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05:2010 WORKING PAPER

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OF LOWERING THE BAC LEVELS

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Children and Family
Working Paper 05:2010

We thank *Trygfonden* and *Ministry of Justice* for generous research support.

The views expressed in this report are those of the author, not necessarily those of the Ministry of Justice, nor do they reflect Government policy.

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Drink-driving convictions and the effect of lowering the BAC levels¹

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(Revised 8th November, 2010)

Abstract

Driving while impaired (DWI) is a factor behind one in four fatal automobile crashes and one in six motoring casualties each year in Denmark. Drink driving is especially a problem for young men. The most important legal initiative has been lowering the blood-alcohol content (BAC) limit from 0.8‰ to 0.5‰ in 1998. The purpose of the paper is to evaluate if this initiative have had the intended effects on reducing young peoples' drink-driving convictions.

Two nationwide birth-cohorts of young men are followed before and after lowering the BAC level. Using complete birth cohorts of men born in 1973 (N=36,540) and 1980 (N=29,944) the incidence of first-time drink-driving convictions was assessed using seven years' experience before and seven years after the changed legislation while the young men were aged 17 to 24 years old. The preliminary results showed that young people (17-24 years old) are estimated to have 27 percent increased risk of DWI-conviction during 1997 to 2004 compared to young people in the same age group in the period 1990-1997.

Several risk factors known to be associated with the probability of being convicted of drink driving were included in the stepwise regression model (e.g. disadvantages during adolescence, severe psychological problems, prior criminal history, living in rural vs. metropolitan area, and their present social position, e.g. educational background). In order to evaluate the effect of changed legislation on the incidence of first-time drink-driving convictions among young people, the attributable-fraction and counterfactual reductions of the known risk factors is estimated on the basis of a discrete time Cox model. Lowering the BAC-level in 1998 was not followed by an expected significant increase in DWI-convictions. The overall risk of DWI-convictions was the same when the mentioned risk factors were included into the regressions model.

A part of the increased number of DWI-convictions during the observation period could be explained by an increase in numbers of young men exposed to risk factors associated with DWI and this was only partly compensated by increase in resilience factors such as education and employment factors. Lowering the BAC-limits seems not to be an effective measure to reduce DWI-convictions but DWI-behaviour must have changed according to the new BAC-limits.

¹ A preliminary version has been presented at IX Conference of The European Society of Criminology, Ljubljana, Slovenia, September 9th – 12th, 2009

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Introduction

During the last decade a disturbing, partly inexplicable, trend in traffic accidents has shown a stagnation or, more seriously, an increase in young people's drink-driving accidents. This trend has not followed the general trend of a reduction automobile accidents and in the numbers of seriously injured casualties (Larsen et al., 2006). In 1998 the BAC level (blood-alcohol content) was changed in order to reduce the number of drink-driving accidents. This present project will evaluate if the lowering of the BAC-level has successfully had the intentional effect of reducing the number of drink-driving incidents.

It is well known that DWI (Driving while impaired) is the most common single cause of serious traffic accidents (Dalgaard, 1977; Steensberg, 2007). Alcohol is the cause of one in four of those killed and one in six casualties each year in Denmark (Danmarks Statistik, 2003; Danmarks Statistik, 2007; Danmarks Statistik, 2008). Alcohol, together with a reduction of speed and the use of seat belts, are the most important preventive measures in traffic accidents (Dalgaard, 1977). Research indicates that alcohol influences driving capacity and there is an increased reaction time as a result. In short, the capability to process stimuli and take relevant decisions is weakened and, thus, risk behaviour is affected by the intake of alcohol. The ability of perceiving, processing and solving multiple tasks, is affected unfavourably when BAC is around 0.4-0.5 (Bernhoft & Behrendorff, 2000). It is often the drunken driver or his/her passengers who are injured. Two thirds of the killed or serious casualties in DWI-accidents are the DWI themselves. In general, far more men than women are injured in DWI-accidents (Danmarks Statistik, 2007; Danmarks Statistik, 2008).

In recent years DWI accidents have become more common among men in the age group 30 to 55 years, but still there is an overrepresentation among young people aged between 18 to 24 years. This age group accounts for every fourth accident although they represent less than ten percent of the population.

For decades there has been a unanimous condemnation of drink driving (Steensberg, 2007) but with the increase in the national income an increase in alcohol consumption has followed (Diderichsen & Skyum-Nielsen, 1969; Skyum-Nielsen, 1962; Ulf-Møller & Skyum-Nielsen, 1968) and, in turn, an increase in the number of those killed and becoming casualties as a result of drink driving. In 1980 DWI accidents accounted for one in five traffic accidents with casualties while DWI accounted for one in three of those killed in traffic accidents (Danmarks Statistik, 1930; Steensberg, 2007).

From the mid 1980s and until 1998 a significant reduction in DWI accidents has been registered, but from 1998 and until the present an expected reduction in DWI accidents has failed to appear. The latest statements from police give the impression that, despite extensive campaigns against DWI, the trend tends to be in the wrong direction (Ritzau, 08). The number of DWI accidents among young persons had stagnated or increased and, thus, failed to follow

the general trend in traffic accidents (Larsen et al., 2006). This trend has provided a rationale for measures concentrated on men in the 30 to 50 years age group and especially young men.

