. Thus about 10 percent of the original study base was excluded due to missing information on important covariates, with males and individuals born outside of Sweden being more likely to be excluded in both cohorts. Labor force status in the LFS is measured prospectively at repeated assessment points and is based on numerous questions, thus minimizing recall bias and misclassification of exposure. Previous research on youth unemployment has to a great extent relied on retrospectively collected data on unemployment, either early, or with 5 years, or up to 10 years between each interview, which increases the risk of recall bias (191, 192).

Youths tend to pursue a variety of educational and employment pathways, and measuring their labor force status several times per year, as is done in the LFS, is expected to capture these changes more completely than measuring only once a year. Consequently, a higher proportion of individuals was defined as unemployed in Study IV, compared with the official national average, which is based on yearly measurements from the LFS (156). This should, however, not have influenced our results, as the main interest was the contextual influence (time period of high vs. low national unemployment rates) on the association between unemployment and mental health.

6.3 PUBLIC HEALTH IMPLICATIONS OF FINDINGS AND FUTURE RESEARCH

Using data from natural experiment settings may be more interesting for policymakers, as the results are closer to what is happening in the "real world." On the other hand, results from studies using natural experiment settings could be difficult to generalize to a wider context, as they are often strongly embedded in the cultural context of the time period and location where the natural experiment took place. As such, the results from Studies I to III might not be directly applicable to other areas, as alcohol norms and alcohol policies differ greatly between countries. Nonetheless, the current results provide additional evidence that restricting alcohol

availability to adolescents may have positive long-term consequences for the affected cohort and future generations.

To be able to study the long-term effects of an alcohol policy change, researchers need to look back over time, which increases the likelihood that the context is different from the present day. However, although the strong beer experiment used in this thesis took place 50 years ago, several aspects of the experiment are still discussed today. For example, there is currently an ongoing debate in the United States regarding lowering the minimum legal drinking age from 21 years (19, 193, 194). In addition, several countries have lowered their minimum legal drinking age or have a low minimum age, while others do not have any age restrictions implemented (2). Furthermore, Finland has recently moved sales of cider and beer up to 5.5% of alcohol by volume from their state-owned monopoly stores to regular grocery stores (195). The consequences of this reform are carefully monitored, but so far there have not been any reports of increasing overall alcohol sales (196).

Previous research on the consequences of increased alcohol availability has focused on the sub-populations restricted by the old policy, consequently missing important vulnerable groups in the population, such as children. Research exploring the effects of an alcohol policy change on the health and well-being of subsequent generations is important to get a better understanding of the potential consequences of increased alcohol availability for both the general population and young adults. The results of Study II suggest that an alcohol policy change might have an effect on the health and well-being of the next generation. However, the results of Studies II and III leave us with the question of whether an effect of the strong beer experiment would have been found if a less severe outcome was chosen. Previous research, using the same alcohol experiment, found a negative impact on less severe outcomes, such as wages, educational attainment, cognitive, and non-cognitive ability (37). In addition, the majority of individuals receiving inpatient care for an alcohol-related diagnosis are above the age of 50 years. Thus, more research is needed on less severe outcomes, such as risk drinking and social harms, as well as studies using a longer follow-up time for the outcome of alcohol-related health problems. Furthermore, as young children are also influenced by parental drinking behavior, research is needed to investigate the potential effects of an alcohol policy change on the health and well-being of children (61, 197).

The results of Study IV suggest that irrespective of the national level of unemployment, youth unemployment is associated with worse mental health that is severe enough to require inpatient care. As the transition from school to unemployment is an important and sensitive phase in life, and an experience shared by many, the results can be generalized to a broader context. This is important, as youth unemployment is an increasing problem in many countries. From the current results, we cannot draw any strong conclusions regarding the specific categories of discharge diagnoses, as there were very few observations in each group. Thus, future research with a larger sample size is needed to disentangle the effects of youth unemployment on these categories of discharge diagnoses. The debate regarding health selection continues in current literature; some authors have proposed that using a time period of high national unemployment rates would reduce the bias related to prior poor health (114). Results from Study IV suggest that this might not be the case, especially among youth, which highlights the importance of finding new ways of dealing with the issue of prior health problems in unemployment research.

Furthermore, a main consequence of the economic crisis in the 1990s was that the age of establishment increased from 20 years to around 30 years in Sweden (125). Therefore, it would be of interest to see if similar effects of unemployment are found among young adults aged 25–30 years. It has become more common for youths and young adults to have part-time jobs, be employed on an hourly basis or have temporary jobs as opposed to having permanent employment. Consequently, youths today have a weaker attachment to the labor market, which also might increase the risk of mental health problems.

6.4 CONCLUSIONS

The results of this thesis suggest that increased alcohol availability can have long-term detrimental effects, not only for the exposed individuals but also for subsequent generations. Furthermore, youth unemployment, even for short spells, is associated with an increased risk of long-term mental health problems that require inpatient care, irrespective of the national unemployment levels.

7 ACKNOWLEDGEMENTS

As I am about to reach the end of this journey. I wish to express my sincere gratitude to my supervisors, friends and family, who have supported and encouraged me throughout this process.

My supervisors **Mats Ramstedt, Finn Rasmussen, Jeroene de Munter**, and **Tomas Hemmingsson**. Finn, thank you for taking me on as a PhD-student and sharing your vast knowledge in epidemiology with me. Mats, thank you for giving me valuable insight into the field of alcohol research, especially during the last two years. Jereone, thank you for all your support and interesting discussions throughout the years. Tomas, thank you for sharing all your knowledge and expertise with me, especially within the field of unemployment. Your insightful comments, mostly from a different perspective, on my work has been greatly appreciated.

