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Birth order and hospitalization for alcohol and narcotics use in Sweden

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ABSTRACT

Background: Previous studies have shown that birth order is an important predictor of later life health as well as socioeconomic attainment. In this study, we examine the relationship between birth order and hospitalization for alcohol and narcotics use in Sweden.
Methods: We study the relationship between birth order and hospitalization related to alcohol and narcotics use before and after the age of 20 using Swedish register data for cohorts born 1987–1994. We apply Cox proportional hazard models and use sibling fixed effects, eliminating confounding by factors shared by the siblings.
Results: Before age 20 we find that later born siblings are hospitalized for alcohol use at a higher rate than first-borns, and there is a monotonic increase in the hazard of hospitalization with increasing birth order. Second-borns are hospitalized at a rate 47% higher than first-borns, and third-borns at a rate 65% higher. Similar patterns are observed for hospitalization for narcotics use. After age 20 the pattern is similar, but the association is weaker. These patterns are consistent across various sibling group sizes.
Conclusions: Later born siblings are more likely to be hospitalized for both alcohol and narcotics use in Sweden. These birth order effects are substantial in size, and larger than the estimated sex differences for the risk of hospitalization related to alcohol and drug use before age 20, and previous estimates for socioeconomic status differences in alcohol and drug abuse.

1. Introduction

Alcohol and narcotics abuse are serious disorders that can blight an individual's life, negatively affecting health, social relationships, and socioeconomic trajectories. The most important psychosocial risk factors for adolescent alcohol initiation are having approval from parents and social peers, having role models for alcohol and drug use, an adolescent's own history of delinquent behaviour, as well as genetic factors (Donovan, 2004; Goldman et al., 2005). Another important factor is age, and the earlier the age of alcohol initiation, the greater the risk of alcohol abuse later in life (Hawkins et al., 1997; Stueve and O'Donnell, 2005; Hingson et al., 2006), though there may be discontinuities in alcohol consumption behaviour between adolescence and early adulthood (Norström and Pape, 2012). Studies generally indicate that there are no consistent differences in the risk of alcohol or other substance abuse by background socioeconomic status in adolescence (Hanson and Chen, 2007).

In this study, we address a factor that has received little attention in the literature on alcohol and substance abuse, which is birth order. Given the importance of peers for alcohol and illicit drug initiation, and the importance of age at initiation for later abuse problems, birth order has the potential to play a very important role in the development of alcohol and drug abuse. Through older siblings later born children may be exposed to alcohol and other substances at younger ages than they otherwise would be. We examine the relationship between birth order and hospitalization for alcohol and non-alcohol substance use for males and females using Swedish register data, and compare siblings within the same family to minimize residual confounding. We also study hospitalization before and after age 20 separately as this is the age at which

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individuals can legally purchase alcohol in Sweden (Systembolaget, 2001).

Both observational and experimental research has shown that peer influence is an important factor for the uptake or continuation of various behaviours (Christakis and Fowler, 2008; Rosenquist et al., 2010; Centola, 2010, 2011; Leonardi-Bee et al., 2011). Adolescents with older siblings who use alcohol, cigarettes, or illicit drugs are more likely to be exposed to these substances at a younger age (Blane and Barry, 1973), and later born siblings in particular are more likely to initiate developmentally inappropriate activities, such as alcohol consumption and sexual activity, at younger ages (Bard and Rodgers, 2003; Rodgers and Rowe, 1988). Studies have indicated that younger siblings are more likely to begin smoking if an older sibling already smokes, but not the other way around (Harakeha et al., 2007). In addition to modelling these behaviours, older siblings may facilitate access to these substances for younger siblings when it would otherwise be difficult for them to obtain those substances independently. Sibling group size may also play a role; parental control may be weaker in larger sibling groups, and later borns in large sibling groups in particular may be supervised less.