It is important to gather information about high risk groups of DWI among the young men because there has been little information about the background of such men, e.g. upbringing, education, social background etc. Likewise there is a need for information which enables a comparison of risk factors for DWI among young people convicted both in the years up to *and* after 1998.

A previous study of the 1966 birth cohort revealed a series of risk factors for those convicted for the first time of DWI in the years 1980-93. Three factors, in particular, were demonstrated to play a decisive role: firstly, education and vocational training reduced the risk of DWI; secondly, young people formerly convicted of criminal offences other than DWI had an increased risk of a first time conviction for DWI; and thirdly, living in the province outside the metropolitan area increased the risk for DWI among young men (Christoffersen et al., 2008).

Unlike previous studies of DWI accidents the study isolated the risk factors in a longitudinal prospective study design following all young men from the same birth cohort (Barjonet et al., 1994; Behrensdorff et al., 1989; Bernhoft & Behrensdorff, 2000; Dahlstedt, 2006; Hubicka et al., 2007; Larsen, 1997; Møller, 2003; SARTRE, 1995). During the last 15 years a series of measures aimed to influence the drinking habits of young people has been launched, but these measures have not specifically targeted the members of the high risk group in the age group 18 to 25 who are marginalised and have no vocational training.

There is a need of further knowledge about the high risk group and about the changing drinking habits among young people (Gundelach & Järvinen, 2006). Some of the high risk groups may have other problems (e.g. family or employment problems) that may overshadow their drinking and driving habits. This possibility seems to indicate that the perspective focusing on prevention could be broadened out and that other parties could be engaged in preventive measures against DWI (Færdselssikkerhedskommissionen, 2007).

Changes of Statute

In order to limit the number of DWI accidents the legislative sanctions have become more severe and the BAC limits have been reduced. For the period 1976 to 1981 legislation differentiated BAC levels 0.81-1.20‰ from DWI with BAC levels more than 1.20‰ and the sanctions gradually became more severe according to BAC levels. In 1981 the statutory penalty for BAC levels over 2.0‰ were being used. In 1998 the lower limit of BAC level was changed from 0.8‰ to 0.5‰. In 2000 the penalty code was changed again with the possibility of community service and suspended sentence with the opportunity to impose conditions that a driver should undergo a treatment. The size of the penalty is dependent on the BAC level. Any influence on changes in actual behaviour must be seen in the context of the social and political debate and campaigns which changed attitudes towards DWI (Steensberg, 2007).

The most important change was the reduced BAC levels in 1998 from 0.8‰ to 0.5‰. In Norway a similar reduction had already taken place in 1936, and in Sweden in 1957, in Iceland in 1959, and in Finland in 1976. In general, Denmark has a larger percentage of DWI accidents compared to other Scandinavian countries³, and interview surveys in Denmark have revealed that there are more drink-driving drivers than are evident in similar studies in Finland, Norway and Sweden (Steensberg, 2007).

The intention was that the change in 1998 would lead to a reduction in DWI accidents. A study has shown that the change induced a change in drinking habits according to survey interview with drivers. In fact, the average number of units was reduced and the percentage of drivers drinking only one unit increased. Knowledge of the new limits increased from 40 percent to 80 percent. However, the changed attitudes did not result in a similar reduction in casualties caused by DWI. The number of fatal DWI accidents increased compared to the number of fatal accidents in general. A reduction in DWI convictions with high BAC levels was registered, but the total number of DWI convictions increased in 1999 compared to 1997 (Bernhoft & Behrendorff, 2000).

Before 1998 we have no knowledge about BAC-levels below 0.8‰, but after 1998 when the lower limit of BAC level was changed from 0.8‰ to 0.5‰, statistics were made available including convictions with low BAC-level (Table 1). The statistics tells us that about 11 percent of the total number of DWI-convictions had BAC-levels between 0.5 to 0.8‰. If we make the supposition that drinking habits were not changed when BAC-levels were changed we could expect an increased number conviction of about 11 percent, assuming that all other factors being equal. We would like to test this assumption taking other predictors into account when we are studying young people's driving habits.

Will we find an increased number of DWI-convictions among young people after 1998 – when relevant predictors were accounted for? Or will the number of conviction after 1998 be at the same level as before 1998 when changes in risk factors were accounted for? If the latter is the case, we could assume that drinking habits among young people were changed in accordance with the new legislation.

Table 1. Percentage of convictions with low BAC-level since 1998.

year	Percentage with BAC-level 0.5-0.8 ‰	Total number DWI-conviction
1998	7,3	11.879
1999	10,8	12.490
2000	11,5	12.041
2001	11,5	13.914
2002	11,6	13.257
2003	11,4	13.098
2004	11,5	13.929
2005	13,3	10.373
Total	11,1	100.981

Source: Annual yearbook from Commissioner of Police (Rigspolitehfen: Politiets årsrapport).

³ There is no comparable studies from Iceland (Steensberg, 2007).

The study

Previous studies have only sporadic information about young DWI drivers' social background and upbringing which may be crucial in evaluating the effect of the latest change in legislation on young people. In fact, there is a series of questions about potential risk factors which could be called upon to explain the DWI behaviour. For example, do their parents have a drinking problem? Is the problem especially large in the provinces because public transportation is poor in late hours and weekends and, therefore, they might hope to drive home on roads with little traffic and minimal control (Færdselssikkerhedskommissionen, 2007)? Have changes in young people's drinking habits led to new categories of young people having adverse DWI habits (Christoffersen et al., 2008)?