My mentor, **Louise Stjernberg**. Thank you for all your encouragement and advice throughout this journey. I have greatly appreciated our lunchtime chats- now it is finally my turn to shout you lunch.

Per Tynelius, thank you for all your help navigating the different registers, and all your guidance and patience during the analyses.

George Davey Smith and **David Carslake,** thank you for inviting me to the University of Bristol and sharing your expertise with me.

To all the current and former colleagues and friends at the **Department of Public Health Sciences,** thank you for all the lunches, laughs and support. To everyone at **CAN**, thank you for welcoming me to your workplace and helping me finish my thesis.

Linnéa Holmén, thank you for all your assistance with the final proofreading and language editing of my thesis.

To my **family** and **friends**, near and far, thank you for all your support and encouragement during the last four years. Finally, a special thank you to my loving husband, **Jonas**, for being my biggest supporter throughout this processes and putting up with my endless discussions of my research. After four years, I think you know my area of research just as well as I do.

8 REFERENCES

1. WHO. Global status report on alcohol and health 2018. Geneva: World Health Organization; 2018.
2. Gruenewald PJ. Regulating availability: how access to alcohol affects drinking and problems in youth and adults. Alcohol Res Health. 2011;34(2):248-56.
3. Popova S, Giesbrecht N, Bekmuradov D, Patra J. Hours and days of sale and density of alcohol outlets: impacts on alcohol consumption and damage: a systematic review. Alcohol Alcohol. 2009;44(5):500-16.
4. Room R, Livingston M. The distribution of customary behavior in a population: The total consumption model and alcohol policy. Sociol Perspect. 2017;60(1):10-22.
5. Statistics Sweden. Youth unemployment - comparability in statistics between a number of European countries (In Swedish: Ungdomsarbetslöshet - jämförbarhet i statisitiken mellan ett antal europeiska länder). Population and Welfare Department, Stockholm, Sweden 2013. Report No.: 4.
6. Reneflot A, Evensen M. Unemployment and psychological distress among young adults in the Nordic countries: A review of the literature. Int J Soc Welfare. 2014;23(1):3-15.
7. Forouzanfar MH, Afshin A, Alexander LT, Anderson HR, Bhutta ZA, Biryukov S, et al. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. The Lancet. 2016;388(10053):1659-724.
8. WHO. Global status report on alcohol and health 2014. World Health Organization; 2014.
9. Room R, Babor T, Rehm J. Alcohol and public health. The Lancet. 2005;365(9458):519-30.
10. Anderson P, Baumberg B. Alcohol in Europe. London: Institute of Alcohol Studies; 2006.
11. WHO. Alcohol in the European Union: Consumption, harm and policy approaches 2012.
12. Trolldal B, Håkan L. Alcohol consumption in Sweden 2017 (In Swedish: Alkoholkonsumtionen i Sverige 2017). Stockholm: Centralförbundet för alkohol-och narkotikaupplysning; 2018. Report No.: 175.
13. Room R. Alcohol control and public health. Annu Rev Public Health. 1984;5(1):293-317.
14. Skog OJ. The collectivity of drinking cultures: a theory of the distribution of alcohol consumption. Br J Addict. 1985;80(1):83-99.
15. Anderson P, Chisholm D, Fuhr DC. Effectiveness and cost-effectiveness of policies and programmes to reduce the harm caused by alcohol. The Lancet. 2009;373(9682):2234-46.
16. Norström T, Ramstedt M. Sweden--is alcohol becoming an ordinary commodity? Addiction. 2006;101(11):1543-5.
17. Paschall MJ, Grube JW, Kypri K. Alcohol control policies and alcohol consumption by youth: a multi-national study. Addiction. 2009;104(11):1849-55.
18. Rossow I, Norström T. The use of epidemiology in alcohol research. Addiction. 2013;108(1):20-5.
19. Wagenaar AC, Toomey TL. Effects of minimum drinking age laws: review and analyses of the literature from 1960 to 2000. J Stud Alcohol Suppl. 2002;14:206-25.
20. Babor T. Alcohol: no ordinary commodity: research and public policy: Oxford University Press; 2010.