Previous research has also shown that, relative to first and earlier born siblings, later borns have worse health and socioeconomic outcomes in adulthood, including lower cognitive ability (Bjerkedal et al., 2007), lower educational attainment (Black et al., 2005), lower physical fitness (Barclay and Myrskylä, 2014), and higher mortality from external causes in the form of accidents, suicides, and events of undetermined intent (Bjørngaard et al., 2013; Rostila et al., 2014; Barclay and Kolk, 2015). If birth order is related to alcohol and drug abuse, this abuse may mediate the relationship between birth order and both health and socioeconomic attainment later in life given that individuals with alcohol and substance abuse issues perform worse in intelligence tests (Brown et al., 2000), achieve lower educational attainment (King et al., 2006), have worse physical fitness in early life (Marti et al., 1988), are much more likely to die in car accidents (Mura et al., 2003; Connor et al., 2004), and are at a higher risk of suicide (Rossow and Amundsen, 1995).

A review of previous research examining the relationship between birth order and alcohol and drug use found that later borns are overrepresented with abuse problems (Blane and Barry, 1973). However, these previous studies have had important limitations that restrict the degree to which it is possible to draw inferences about the causal nature of the relationship between birth order and alcohol and drug use. Many previous studies on this topic have been limited by using non-representative samples, and none have adequately accounted for potential confounding factors that might bias the results (Ernst and Angst, 1983). In this study, we improve on previous research by using Swedish population register data on complete birth cohorts of individuals born 1987–1994. Furthermore, we are the first to apply a sibling fixed effect approach to analyze this research question, which minimises residual confounding from unmeasured time-invariant factors that are shared amongst siblings, such as parenting style, household religiosity, and parental patterns of alcohol and drug use. Such factors are commonly unobserved or unmeasured, and if the analyses are not adjusted for these variables then there is a strong potential for bias in the results.

2. Methods

2.1. Data

We use Swedish register data on men and women born between 1987 and 1994. The Swedish Multi-generational Register (Statistics Sweden, 2011) allows us to link these index individuals to their parents and siblings, including siblings born before 1987 and after 1994, meaning that family size and birth order are calculated from the full sibling group. Family size and birth order was based on the full fertility history of mothers. The Medical Birth Register (Swedish National Board of Health and Welfare, 2003) was used to identify birth order, as well as twins or other multiple births. The Medical Birth Register also provides information on birth weight. To identify hospitalization attributable to alcohol or narcotics use, we use the Inpatient Register (Ludvigsson et al., 2011), which provides coverage over the period 1987–2013. External reviews of the Inpatient Register suggest that 85–95% of diagnoses are valid (Ludvigsson et al., 2011). We study hospitalization for alcohol or narcotics related events before the age of 20, and after the age of 20. The diagnostic categories for alcohol-related hospitalizations are 291, 303, 305.0, 357.5, 425.5, 535.3, 571, E860, E980 + 980 from ICD-9, and E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K86.0, O35.4, T51, Y90, Y91, Z50.2, Z71.4, Z72.1 from ICD-10. The diagnostic categories for narcotics hospitalizations are 292, 304, 965.0, 968.5, 969.6, 969.7 from ICD-9, and F11–F16, F18, F19, O35.5-T40 (except T40.4), T43.6, Z50.3, Z71.5 from ICD-10. The follow-up is from birth to age 20 in the analysis of hospitalizations up to age 20, and up to age 26 in the analysis of hospitalizations after age 20. Individuals hospitalized before age 20 are excluded in the analysis of hospitalization after the age of 20. We also conducted sensitivity checks that did not exclude individuals who were hospitalized before age 20.

2.2. Ethical approval

This study was approved by the Ethical Review Board, Stockholm.

2.3. Statistical analyses

To analyze the relationship between birth order and hospitalization for alcohol and narcotics use we apply Cox proportional hazard models (Cox, 1972). The failure event is the first hospitalization of the index person. The baseline hazard for hospitalization before age 20 is time since birth, and for hospitalization after age 20 is time since turning age 20. For each of our outcomes, we run two different models. The first is a regular Cox proportional hazard model on the full population. The second model uses sibling fixed effects to estimate the hazards of hospitalization based upon a within-family comparison. By comparing siblings in the same family we are able to adjust for all time invariant observed and unmeasured factors within the family that are shared by siblings. This includes completed family size, as well as parental socioeconomic status and parenting style to the extent that they remain constant over time. However, we are not able to adjust for a time-varying measure of parental socioeconomic status. Due to its ability to minimize confounding from unobserved or unmeasured variables, we consider the sibling fixed effects approach to be superior to the regular Cox proportional hazard model for addressing our research question. These sibling fixed effect analyses are based upon stratified Cox models where siblings share the same baseline hazard (Allison, 2009). The group variable by which the analyses are stratified is the shared mother ID. These sibling fixed effects analyses are based upon sibling groups with variance in the outcome, meaning that there must be at least two siblings in the family, and at least one of the siblings has to have been hospitalized. In the very rare cases where all of the siblings have been hospitalized, these sibling groups remain in the analysis if they are discordant on time to hospitalization. These analyses were performed using Stata 12 (StataCorp, 2011).