The focus of the present study is to evaluate whether the changed legislation in 1998 which reduced the BAC limits from 0.8‰ to 0.5‰ has effected a change among young people's DWI convictions when taking other changes in risk factors into account.

Theories about DWI

There are contradictory hypotheses explaining DWI behaviour and the underlying causes. On the one hand, there is the assumption that DWI most often takes place among the more affluent groups or, at least, among the general run of drivers. For example showed a study (1985-87) that 30 percent of drivers outside the urban zone had driven in an intoxicated state although they recognised that it was illegal (Behrendorff et al., 1989). On the other hand, some theories make the assumption that persons convicted of DWI probably have other personal and/or social problems and may also be developing a dependency on alcohol. A British study showed for example that two out of five DWI drivers had been previously convicted of DWI. And 30 percent of the DWI drivers who were arrested for a third time did not have a valid driver's licence (Road and Traffic Authority, 2003).

Research in criminal behaviour can traditionally be categorized in at least five paradigms each with its own explanation of criminal behaviour and with its own assumptions on crime reduction (Hope, 2000; Loeber & Farrington, 2000). Paradigm (1) suggests that differences in crime can, for the most part, be traced to characteristics in the local area rather than to individual and personal characteristics (Sampson et al., 2005). In paradigm (2) the focus is on a person's upbringing (Farrington, 1994; Loeber, 2000; Loeber & Stouthamer-Loeber, 1986), with such influences as parental alcohol abuse, teenage motherhood, divorces, poverty, unemployment or reduced parenting skills being involved in predicting an increased risk of children's future criminal conduct. A third paradigm (3) explains criminal behaviour as a result of an individual's actual resources (e.g. unemployment, poverty, lack of education, and vocational training). A fourth paradigm (4) emphasizes situational factors as the most important factor (Clarke, 1980). In this paradigm it is the specific situational circumstances that constitute the risk for criminal behaviour rather than individual or personal

characteristics, and within this paradigm the measures of crime reduction are, for example, removing the physical possibilities of committing the crime.

Finally, according to the fifth paradigm (5), DWI can be seen as rational behaviour (Becker, 1968), DWI is one way among several possibilities of moving from A to B. Considering DWI from this point of view, any reductions depend on (a) how easy will illegal transportation (DWI) be in comparison with legal opportunities; (b) what is the risk of being discovered and convicted; (c) what is the severity of the penalty in the case of conviction; (d) individual capability of risk bearing together with (e) social capital – e.g. reputation, employment, marriage (Williams & Sickles, 2002).

The paradigms can be only partly be considered as mutually exclusive. Importantly, however, these different theoretical perspectives propose different risk factors to be pivotal in crime reduction strategies. In turn, the paradigms lead to different recommendations and proposed measures in crime prevention. The first paradigm, emphasizing social control, leads to notions of activating the local society (Lewis & Salem, 1981), while the second perspective focuses on the conditions of upbringing and typically include preventive programmes targeting vulnerable disadvantaged families (Farrington, 1994; Farrington & Welsh, 2003; Loeber & Stouthamer-Loeber, 1986). The third paradigm focuses on measures improving individual resources through education and vocational training. The fourth paradigm includes means of preventing the possibility of DWI e.g. anti-alcohol barrage. Finally, the fifth paradigm emphasize the situational circumstances e.g. easy access to public transportation (night busses on special weekdays) or by removing the physical opportunity of DWI (Clarke, 1980).

In research about the underlying causes of DWI, there are various conflicting assumptions. On the one hand, there is the assumption that developing alcoholism is the main thrust behind DWI while, on the other hand, we have an assumption launched by Hirschi & Gottfredson (1994), that it is a trait in personality with low self-control that is the main explanation of criminal behaviour in general and DWI in particular (Strand & Garr, 1994).

A third assumption, which is widespread in the literature, is that DWI is the most common crime committed by non-criminal persons (Greve, 1972; Joye, 1988). The assumption is supported to some degree in some early Danish studies where a great part of the drivers admitted to have been driving while intoxicated e.g. 44 percent of 30 to 45 year old men in 1965-67 (Carstensen et al., 1978; Diderichsen & Skyum-Nielsen, 1969). But the results have not been repeated in the last decade differentiating between previous convicted persons and non-criminal persons.

Data and statistical methods

The present study includes all men in the age group 17 to 24 years, born 1973 or 1980. DWI includes all convictions with BAC over the limits of blood contents of euphoriants.

Of course, only a fraction of DWI incidents ends with a conviction.⁴ However, the risk of being involved in a traffic accident or stopped at a road block while driving intoxicated will increase according to the number of incidents. Reports have suggested that drink-driving is a repetitive offence. As a consequence, previous DWI arrests substantially increase the risk of eventual death in an alcohol-related crash (Brewer et al., 1995). It means that people who repeat DWI will be overrepresented among the convicted and probably have more severe personal problems than people who only drive intoxicated once in a life time.

Outcome measurements of first time conviction of drink-driving.

Convicted drink-driving	There are normally two way of being discovered when driving impaired, one is roadblocks another is the routine procedure with blood samples when traffic accidents are reported. In case of injuries and fatal accidents a blood sample will routinely be collected from the persons involved in order to have an exact measure of BAC for the driver, the passengers, or other involved persons.
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In the present study data on the young people’s upbringing and living conditions are included from a series of registers e.g. the neighbourhood, degree of urbanization, information about health according to hospitals admissions, education, employment, crime convictions. Similar information on parents is included in order to describe the upbringing and family resources. The families are followed from the child’s 17th until their 25th birthday. The results will therefore be linked to the relevant time period. Hence, results will reflect the significantly higher level of unemployment for young people born in 1973 compared to the employment opportunities available to young people born in 1980.