21. Huckle T, Pledger M, Casswell S. Trends in alcohol-related harms and offences in a liberalized alcohol environment. Addiction. 2006;101(2):232-40.
22. Callaghan RC, Gatley JM, Sanches M, Benny C. Do drinking-age laws have an impact on crime? Evidence from Canada, 2009–2013. Drug Alcohol Depend. 2016;167:67-74.
23. Everitt R, Jones P. Changing the minimum legal drinking age-its effect on a central city emergency department. N Z Med J. 2002;115(1146):9-11.
24. DeJong W, Blanchette J. Case closed: research evidence on the positive public health impact of the age 21 minimum legal drinking age in the United States. J Stud Alcohol Drugs Suppl. 2014(s17):108-15.
25. Norberg KE, Bierut LJ, Grucza RA. Long-term effects of minimum drinking age laws on past-year alcohol and drug use disorders. Alcohol Clin Exp Res. 2009;33(12):2180-90.
26. Plunk AD, Cavazaos-Rehg P, Bierut LJ, Grucza RA. The persistent effects of minimum legal drinking age laws on drinking patterns later in life. Alcohol Clin Exp Res. 2013;37(3):463-9.
27. Plunk AD, Krauss MJ, Syed-Mohammed H, Hur M, Cavzos-Rehg PA, Bierut LJ, et al. The Impact of the Minimum Legal Drinking Age on Alcohol-Related Chronic Disease Mortality. Alcohol Clin Exp Res. 2016;40(8):1761-8.
28. Thern E, Jia T, Willmer M, de Munter J, Norström T, Ramstedt M, et al. No effects of increased alcohol availability during adolescence on alcohol-related morbidity and mortality during four decades: a natural experiment. J Epidemiol Community Health. 2017;71(11):1072-77.
29. Sherk A, Stockwell T, Chikritzhs T, Andréasson S, Angus C, Gripenberg J, et al. Alcohol consumption and the physical availability of take-away alcohol: systematic reviews and meta-analyses of the days and hours of sale and outlet density. J Stud Alcohol Drugs. 2018;79(1):58-67.
30. Bryden A, Roberts B, McKee M, Petticrew M. A systematic review of the influence on alcohol use of community level availability and marketing of alcohol. Health Place. 2012;18(2):349-57.
31. Azar D, White V, Coomber K, Faulkner A, Livingston M, Chikritzhs T, et al. The association between alcohol outlet density and alcohol use among urban and regional Australian adolescents. Addiction. 2016;111(1):65-72.
32. Rowland B, Toumbourou J, Satyen L, Tooley G, Hall J, Livingston M, et al. Associations between alcohol outlet densities and adolescent alcohol consumption: A study in Australian students. Addict Behav. 2014;39(1):282-8.
33. Young R, Macdonald L, Ellaway A. Associations between proximity and density of local alcohol outlets and alcohol use among Scottish adolescents. Health Place. 2013;19:124-30.
34. Barreca A, Page M. A pint for a pound? Minimum drinking age laws and birth outcomes. Health Econ. 2015;24(4):400-18.
35. Fertig AR, Watson T. Minimum drinking age laws and infant health outcomes. J Health Econ. 2009;28(3):737-47.
36. Zhang N, Caine E. Alcohol policy, social context, and infant health: The impact of minimum legal drinking age. Int J Environ Res Public Health. 2011;8(9):3796-809.
37. Nilsson JP. Alcohol Availability, Prenatal Conditions, and Long-term Economic Outcomes. J Polit Econ. 2017;125(4):1149-207.
38. Seabrook J, Woods N, Clark A, de Vrijer B, Penava D, Gilliland J. The association between alcohol outlet accessibility and adverse birth outcomes: A retrospective cohort study. J Neonatal Perinatal Med. 2018;11(1):71-7.
39. Nycander S. Addiction History Ivan Bratt: the man who saved Sweden from prohibition. Addiction. 1998;93(1):17-25.

40. Norström T. The abolition of the Swedish alcohol rationing system: effects on consumption distribution and cirrhosis mortality. Br J Addict. 1987;82(6):633-41.
41. SOU. The pilot project of strong beers sales in Gothenburg and Bohus County and Värmland County (In Swedish: Försöksverksamheten med fri starkölsförsäljning i Göteborgs och Bohus samt Värmlands län. I: Svenska folkets alkoholvanor). Rapport från försök och utredningar i alkoholpolitiska utredningens regi. Stockholm: Finansdepartmentet; 1971.
42. Room R. The effects of Nordic alcohol policies. What happens to drinking and harm when alcohol controls change? . 2002.
43. Noval S, Nilsson T. The effects of medium beer on consumption levels and the rise in overall alcohol consumption (In Swedish: Mellanölets effekt på konsumtionsnivån och tillväxten hos den totala alkoholkonsumtionen). Nilsson T, editor. Linköping, Sweden: Samhällsvetenskapliga institutionen, Universitetet i Linköping 1984.
44. Socialdepartementet. A cohesive strategy for alcohol, narcotic drugs, doping and tobacco (ANDT) policy 2016-2020 (In Swedish: En samlad strategi för alkohol-, narkotika-, dopnings- och tobakspolitiken 2016 – 2020). In: Socialdepartementet, editor. Stockholm, Sweden 2015.
45. SOU. Medium strength beer (Mellanölsfrågan). Statens offentliga utredningar: Stockholm: Finansdepartementet; 1971.
46. Kontrollstyrelsen. Strong beer experiment (In Swedish: Starkölsförsöket 1967-1968). Riksarkivet; 1968.
47. Sveriges Officiella Statistik. Alcohol statistics 1968 (In Swedish: Alkoholstatistik 1968). Stockholm; 1969.
48. Kuh D, Ben-Shlomo Y, Lynch J, Hallqvist J, Power C. Life course epidemiology. J Epidemiol Community Health. 2003;57(10):778-83.
49. Viner RM, Ross D, Hardy R, Kuh D, Power C, Johnson A, et al. Life course epidemiology: recognising the importance of adolescence. J Epidemiol Community Health. 2015;69(8):719-20.
50. Johnstone BM, Leino EV, Ager CR, Ferrer H, Fillmore KM. Determinants of life-course variation in the frequency of alcohol consumption: meta-analysis of studies from the collaborative alcohol-related longitudinal project. J Stud Alcohol. 1996;57(5):494-506.
51. Carvajal F, Lerma-Cabrera JM. Alcohol Consumption Among Adolescents—Implications for Public Health. In: Claborn D, editor. Topics in Public Health: IntechOpen; 2015.
52. Popova S, Lange S, Probst C, Gmel G, Rehm J. Estimation of national, regional, and global prevalence of alcohol use during pregnancy and fetal alcohol syndrome: a systematic review and meta-analysis. Lancet Global Health. 2017;5(3):e290-e9.
53. Chrapkowska C, Wold A. Praktika för blivande föräldrar: Gravidfakta & Barnkunskap på vetenskaplig grund. Falun: Wahlström & Widstrand; 2017.
54. The National Board of Health and Welfare. Pregnancy and abuse (In Swedish: Graviditet och missbruk). 2010.
55. Skagerström J, Alehagen S, Häggström-Nordin E, Årestedt K, Nilsen P. Prevalence of alcohol use before and during pregnancy and predictors of drinking during pregnancy: a cross sectional study in Sweden. BMC Public Health. 2013;13(1):1-10.
56. The Swedish National Insititute of Public Health. Low dose alcohol exposure during pregnacy-does it harm? Östersund, Sweden; 2009.
57. Pryor J, Patrick SW, Sundermann AC, Wu P, Hartmann KE. Pregnancy Intention and Maternal Alcohol Consumption. Obstet Gynecol. 2017;129(4):727-33.
58. Almond D, Currie J. Killing me softly: The fetal origins hypothesis. J Econ Perspect. 2011;25(3):153-72.
59. Jones K, Smith D, Ulleland C, Streissguth A. Pattern of malformation in offspring of chronic alcoholic mothers. The Lancet. 1973;301(7815):1267-71.