In each of our analyses we adjust for sex, maternal and paternal age at the time of birth using 5-year categories, and birth

year using individual year dummies. We adjust for parental age to take into account potential changes to parental consumption of alcohol and other substances with increasing age, which might influence offspring consumption behaviours. We adjust for birth year to adjust for cohort trends in alcohol and drug use. In our between-family analyses we also adjust for the size of the sibling group, categorically coded 1–4 or larger. In the within-siblings analysis there is no need to adjust for factors such as parental education or socioeconomic status because the sibling-comparison automatically removes the confounding effect of such factors that are shared by the siblings. We also conduct additional analyses where we adjust for birth weight in addition to our other control variables in order to check the robustness of the results.

3. Results

3.1. Descriptives

Descriptive statistics for analysis of hospitalization before age 20 that uses the full cohort of individuals born 1987–1994 can be seen in Table 1. It can be seen that higher birth order individuals disproportionately come from families with lower socioeconomic status and have parents with lower levels of education. Furthermore, it can be seen that the rate of hospitalizations is higher for later borns than it is for first borns. Table 2 shows the descriptive statistics for the analytical sample for the fixed effects models used in the analyses before the age of 20. The total number of hospitalizations related to alcohol and narcotics use are highest amongst second borns, and lowest amongst those who are fourth born or later. However, the rate of hospitalizations is lowest for first borns, and highest for second borns. Table 1 also shows that the rate of hospitalizations is higher for women than men, and decreases with increasing sibling group size. Tables 1 and 2 both show that before age 20 rates of hospitalization for alcohol and other narcotics are very similar for men and women.

Table 3 provides information on the descriptive characteristics of the full cohort used for the analysis of hospitalization after age 20. In this case the rate of hospitalizations for both alcohol and drug related events increases monotonically with increasing birth order. Table 4 shows the descriptive statistics for the analytical sample from the fixed effects models used in the analyses of hospitalization related to alcohol and other substance use after the age of 20. It shows that the number of hospitalizations is highest for first borns, and lowest for fourth or later borns. The rate of hospitalizations related to alcohol use is highest for second borns, and lowest for third borns. The rate of hospitalizations related to narcotics use is highest for first borns, but is lowest for third borns. Rates of hospitalization are higher for men than women, and lower in larger sibling groups. Tables 3 and 4 show that rates of hospitalization for alcohol and narcotics after age 20 are substantially higher for men than for women.

3.2. Multivariate analyses

Table 5 shows the results from analyses examining the relationship between birth order and hospitalization related to alcohol use before the age of 20. Full results tables for these analyses can be found in the Supplementary materials, in Tables S1–S4. The results from model 1 show that, relative to first borns, second, third and fourth borns are around 50% more likely to be hospitalized for alcohol use before the age of 20. In model 2, applying a sibling fixed effect analysis, second borns are hospitalized at a rate 47% higher (95% CI: 1.35, 1.60), third borns 65% higher (95% CI: 1.41, 1.94), and fourth or later borns 91% (95% CI: 1.50, 2.43) higher than their first born sibling. Estimates for the other covariates included in the model, shown in Table S1, indicate that women are hospitalized at a rate 6 or 7% higher than men, that adolescents from larger families are hospitalized at a higher rate than adolescents from smaller families, and that adolescents born to teenage mothers are hospitalized at a higher rate than those born to older mothers.