The following analysis is limited to these two birth cohort who have the possibility of being convicted of DWI aged 17 to 24 on both sides of the year 1998, when legislation was changed.

The history of an individual’s or group’s history can be analyzed as a series of life-events, reflecting when a person leaves school, graduates, marries, starts a family, becomes a pensioner, and eventually dies. Sociologists try to predict and to explain these events (Allison, 1982). So, for example, why do some groups of people try drugs why others do not? Why do some young men drive a car in an intoxicated state while others do not?

A statistical model has been developed with the purpose of exploring these various types of life-events. The statistical model used is the discrete-time Cox model developed by Allison (1982). This approach has been shown to be useful when studying for example demographic event histories (Arjas & Kangas, 1992; Breslow, 1992; Christoffersen et al., 2007; Hoem & Hoem, 1992).

In short, the aim is to discover in which ways life have been different for the adolescents and young adults who have been convicted of driving while impaired. Our purpose is to gain some

⁴ Former studies of traffic accidents shows that the number of accidents not registered is about 5 times higher than the number registered by police and hospitals. Although, more severe accidents is covered by statistics, and for fatal accidents the coverage will be 100 percent (Danmarks Statistik, 2003).

knowledge on the onset of drink-driving in this early period of their lives before these young adults become settled and start having children. All males born in 1973 or 1980 are followed from 17 to 24 years. We compare the situation for the adolescents with DWI convictions with their contemporaries.

The controls (years at risk) were constructed from members of the total birth cohort who have not experienced the event in focus. Subjects were excluded from the case group and the controls after the first relevant conviction or if they had died or emigrated. Pooling all non-event years of all individuals, the controls were made up of all the non-censored person-years (Allison, 1982).

Using the general population as a control group provides a good standard of reference as well as the possibility of generalizing the results to all young men. However, we can only strictly generalize to the birth cohorts born in 1973 and 1980, since the relevant risk factors may have changed in the following years. Nevertheless, the analysis should provide some overall indication of trends.

The nationwide registers used were the following: Population Statistics, Medical Register on Vital Statistics, Causes of Death Register, Population and Housing Census, Unemployment Statistics, Education Statistics, Social Assistance Act Statistics, Income Compensation Benefits, Labour Market Research, Fertility Research, Criminal Statistic Register, National Patient Register, Danish Psychiatric Nationwide Case Register and Medical Birth Register. Personal identity numbers were initially used to link information for each individual born in 1973, or 1980 together with the information about their parents. Later, the personal identity numbers were erased from the database for security and ethical reasons.

The collected data have two attributes of particular interest: 1) Data are registered prospectively - that is, information gathered in calendar year 't+1' has no influence whatsoever on data filed in calendar year 't'. 2) Data are collected independently from a series of agencies. In other words, we assume that agency A has no knowledge of any register data completed by agency B.

The available event history data contains information on events that fell within a calendar year from 1980 until January 2006. Individuals' event history is broken up into a set of discrete time units (a calendar year) in which an event either did or did not occur⁵. The data is analysed solely for conviction of driving while impaired. Each individual is observed until time t , at which point an event occurs or the observation is censored because it was outside the age limits, because of death, or the individual is lost for observation for other reasons.

Pooling the non-censored years of all individuals, the person-years made up the controls. The controls (years at risk) were constructed by the total birth cohort of 36,540 men, and 29,944

⁵ When the discrete time unit is a calendar year, it is difficult to use continuous-time methods, since more than one individual experience an event in the same time interval (see Table 1). We will therefore apply a discrete-time model, which treats each individual's history as a set of independent observations. Earlier findings show that the maximum likelihood estimator can be obtained by treating all the time units for all individuals as though they were independent, when studying *first*-time events (Allison, 1982; Clayton & Hills, 1993; Rothman & Greenland, 1998).

men, respectively⁶. Separate analysis was carried out for each birth cohort. The number of non-censored person-years varies depending on the event in focus and the birth cohort.⁷

We assume that time takes only positive integer values age ($t=17,18,19,\dots,24$) and we examine ‘ n ’ independent individuals ($i=1,2,3,\dots,n$) while the observed explanatory variables x_{it} may take on different values at different discrete times. Only lagged values of explanatory variables are included. P_{it} is the conditional probability that an event occurs at time t , given that it has not already occurred. α_t is a set of constants for each age 17 to 24 years. This logistic regression function specifies how the hazard rate depends on time and the explanatory variables⁸ can be written in logit form (Allison, 1982):

$$\log \frac{P_{it}}{1 - P_{it}} = \alpha_t + \beta x_{it} + \delta C_{80} + \varphi C_{80} x_{it}$$

Risk is as a probability for an event (or outcome) within a specified population. In the present study the outcome is first time driving while impaired. The outcome is binary – either it occurs or it does not occur. We then define a risk factor (beta) as a correlate that is shown to precede the outcome of interest according to Kraemer and colleagues (Kraemer & Lowe, 2005).