60. Barker DJ. The fetal and infant origins of adult disease. Br Med J. 1990;301(6761):1111.
61. Foltran F, Gregori D, Franchin L, Verduci E, Giovannini M. Effect of alcohol consumption in prenatal life, childhood, and adolescence on child development. Nutr Rev. 2011;69(11):642-59.
62. Ruisch IH, Dietrich A, Glennon JC, Buitelaar JK, Hoekstra PJ. Maternal substance use during pregnancy and offspring conduct problems: A meta-analysis. Neurosci Biobehav Rev. 2017;84:325-36.
63. Haycock PC. Fetal alcohol spectrum disorders: the epigenetic perspective. Biol Reprod. 2009;81(4):607-17.
64. Wong CC, Mill J, Fernandes C. Drugs and addiction: an introduction to epigenetics. Addiction. 2011;106(3):480-9.
65. Behnke M, Smith VC, Levy S, Ammerman SD, Gonzalez PK, Ryan SA, et al. Prenatal substance abuse: short-and long-term effects on the exposed fetus. Pediatrics. 2013;131(3):e1009-e24.
66. Tsang TW, Lucas BR, Olson HC, Pinto RZ, Elliott EJ. Prenatal alcohol exposure, FASD, and child behavior: A meta-analysis. Pediatrics. 2016;137(3):e20152542.
67. Flak AL, Su S, Bertrand J, Denny CH, Kesmodel US, Cogswell ME. The association of mild, moderate, and binge prenatal alcohol exposure and child neuropsychological outcomes: a meta-analysis. Alcohol Clin Exp Res. 2014;38(1):214-26.
68. Riley EP, Infante MA, Warren KR. Fetal alcohol spectrum disorders: an overview. Neuropsychol Rev. 2011;21(2):73-80.
69. Henderson J, Gray R, Brocklehurst P. Systematic review of effects of low–moderate prenatal alcohol exposure on pregnancy outcome. BJOG. 2007;114(3):243-52.
70. Mamluk L, Edwards HB, Savović J, Leach V, Jones T, Moore TH, et al. Low alcohol consumption and pregnancy and childhood outcomes: time to change guidelines indicating apparently 'safe' levels of alcohol during pregnancy? A systematic review and meta-analyses. BMJ open. 2017;7(7):e015410.
71. Sood B, Delaney-Black V, Covington C, Nordstrom-Klee B, Ager J, Templin T, et al. Prenatal alcohol exposure and childhood behavior at age 6 to 7 years: I. dose-response effect. Pediatrics. 2001;108(2):e34.
72. Baer JS, Barr HM, Bookstein FL, Sampson PD, Streissguth AP. Prenatal alcohol exposure and family history of alcoholism in the etiology of adolescent alcohol problems. J Stud Alcohol. 1998;59(5):533-43.
73. Baer JS, Sampson PD, Barr HM, Connor PD, Streissguth AP. A 21-year longitudinal analysis of the effects of prenatal alcohol exposure on young adult drinking. Arch Gen Psychiatry. 2003;60(4):377-85.
74. Streissguth A. Offspring effects of prenatal alcohol exposure from birth to 25 years: The Seattle Prospective Longitudinal Study. J Clin Psychol Med Settings. 2007;14(2):81-101.
75. Alati R, Al Mamun A, Williams GM, O'Callaghan M, Najman JM, Bor W. In utero alcohol exposure and prediction of alcohol disorders in early adulthood: a birth cohort study. Arch Gen Psychiatry. 2006;63(9):1009-16.
76. Pfinder M, Liebig S, Feldmann R. Adolescents' use of alcohol, tobacco and illicit drugs in relation to prenatal alcohol exposure: modifications by gender and ethnicity. Alcohol Alcohol. 2014;49(2):143-53.
77. Day NL, Helsel A, Sonon K, Goldschmidt L. The association between prenatal alcohol exposure and behavior at 22 years of age. Alcohol Clin Exp Res. 2013;37(7):1171-8.
78. Disney ER, Iacono W, McGue M, Tully E, Legrand L. Strengthening the case: prenatal alcohol exposure is associated with increased risk for conduct disorder. Pediatrics. 2008;122(6):e1225-e30.

79. D'Onofrio BM, Van Hulle CA, Waldman ID, Rodgers JL, Rathouz PJ, Lahey BB. Causal inferences regarding prenatal alcohol exposure and childhood externalizing problems. Arch Gen Psychiatry. 2007;64(11):1296-304.
80. O'leary CM, Nassar N, Zubrick SR, Kurinczuk JJ, Stanley F, Bower C. Evidence of a complex association between dose, pattern and timing of prenatal alcohol exposure and child behaviour problems. Addiction. 2010;105(1):74-86.
81. Robinson M, Oddy W, McLean N, Jacoby P, Pennell C, De Klerk N, et al. Low–moderate prenatal alcohol exposure and risk to child behavioural development: a prospective cohort study. BJOG. 2010;117(9):1139-52.
82. Skogerbø Å, Kesmodel US, Wimberley T, Støvring H, Bertrand J, Landrø NI, et al. The effects of low to moderate alcohol consumption and binge drinking in early pregnancy on executive function in 5-year-old children. BJOG. 2012;119(10):1201-10.
83. The Swedish Council for Information on Alcohol and Other Drugs. Alcohol and drug use among students 2017 (In Swedish: Skolelevers drogvanor 2017). Stockholm, Sweden; 2017. Report No.: CAN Rapport 170.
84. McCambridge J, McAlaney J, Rowe R. Adult consequences of late adolescent alcohol consumption: a systematic review of cohort studies. PLoS Med. 2011;8(2):e1000413.
85. Maimaris W, McCambridge J. Age of first drinking and adult alcohol problems: systematic review of prospective cohort studies. J Epidemiol Community Health. 2013;68:268-74.
86. Marshall EJ. Adolescent alcohol use: risks and consequences. Alcohol Alcohol. 2014;49(2):160-4.
87. Dawson DA, Goldstein RB, Patricia Chou S, June Ruan W, Grant BF. Age at first drink and the first incidence of adult-onset DSM-IV alcohol use disorders. Alcohol Clin Exp Res. 2008;32(12):2149-60.
88. Spear LP. Adolescent alcohol exposure: are there separable vulnerable periods within adolescence? Physiol Behav. 2015;148:122-30.
89. Petit G, Kornreich C, Verbanck P, Cimochowska A, Campanella S. Why is adolescence a key period of alcohol initiation and who is prone to develop long-term problem use?: A review of current available data. Socioaffect Neurosci Psychol. 2013;3(1):21890.
90. Witt ED. Research on alcohol and adolescent brain development: opportunities and future directions. Alcohol. 2010;44(1):119-24.
91. Verhulst B, Neale MC, Kendler KS. The heritability of alcohol use disorders: a meta-analysis of twin and adoption studies. Psychol Med. 2015;45(5):1061-72.
92. Rose RJ, Winter T, Viken RJ, Kaprio J. Adolescent alcohol abuse and adverse adult outcomes: evaluating confounds with drinking-discordant twins. Alcohol Clin Exp Res. 2014;38(8):2314-21.
93. Waldron JS, Malone SM, McGue M, Iacono WG. A co-twin control study of the relationship between adolescent drinking and adult outcomes. J Stud Alcohol Drugs. 2018;79(4):635-43.
94. Rossow I, Felix L, Keating P, McCambridge J. Parental drinking and adverse outcomes in children: A scoping review of cohort studies. Drug Alcohol Rev. 2016;35(4):397-405.
95. Toumbourou JW, Stockwell T, Neighbors C, Marlatt G, Sturge J, Rehm J. Interventions to reduce harm associated with adolescent substance use. The Lancet. 2007;369(9570):1391-401.
96. Arata CM, Stafford J, Tims MS. High school drinking and its consequences. Adolescence. 2003;38(151):567-79.
97. Hall WD, Patton G, Stockings E, Weier M, Lynskey M, Morley KI, et al. Why young people's substance use matters for global health. Lancet Psychiatry. 2016;3(3):265-79.
98. Irons DE, Iacono WG, McGue M. Tests of the effects of adolescent early alcohol exposures on adult outcomes. Addiction. 2015;110(2):269-78.

99. Wells JE, Horwood LJ, Fergusson DM. Drinking patterns in mid-adolescence and psychosocial outcomes in late adolescence and early adulthood. Addiction. 2004;99(12):1529-41.
100. Viner RM, Taylor B. Adult outcomes of binge drinking in adolescence: findings from a UK national birth cohort. J Epidemiol Community Health. 2007;61(10):902-7.
101. Ellickson PL, Tucker JS, Klein DJ. Ten-year prospective study of public health problems associated with early drinking. Pediatrics. 2003;111(5):949-55.
102. Sidorchuk A, Hemmingsson T, Romelsjö A, Allebeck P. Alcohol use in adolescence and risk of disability pension: a 39 year follow-up of a population-based conscription survey. PLoS One. 2012;7(8):e42083.
103. Upmark M, Hemmingsson T, Romelsjö A, Lundberg I, Allebeck P. Predictors of disability pension among young men. Eur J Public Health. 1997;7(1):20-8.
104. Upmark M, Lundberg I, Sadigh J, Allebeck P, Bigert C. Psychosocial characteristics in young men as predictors of early disability pension with a psychiatric diagnosis. Soc Psychiatry Psychiatr Epidemiol. 1999;34(10):533-40.
105. Upmark M, Thundal K-L. An explorative, population-based study of female disability pensioners: the role of childhood conditions and alcohol abuse/dependence. Scand J Public Health. 2002;30(3):191-9.
106. Statistics Sweden. Labour Force Survey 1980-1999 (In Swedish: Arbetskraftsundersökningarna 1980-1990). Stockholm, Sweden: Statistics Sweden, Statistiska meddelanden., Serie Am; 1991.
107. Statistics Sweden. Labour Force Survey 1985-1994: population aged 16-64 years (In Swedish: Arbetskraftsundersökningarna 1985-1994: Befolkningen i åldern 16-64 år). Stockholm, Sweden: Statistics Sweden, Statistiska meddelanden., Serie Am; 1995.
108. Janlert U, Hammarström A. Which theory is best? Explanatory models of the relationship between unemployment and health. BMC Public Health. 2009;9(1):1.
109. Jahoda M. Employment and unemployment: A social-psychological analysis: CUP Archive; 1982.
110. Warr P. Work, unemployment, and mental health. New York, NY, US: Oxford University Press; 1987.
111. Ezzy D. Unemployment and mental health: a critical review. Soc Sci Med. 1993;37(1):41-52.
112. Bartley M, Ferrie J. Glossary: unemployment, job insecurity, and health. J Epidemiol Community Health. 2001;55(11):776-81.
113. Paul KI, Moser K. Unemployment impairs mental health: Meta-analyses. J Vocat Behav. 2009;74(3):264-82.
114. Martikainen PT, Valkonen T. Excess mortality of unemployed men and women during a period of rapidly increasing unemployment. Lancet. 1996;348(9032):909-12.
115. Lundin A, Lundberg I, Hallsten L, Ottosson J, Hemmingsson T. Unemployment and mortality—a longitudinal prospective study on selection and causation in 49321 Swedish middle-aged men. J Epidemiol Community Health. 2010;64(01):22-8.
116. Montgomery S, Udumyan R, Magnuson A, Osika W, Sundin P-O, Blane D. Mortality following unemployment during an economic downturn: Swedish register-based cohort study. BMJ Open. 2013;3(7):e003031.
117. Mäki N, Martikainen P. A register-based study on excess suicide mortality among unemployed men and women during different levels of unemployment in Finland. J Epidemiol Community Health. 2010;66(4):302-7.
118. Åhs AM, Westerling R. Mortality in relation to employment status during different levels of unemployment. Scand J Public Health. 2006;34(2):159-67.