C_{80} is a dummy variable equal to 0 if a person is born 1973, and equal to 1 if a person is born in 1980. This variable will be used to test the overall differences between the two birth cohorts. The product of the second and the third term $\varphi C_{80} x_{it}$ is the last vector, which gives additional information if the variables from the 1980 birth cohort add any significant extra information explaining the outcome. This term will be used to test if any of the risk factors had undergone a change between the two birth cohorts.

The 1973 birth cohort and the 1980 birth cohort are analysed together in order to test any significant differences between the period 1990-1997 and 1997-2004 when the birth cohorts were 17 to 24 years old. Treatment of all teenagers and young adolescents as a coherent group may seem problematic, because the age group 17 to 19 is expected to experience a very different position compared to 22 to 24 year old persons. Therefore a dummy variable for each age under observation is created to estimate the parameters (alpha). Each age group will have their own initial level (α_t). This constant includes information on age and therefore estimation takes age into account. Thus, a kind of age-standardisation is incorporated into the model. Maximum likelihood estimators for the regression models are then calculated on the basis of pooling all the time units over all individuals.⁹

⁶ The study includes only men born 1973 or 1980 that were present according to registers first of January 1987 or 1994, respectively.

⁷ The numbers at risk were $N=283,147$ and $N=230,471$ person-years, when analyzing the 1973 birth cohort, and birth cohort 1980, respectively.

⁸ The risk factor or the explanatory variables (beta) are defined in Appendix in previous studies (Christoffersen et al., 2008; Soothill et al., 2009).

⁹ The log-likelihood function L of the data may thus be written as

The controls are constituted by the person-years under risk of an event (e.g. first time conviction of DWI) in the chosen ages from seventeen to twenty four years. The overall exposure to risk factors among adolescents and young adults is presented in Table 2 in the column labelled: ‘% of controls’ (i.e. % of non-censored person-years).

The purpose of the present analysis is to locate relevant risk factors and describe both the strength (odds ratio) of different risk factors and the overall exposure of risk factors. In order to evaluate the risk factors’ contribution to the number of first-time drink-drive convictions in adolescents and young adults, attributable fractions (AF) are calculated¹⁰ separately for the two birth cohorts (Greenland & Drescher, 1993; Greenland, 2008).

Results

The population based birth cohort study explores risks for first time convictions of driving while intoxicated. In the present study we have decided to explore convictions; although, convictions in many ways differ from the non-convicted drink-driving behaviour. For example will the deadly injured person not be convicted; secondly, the convicted will generally have several attempts of drink-driving before being captured and convicted.

Table 2. Drink-driving (first time conviction of drink-driving) in men born 1973 or 1980 followed until their 25th birthday.

Age	17	18	19	20	21	22	23	24	Total	non-censored person years	
										numbers	percent
1973	112	222	265	241	205	184	159	173	1,561	284,708	0.55
1980	99	245	284	254	226	199	169	149	1,625	232,096	0.70

Note: Total number of males in register at first January 1987 and 1994 for birth cohort 1973 or 1980: N=36,549 and N=29,944, respectively.

The study shows a significant increase in drink-driving convictions among adolescents and young adults aged 17 to 24 years (Table 2). Children born in 1973 (N=36,549) were convicted of DWI in 42.7 per thousand¹¹. The increase of DWI for the 1980 birth cohort was significant; they were convicted of DWI in 54.3 per thousand (N=29,944). The observed 27 per cent

$$\log L = \sum_{i=1}^N \sum_{j=1}^{t_i} y_{ij} \log \left\{ \frac{P_{ij}}{1 - P_{ij}} \right\} + \sum_{i=1}^N \sum_{j=1}^{t_i} \log(1 - P_{ij})$$

while y_{ij} is a dummy variable equal to 1 if a person experiences an event at time t , otherwise zero (Allison, 1982).

¹⁰ Attributable fractions (AF) express the reduction in incidence first time drink-drive convictions that would be achieved if the population had not been exposed at all, compared with the current exposure pattern, according to Greenland and Drescher (1993).

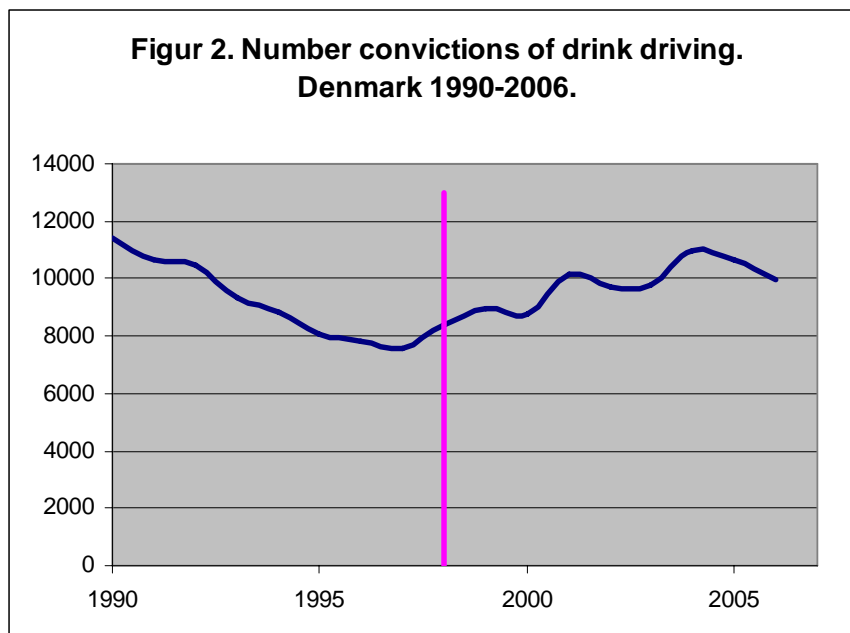
¹¹ The study includes only children born 1973 or 1980 who were present according to registers first of January 1987 or 1994, respectively.

increase could be a result of variations in the number of adolescents exposed to various risk factors between the 1973 birth cohort and the 1980 birth cohort or the increase in DWI-convictions could be a result of changes in the strength (odds ratio) of the included risk factors.