119. Garcy AM, Vågerö D. Unemployment and suicide during and after a deep recession: a longitudinal study of 3.4 million Swedish men and women. Am J Public Health. 2013;103(6):1031-8.
120. Novo M, Hammarström A, Janlert U. Health hazards of unemployment–only a boom phenomenon? A study of young men and women during times of prosperity and times of recession. Public Health. 2000;114(1):25-9.
121. Virtanen P, Hammarström A, Janlert U. Children of boom and recession and the scars to the mental health–a comparative study on the long term effects of youth unemployment. Int J Equity Health. 2016;15(1):14.
122. Clark AE. Unemployment as a social norm: Psychological evidence from panel data. J Labor Econ. 2003;21(2):323-51.
123. McKee-Ryan F, Song Z, Wanberg CR, Kinicki AJ. Psychological and physical well-being during unemployment: a meta-analytic study. J Appl Psychol. 2005;90(1):53.
124. Frasquilho D, Matos MG, Salonna F, Guerreiro D, Storti CC, Gaspar T, et al. Mental health outcomes in times of economic recession: a systematic literature review. BMC Public Health. 2016;16(1):115.
125. Bergmark Å, Palme J. Welfare and the unemployment crisis: Sweden in the 1990s. Int J Soc Welfare. 2003;12(2):108-22.
126. Bell DN, Blanchflower DG. Young people and the Great Recession. Oxford Review of Economic Policy. 2011;27(2):241-67.
127. Statistics Sweden. Employment and unemployment 1976-2004 (In Swedish: Sysselsättning och arbetslöshet 1976-2004). Statistics Sweden: Avdelning för arbetsmarknads-och utbildningsstatistik; 2005.
128. OECD. OECD Labour Force Statistics 2017. 2018.
129. Strandh M, Winefield A, Nilsson K, Hammarström A. Unemployment and mental health scarring during the life course. Eur J Public Health. 2014;24(3):440-5.
130. Daly M, Delaney L. The scarring effect of unemployment throughout adulthood on psychological distress at age 50: Estimates controlling for early adulthood distress and childhood psychological factors. Soc Sci Med. 2013;80:19-23.
131. Arulampalam W, Gregg P, Gregory M. Unemployment scarring. The Economic Journal. 2001;111(475):577-84.
132. Dooley D, Prause J. Underemployment and alcohol misuse in the National Longitudinal Survey of Youth. J Stud Alcohol Drugs. 1998;59(6):669-80.
133. Janlert U, Hammarström A. Alcohol consumption among unemployed youths: results from a prospective study. Br J Addict. 1992;87(5):703-14.
134. Reine I, Novo M, Hammarström A. Unemployment and ill health–A gender analysis: Results from a 14-year follow-up of the Northern Swedish Cohort. Public Health. 2013;127(3):214-22.
135. Reine I, Novo M, Hammarström A. Does the association between ill health and unemployment differ between young people and adults? Results from a 14-year follow-up study with a focus on psychological health and smoking. Public Health. 2004;118(5):337-45.
136. Hammarström A, Janlert U. Early unemployment can contribute to adult health problems: results from a longitudinal study of school leavers. J Epidemiol Community Health. 2002;56(8):624-30.
137. Christoffersen MN, Poulsen HD, Nielsen A. Attempted suicide among young people: risk factors in a prospective register based study of Danish children born in 1966. Acta Psychiatr Scand. 2003;108(5):350-8.
138. Helgesson M, Johansson B, Nordqvist T, Lundberg I, Vingård E. Unemployment at a young age and later sickness absence, disability pension and death in native Swedes and immigrants. Eur J Public Health. 2013;23(4):606-10.
139. Davila EP, Christ SL, Martinez AC, Lee DJ, Arheart K, LeBlanc WG, et al. Young adults, mortality, and employment. J Occup Environ Med. 2010;52(5):501-4.

140. Helgesson M, Johansson B, Nordqvist T, Lundberg I, Vingård E. Unemployment at a young age and later unemployment in native Swedish and immigrant young adults. Modern Economy. 2014;5(01):24.
141. Craig P, Cooper C, Gunnell D, Haw S, Lawson K, Macintyre S, et al. Using natural experiments to evaluate population health interventions: new Medical Research Council guidance. J Epidemiol Community Health. 2012;66(12):1182-6.
142. Leatherdale ST. Natural experiment methodology for research: a review of how different methods can support real-world research. Int J Soc Res Method. 2018:1-17.
143. Ludvigsson JF, Otterblad-Olausson P, Pettersson BU, Ekbom A. The Swedish personal identity number: possibilities and pitfalls in healthcare and medical research. Eur J Epidemiol. 2009;24(11):659-67.
144. Ludvigsson JF, Almqvist C, Bonamy A-KE, Ljung R, Michaëlsson K, Neovius M, et al. Registers of the Swedish total population and their use in medical research. Eur J Epidemiol. 2016;31(2):125-36.
145. Statistics Sweden. Multi-generation register 2010: A description of contents and quality. Örebro, Sweden 2011.
146. Statistics Sweden. Former National Population and Housing Censuses 1960-1990 (In Swedish: Tidigare Folk- och bostadsräkningar (FoB) 1960-1990). Örebro, Sweden; 2001.
147. Statistics Sweden. Background facts, labour and education statistics, 2011:4 Intergrated database for labour market research 1990-2009 (In Swedish: Bakgrundsfakta, Arbetsmarknads- och utbildningsstatistik 2011:4, Longitudinell integrationsdatabas för Sjukförsäkrings- och Arbetsmarknadsstudier (LISA) 1990–2009). Stockholm, Sweden 2011.
148. The National Board of Health and Welfare. Quality declaration: Activity compensation and sickness compensation (In Swedish: Kvalitetsdeklaration: Aktivitets - och sjukersättning) Stockholm, Sweden; 2018.
149. Lindwall U. Changes in social security and welfare contributions 1986-01-01 to 2015-09-01 (In Swedish: Förändringar inom socialförsäkrings - och bidragsområderna 1968-01-01--2015-09-01). Stockholm, Sweden:: Försäkringskassan 2015.
150. Hörnquist JO. Abuse of Alcohol and Disability Pension The Effect of the Liberalization in Sweden in 1977. Scand J Public Health. 1982;10(3):113-8.
151. Goverment proposal of changes to the Act (1962:381) on general insurance etc (In Swedish: Prop. 1976/77:44 Regeringens proposition 1976/77:44 om ändring i lagen (1962:381) om allmän försäkring, m. m.), (1976).
152. Ludvigsson JF, Andersson E, Ekbom A, Feychting M, Kim J-L, Reuterwall C, et al. External review and validation of the Swedish national inpatient register. BMC Public Health. 2011;11(1):450.
153. The National Board of Health and Welfare. Quality and content in the National Patient Register (In Swedish: Kvalitet och innehåll i patientregistret). Stockholm: Socialstyrelsen: Epidemiologiska centrum 2009.
154. The National Board of Health and Welfare. Cause of death 2013 (In Swedish: Dödsorsaker 2013). Stockholm, Sweden: Sveriges officiella statistik; 2014.
155. The Swedish National Council for Crime Prevntion (Brå). The art of reading crime statistics (In Swedish: Konsten att läsa statistik om brottslighet). Stockholm; 2006.
156. Statistics Sweden. Labour Force Surveys. Stockholm, Sweden; 2014.
157. The National Board of Health and Welfare. Inpatient care diagnoses (In Swedish: Sjukdomar i sluten vård 1987-2001). Stockholm: Socialstyrelsen: Epidemiologiskt centrum 2003.
158. Chang Z, Lichtenstein P, Långström N, Larsson H, Fazel S. Association between prescription of major psychotropic medications and violent reoffending after prison release. JAMA. 2016;316(17):1798-807.

159. Grönqvist H. Youth unemployment and crime: new lessons exploring longitudinal register data. SOFI Working Paper no 7/20112011.
160. Statistics Sweden. Localities 2010: Population, age and gender (In Swedish with English summary: Tätorter 2010: Befolkningsstruktur). Stockholm, Sweden; 2012.
161. Statistics Sweden. Population and Housing Census 1970. Part 2 (In Swedish: Folk-och bostadsräkningen 1970. Del 2 Befolkning i tätorter). National Central Bureau of Statistics, Stockholm; 1972.
162. The Swedish National Council for Crime Prevntion (Brå). Crime statistics 2011 (In Swedish: Kriminalstatistik 2011). Stockholm; 2012.
163. Fine JP, Gray RJ. A proportional hazards model for the subdistribution of a competing risk. J Am Stat Assoc. 1999;94(446):496-509.
164. Ministry of Justice. Personal Data Protection: Information on the Personal Data Act. Stockholm; 2006.
165. Ministry of Justice. Public Access to Information and Secrecy Act: Information concerning public access to information and secrecy legislation, etc. Stockholm; 2009.
166. Rahman S, Mittendorfer-Rutz E, Alexanderson K, Jokinen J, Tinghög P. Disability pension due to common mental disorders and healthcare use before and after policy changes; a nationwide study. Eur J Public Health. 2016;27(1):90-6.
167. Olsson S. Regional differences in sickness benefits and disability pension (In Swedish: Regionala skillnader i utgifter för sjukpenning och förtidspension: En studie av utbetalade belopp i rikets kommuner 1993-2000). RFV Analyserar: Stockholm: Riksförsäkringsverket; 2004.
168. The Swedish Social Insurance Inspectorate. Regional differences in health insurance outcomes: An analysis of the development 1996-2010 (In Swedish: Regionala skillnader i sjukförsäkringens utfall: En analys av utvecklingen 1996-2010). Stockholm; 2010.
169. Gipson JD, Koenig MA, Hindin MJ. The effects of unintended pregnancy on infant, child, and parental health: a review of the literature. Stud Fam Plann. 2008;39(1):18-38.
170. Cornelius MD, Goldschmidt L, Day NL. Gestational alcohol exposure and other factors associated with continued teenage drinking. Health Educ Behav. 2015;43(4):428-33.
171. The Swedish Council for Information on Alcohol and Other Drugs. Drug Trends in Sweden 2017. Stockholm; 2017. Report No.: CAN report 163.
172. Streissguth A, Barr H, Kogan J, Bookstein F. Understanding the occurrence of secondary disabilities in clients with fetal alcohol syndrome (FAS) and fetal alcohol effects (FAE). 1996.
173. Popova S, Lange S, Bekmuradov D, Mihic A, Rehm J. Fetal alcohol spectrum disorder prevalence estimates in correctional systems: a systematic literature review. Can J Public Health. 2011:336-40.
174. The National Board of Health and Welfare. The Swedish Medical Birth Register–a summary of content and quality. National Board of Health and Welfare Stockholm, Sweden; 2003.
175. Mäkelä P, Paljärvi T. Do consequences of a given pattern of drinking vary by socioeconomic status? A mortality and hospitalisation follow-up for alcohol-related causes of the Finnish Drinking Habits Surveys. J Epidemiol Community Health. 2008;62(8):728-33.
176. Hollander A-C, Bruce D, Ekberg J, Burström B, Ekblad S. Hospitalisation for depressive disorder following unemployment—differentials by gender and immigrant status: a population-based cohort study in Sweden. J Epidemiol Community Health. 2013;67(10):875-81.