A natural experiment

The history gives an opportunity to evaluate the consequences of changes of BAC level which took effect in 1998. This is an observational study where the assignment of the lowering of the BAC-limits (treatment) to subjects has been haphazard to subjects after 1998. Since the assignment of treatment has been made not by experimenters, the natural experiment is not a controlled experiment. The data base gives a possibility to make comparisons between the 1973 birth cohort and the 1980 birth cohort aged 17 to 24 years. The 1973 birth cohort had been in the age group 17-24 before the changed BAC levels, while the 1980 birth cohort was initial drivers after 1998 in the same age group.

A series of risk factors for those convicted for the first time of DWI revealed three factors, in particular, were demonstrated to play a decisive role: firstly, education of the young people in focus, parental vocational training and employment reduced risk of DWI; secondly, young people formerly convicted of criminal offences other than DWI had an increased risk of a first time conviction for DWI; and thirdly, living in the province outside the metropolitan area increased the risk for DWI among young men.



Risk factors from all the mentioned paradigms add new significant explanation of DWI: Characteristics of the local area (living in Metropolitan area vs. provinces), characteristics of upbringing conditions, the young person's individual resources, situational circumstances (being poor and not having access to a car or other motor vehicle).

Taking all the significant risk factors into account the DWI incidents are not more common in the years *after* lowering the BAC-limits in 1998 – the term in the model δC_{80} turned out to

be insignificant. The increased risk could be a consequence of changes in strength of one or more of the risk factors, but the test of this assumption gives a negative result – the term $\varphi C_{80} x_{it}$ in the model. Only three risk factors are significant different from zero: ‘parental suicidal behaviour’, psychiatric disorder for the child in focus and ‘other crime conviction’ had a changed risk level, and the strength (odds ratio) of these factors have decreased after 1998. Having a psychiatric disorder in the 1980 generation turned out to be a resilient factor. An explanation of this could be partly that more youth are treated for psychiatric disorder and improved treatment may have reduced the drink-driving behaviour. Crime convictions among the 1980 birth cohort reduce the subsequent risk of DWI compared to crime convictions in the 1973 birth cohort (table 3).

The only two explanations left are that the increased risk of DWI-conviction among young people is caused by other risk factors than the factors included in the model. Or for some reason or other, more young people are exposed to the negative risk factors or fewer to the positive risk factors that decreased the risk of DWI.

At the one hand, some factors had improved. More of the 1980-birth cohort had graduated, more young men were employed or being educated, fewer were long-term unemployed and more young people have been treated for psychiatric disorders (table 3).

At the other hand the 1980-birth cohort was exposed more often to domestic violence, child abuse and neglect, family separations, and parental unemployment and severe poverty at some time in their adolescence. A larger number of the new generation had been admitted to a hospital in connection with substance abuse problems (table 3).

1. Parental child rearing methods

The result evidence the importance of child abuse and neglect during adolescence as a significant risk of later drink-driving convictions, even when other risk factors were included in the analyses. Child abuse and neglect or the battered child syndrome according to hospitals admissions increased the risk for later drink-driving convictions (Table 3). Similar findings were not registered for another indicator of poor parenting (child taken into care or ‘looked after children’).

Fortunately, only few children are exposed to these risk factors and therefore these risk factors can only partly explain the early onset of drink-driving convictions in teenagers and young adults. Attributable fractions¹² for the 1973 birth cohort and the 1980 birth cohort were: AF=1.4 to 6.7 percent, respectively. The long term perspective seems to be serious for the few children exposed to these risk factors. The increase in AF reflect that more children are registered in the category ‘child abuse and neglect’ since there is no significance differences between the odds ratio for the two birth cohort under investigation.

¹² Attributable fractions (AF) express the reduction in incidence of suicidal behaviour that would be achieved if the population had not been exposed at all, compared with the current exposure pattern (Greenland & Drescher, 1993).

Family pathway to offspring early-onset drink-driving convictions is found to include parental history of parental suicide attempt, and parental substance abuse. Parental substance abuse could indicate a genetic disposition to predispose drink-driving convictions. At the same time, the risk factor could be a strain and disadvantage in the family with less supportive parents. The present study do not have the power to disentangle these processes, but the results support that the presence of a family history of substance abuse is a significant precursor of adolescents' onset of drink-driving convictions, although these risk factors can only contribute to 2-3 percent of the total number of first time DWI convictions, furthermore incidences of parental mental illness, parental suicidal behaviour or parental substance abuse seems to be at the same level for the 1973 birth cohort as for the 1980 birth cohort. The increased number of DWI convictions could not be explained from the intergenerational transference.

The findings indicates, that family separation lead to less resourceful parenting and in both cases the risk of early onset of offspring's drink-driving convictions even when including other risk factors (e.g. parental substance abuse) in the stepwise regression model. The study finds an association between separation/divorces and offspring's risk of DWI conviction, and separation/divorces can account for an increase of AF=7.2 percent. The increase in AF reflects that more children experience separation of their parents, since the strength (odds ratio) of the risk factor has not changed between the two births cohorts.

2. Structural factors relation to the family during adolescence

The educational level or the level of unemployment is structural risk factor, similar to the degree of income inequality in a society. Educational qualification of the parents seems to build a protective factor against drink-driving convictions, while parental unemployment increase the risk of first time DWI convictions in their offspring as teenagers and young adults.

The parents of the 1966 birth cohort were established on the labour market while employment possibilities were prosperous, while the parents of the 1973 birth cohort and in particular, the 1980 birth cohort were newly established while unemployment was at the highest level in society. Their offspring were exposed to parental unemployment during childhood to a high level.

The families of the 1980 birth cohort were more influenced by parental unemployment because more families were exposed to parental unemployment. And the 1980 birth cohort was more influenced by income inequality because children were exposed to more poverty than previous generation. Structural factors as increase in income inequality in society or increased level of unemployment could only explain a minor part of the increased level of early onset of DWI convictions.

3. The geographical segregation paradigm – population density

The present paper has only access to sparse information on indicators of characteristics of the local community, social control via the community, and the degree of integration.

The present paper is dealing with first time drink-driving convictions and no population density differences were found between the 1973 birth cohort and the 1980 birth cohort. Living in the metropolitan area or in the biggest Danish cities seem to be a protective factor for the early onset of DWI convictions (AF=-31 percent in both birth cohorts and the counterfactual reductions are 1,067 among the 3,186 convictions of first time DWI). An increased tendency in drink-driving convictions between 1973 birth cohort and the 1980 birth cohort was partly explained by more young people living in rented housing – a risk factor which probably indicate less established housing conditions and less car-ownerships (AF=5.9 percent and AF=12.1 percent, respectively).

4. Individual resource deficit

Now we turn from the parental upbringing and structural factors relating to the family during adolescence and focus at the young people's individual resource deficits.

Many more of the birth cohort in 1980 graduated than youth born in 1973 and those who graduated had a lower risk early onset of DWI convictions.

Previous convictions of other crime than DWI are significant precursors of DWI both for the 1973 birth cohort and the 1980 birth cohort. Their risk of early onset of DWI convictions were estimated to 3 times higher than their contemporaries (adjusted OR=2.9). Previous criminal behaviour could account for 18 to 20 percent of the first time DWI convictions (the counterfactual reductions were 713). Since criminal convictions had not increased from the 1973 birth cohort to the 1980 birth cohort this risk factor could not explain the increased number of DWI convictions.

Poverty among young people seems to be a protective factor against this special criminal behaviour probably because of no car ownership (counterfactual reduction is estimated to 984). The relatively small increase in poverty among young people accompanied a decrease in strength of this resilient factor which did not lead to a change in the number of DWI convictions.

Conclusions

Following the 1973 and the 1980 birth cohorts in the age span 17 to 24 years reveal that risk of drink-driving convictions had increased with 27 percent. A series of risk factors add new information and explain a part of the DWI-convictions, but the strength of the risk factors seems to be constant during the period 1980-2004. The only exceptions are 'parental suicidal behaviour', psychiatric disorder and 'other crime' committed of the young men. Changes in these factors has en reduced odds ratio after 1997 and could therefore not explain the overall increased risk of DWI among young men.

The increase in drink-driving convictions may be explained by increase in number of young persons exposed to poor parenting (child abuse and neglect, domestic violence), and poor parental support (more separations). Structural factors related to the family during adolescence e.g. parental unemployment or poverty during adolescence were also associated to early onset of DWI convictions. An increased part of the youth was exposed to substance abuse problems but this is very unusual and can only explain a small increase in DWI convictions.

Considerable part of the increase in drink-driving convictions must be caused by other factors than family background, structural factors, geographical segregation, or individual resource deficits.

Lowering the BAC level seems not to have the desired result on the young men. The usual background factors and confounders (vulnerably background, parental substance abuse, population density, etc.) could only partly explain the increased risk of DWI between the 1973 birth cohort and the 1980 birth cohort.

The increase in education (more graduated), employment, and vocational training together with a decrease in exposure to youth unemployment between the two birth cohorts were associated with a decrease in the risk of drink-driving convictions. These increased numbers of young persons experiencing resilient factors was associated with a reduced risk of DWI, but this could not compensate for the disadvantage of the risk factors.

The change of the BAC-limit may not in itself be a useful measure when targeting DWI among young men. Changes in society - where more young men had experienced disadvantages in upbringing associated with an increased risk of DWI and more men had experienced resilience factors - could only partly explain the increased numbers of DWI convictions.

Acknowledgements: AKF, Danish Institute of Governmental Research is thanked for granting us permission to use their data on deprived areas. We owe a debt of gratitude to M. Azhar Hussein, Keith Soothill and Brian Francis for using their previous work on the longitudinal data. David P. Farrington is thanked for his useful and constructive comments. We thank *Trygfonden* and *Ministry of Justice* for generous research support.

Appendix B. Estimation of the counterfactual reduction

by M. Azhar Hussain¹³.