177. Eliason M, Storrie D. Inpatient psychiatric hospitalization following involuntary job loss. Int J Ment Health. 2010;39(2):32-55.
178. Beland F, Birch S, Stoddart G. Unemployment and health: contextual-level influences on the production of health in populations. Soc Sci Med. 2002;55(11):2033-52.
179. Strandh M, Novo M, Hammarström A. Mental health among the unemployed and the unemployment rate in the municipality. Eur J Public Health. 2011;21(6):799-805.
180. Dunning T. Improving causal inference: Strengths and limitations of natural experiments. Polit Res Quart. 2008;61(2):282-93.
181. Gage SH, Munafò MR, Davey Smith G. Causal Inference in Developmental Origins of Health and Disease (DOHaD) Research. Annu Rev Psychol. 2016;67:567-85.
182. Davis CG, Thake J, Vilhena N. Social desirability biases in self-reported alcohol consumption and harms. Addict Behav. 2010;35(4):302-11.
183. Petticrew M, Cummins S, Ferrell C, Findlay A, Higgins C, Hoy C, et al. Natural experiments: an underused tool for public health? Public Health. 2005;119(9):751-7.
184. Sveriges Officiella Statistik. Alcohol sales 1965 (In Swedish: Rusdrycksförsäljning m.m. 1965). Stockholm 1966.
185. Lipsitch M, Tchetgen ET, Cohen T. Negative controls: a tool for detecting confounding and bias in observational studies. Epidemiology. 2010;21(3):383-8.
186. Irner TB. Substance exposure in utero and developmental consequences in adolescence: a systematic review. Child Neuropsychol. 2012;18(6):521-49.
187. Hensing G, Wahlström R. Sickness absence and psychiatric disorders. Scand J Public Health. 2004;32(63 suppl):152-80.
188. Rehm J, Gmel Sr GE, Gmel G, Hasan OS, Imtiaz S, Popova S, et al. The relationship between different dimensions of alcohol use and the burden of disease—an update. Addiction. 2017;112(6):968-1001.
189. The Swedish Council for Information on Alcohol and Other Drugs. Drug trends in Sweden 2014 (In Swedish: Drogutvecklingen i Sverige 2014). Stockholm, Sweden; 2014. Report No.: CAN rapport 144.
190. Public Health Agency of Sweden. Public Health in Sweden (In Swedish: Folkhälsa i Sverige). Stockholm, Sweden 2014.
191. Hammarström A, Janlert U. Early unemployment can contribute to adult health problems: results from a longitudinal study of school leavers. J Epidemiol Community Health. 2002;56(8):624-30.
192. Montgomery SM, Cook DG, Bartley MJ, Wadsworth M. Unemployment pre-dates symptoms of depression and anxiety resulting in medical consultation in young men. Int J Epidemiol. 1999;28(1):95-100.
193. Pitts JR, Johnson ID, Eidson JL. Keeping the case open: responding to Dejong and Blanchette's "case closed" on the minimum legal drinking age in the United States. J Stud Alcohol Drugs. 2014;75(6):1047-9.
194. DeJong W, Blanchette J. When enough is enough: the public health argument for the age 21 minimum legal drinking age. J Stud Alcohol Drugs. 2014;75(6):1050-2.
195. Ministry of Social Affairs and Health. Comprehensive reform of Alcohol Act Finland 2018 [Available from: https://stm.fi/en/comprehensive-reform-of-alcohol-act].
196. Valvira (National Supervisory Authority for Welfare and Health). Alcohol statistics 2018 (In Finnish: Alkoholitilastot vuosi 2018) 2018 [Available from: https://www.valvira.fi/alkoholi/tilastot/alkoholitilastot-vuosi-2018].
197. Rossow I, Keating P, Felix L, McCambridge J. Does parental drinking influence children's drinking? A systematic review of prospective cohort studies. Addiction. 2016;111(2):204-17.