Counterfactual simulations applying estimated parameters are carried out in order to quantify how many of the total number of events are caused by a given risk factor. We use a slightly modified version of the methodology applied in Hussain ((Hussain, 02)). First a base simulation is run where each teenager i in the sample keeps her actual characteristics X_i , and then the probability of the event taking place $P(Y=1)$ is simulated. The characteristics can be divided into the risk factor of interest d_i and other characteristics X_i^* , thus $X_i = [X_i^* d_i]$. The probability is defined as

$$P(Y_i = 1) = \frac{e^{\alpha + \beta^* X_i^* + \beta_d d_i}}{1 + e^{\alpha + \beta^* X_i^* + \beta_d d_i}}$$

α is the estimated intercept term and β^* is a vector of estimated parameters representing effects of risk factors, except risk factor d_i , whose effect is represented by β_d . Then a counterfactual simulation is run where the risk factor d_i is assumed to be non-existing, thus $d_i = 0$. The probability of the event in the counterfactual case is

$$P(Y_i^* = 1) = \frac{e^{\alpha + \beta^* X_i^*}}{1 + e^{\alpha + \beta^* X_i^*}}$$

The actual (n) and counterfactual number (n^*) of events is thus

$$n = \sum_{i=1}^N P(Y_i = 1) \qquad n^* = \sum_{i=1}^N P(Y_i^* = 1)$$

where N (=Qin et al., 2006), see footnote 6) is the sample size. The reduction in the number of events if a risk factor was eliminated is then $n - n^*$.

¹³ M. Azhar Hussain is Assistant Research Professor at University of Copenhagen, Denmark

Table 3: Risk factors before first time conviction of DWI.

Adjusted odds ratio based on the final stepwise logistic regression model for both the 1973 and the 1980 birth cohort.

1973 and 1980 birth cohort							
Risk factors included	Type	Number First-time convictions (N=3,186)	Adjusted OR	CI 95%	Counter factual reduction	1973 % of Controls Person years	1980 % of Controls Person years
PARENTAL CHILD REARING METHODS							
<i>Intergenerational transfer</i>							
Parental mental illness	III		Ns			12.6	12.8
Parental suicidal behaviour	II	253	1.4	1.2-1.7	-71	4.3	4.1
<i>Family background</i>							
Parental substance abuse	III	500	1.2	1.1-1.3	-82	9.6	8.7
Domestic violence	III	425	1.1	1.0-1.3	-48	5.9	8.2
Child abuse or neglect	II	474	1.7	1.5-1.9	-192	2.8	9.0
Child in care ('looked after children')	II	476	Ns			7.1	7.9
Mother teenager	II	248	Ns			4.5	4.0
Family separation	II	1489	1.1	1.0-1.2	-163	32.2	38.9
STRUCTURAL FACTORS RELATING TO THE FAMILY DURING ADOLESCENCE							
<i>Educational qualifications of parents</i>							
Mother has no vocational qualification	I	2765	1.2	1.0-1.3	-395	79.1	73.0
Father has no vocational qualification	I	2870	1.3	1.1-1.5	-639	79.5	78.3
<i>Parental employment and poverty</i>							
Parental unemployment > 21 weeks	II	1985	1.1	1.0-1.2	-239	40.4	56.3
Poverty (<40% of median income)	II	1042	1.1	1.0-1.2	-97	26.8	31.9
Parental disability pension	II		Ns			14.2	15.2
GEOGRAPHICAL SEGREGATION							
Living outside metropolitan area	I	2558	1.7	1.6-1.9	-1,067	69.2	69.1
Self-owner (not rented) housing	I	1855	1.2	1.1-1.3	-350	58.4	55.1
INDIVIDUAL RESOURCE DEFICITS							
Unemployment > 21 weeks	I	387				8.9	4.1
Not graduated	II	2691	2.7	2.4-3.0	-1,670	60.6	55.1
No poverty (<50% of median income)	I	2844	1.5	1.4-1.7	-984	88.0	84.3
Employed or education	I	1698	Ns			55.9	61.6
Unusual serious crime	II	165	1.2	1.0-1.4	-26	1.9	1.5
Violent crime	II	354	1.8	1.5-2.0	-149	2.5	3.1
Other crime	II	1096	2.9	2.6-3.3	-713	11.6	11.4
Psychiatric disorder	II	115	Ns			1.3	3.1
Substance abuse	II	196	1.6	1.4-1.9	-74	1.0	3.5
CHANGES FROM 1980-1997 TO 1997-2004: THE 1973- VS. THE 1980-BIRTH COHORT							
Born in 1980 vs. 1973	III	1625	Ns				
Parental suicidal behaviour-1980	II	114	0.7	0.5-0.9	48		
No psychiatric disorder-1980	II	1542	1.3	1.2-1.4	-372		
Other crime-1980	II	538	0.8	0.7-1.0	101		

Note: 'N/a' stands for: 'Not applicable' while 'Ns' stands for: 'Not significant'. * 0.05-level; ** 0.01-level; *** 0.0001-level. Type I: exposed to risk factor the previous year. Type II: exposed to risk factor at least one of the previous years. Type III: risk factor observed for at least one of the years under investigation. The total number of first time drink-drive convictions in 1973-birth cohort and the 1980-birth cohort is 1,561 and 1,625, respectively; the number of person-years is 284,708 and 232,096, respectively. More information about the database and definitions is found in the previous publications {Soothill, 2010 4631 /id;Christoffersen, 2009 4623 /id}.

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