Model 1 in Table 5 shows the results from analyses examining the relationship between birth order and hospitalization for narcotics use before the age of 20. Model 1 shows that there is a positive monotonic relationship between birth order and the risk of hospitalization for narcotics use before the age of 20. Model 2, applying a sibling fixed effects analysis, finds very similar results. In model 2, second borns are hospitalized at a rate 34% higher (95% CI: 1.15, 1.56), third borns 66% higher (95% CI: 1.26, 2.19), and fourth or later borns 121% (95% CI: 1.46, 3.34) higher than their first born sibling. Estimates from the other covariates, shown in Table S2, show that women are hospitalized at a rate 2% higher than men in full data, and 8% higher than men in the sibling comparison analysis, while adolescents born to teenage mothers and from large families have relatively high rates of hospitalization.

The results from models examining the relationship between birth order and hospitalization related to alcohol use after the age of 20 are also shown in Table 5. Model 1 shows a positive and monotonic relationship between birth order and the hazard of hospitalization for alcohol use. Model 2, applying the sibling fixed effects, also shows that later born siblings are more likely to be hospitalized for alcohol use than first borns after the age of 20, with second borns estimated to be 21% more likely to be hospitalized (95% CI: 0.99, 1.49), and fourth and later borns estimated to be 30% more likely to be hospitalized (95% CI: 0.73, 2.32). The other control variables, shown in Table S3, indicate that men are substantially more likely than women to be hospitalized for alcohol after age 20.

Table 5 also shows the results from analyses examining the relationship between birth order and hospitalization for narcotics use after the age of 20. Model 1 finds a positive and monotonic relationship between birth order and the hazard of hospitalization. Model 2 also shows that there is a positive and monotonic relationship between birth order and the hazard of hospitalization for narcotics use after the age of 20. Relative to first borns, second borns are estimated to be 30% more likely to be hospitalized (95% CI: 1.00, 1.70), and fourth and later borns are estimated to be 66% more likely to be hospitalized (95% CI: 0.76, 3.62). The full set of coefficients, shown in Table S4, indicates that men are much more likely to be hospitalized for narcotics than women after age 20.

Table 6 shows the results from sibling group size specific analyses using a fixed effects estimator for the hazard of hospitalization related to alcohol use before and after age 20, and hospitalization for narcotics use before and after age 20. Looking across Table 4 it is clear that the birth order effects found in the main models presented above are consistent across family sizes, including the most common family sizes in Sweden. Even in two-child sibling groups, second borns are 59% more likely to be hospitalized for alcohol use before age 20 than first borns (95% CI: 1.35, 1.87), and are 41% more likely to be hospitalized for narcotics use (95% CI: 1.05, 1.89). We find that birth order effects on hospitalization for alcohol and substance use are generally weaker after age 20, but they remain relatively consistent across family sizes.

We have also conducted analyses examining the relationship between birth order and hospitalization separately by gender. In the between-family analyses we find that the results are generally very similar to those presented above both before and after age 20. In the sibling comparison analyses we find that the results are similar for men and women before age 20, though the association is stronger for men for both alcohol and drug related hospitalization. In the sibling comparison analyses for hospitalization after age 20, we find that the overall association is driven by the results

Table 1
Descriptive Statistics for Full Cohort Analytical Sample Used in Models without Fixed Effects: Birth Order and Hospitalization for Alcohol Abuse or Narcotics Abuse Before the Age of 20 for Swedish Men and Women Born 1987–1994.

		Alcohol Abuse					Narcotics Abuse				
		Birth Order					Birth Order				
		1	2	3	4+	Total	1	2	3	4+	Total
N		290,044	298,407	132,459	53,720	774,630	290,044	298,407	132,459	53,720	774,630
%		37.4	38.5	17.1	6.9	100.0	37.4	38.5	17.1	6.9	100.0
Male	%	51.4	51.4	51.0	51.0	51.3	51.4	51.4	51.0	51.0	51.3
Maternal Age	Mean	25.5	28.2	30.6	32.6	27.9	25.5	28.2	30.6	32.6	27.9
Paternal Age	Mean	28.2	30.7	32.9	34.4	30.4	28.2	30.7	32.9	34.4	30.4
Birth Year	Mean	1990.4	1990.6	1990.6	1990.8	1990.6	1990.4	1990.6	1990.6	1990.8	1990.6
Sibling Group Size	Mean	2.5	2.6	3.4	4.9	2.8	2.5	2.6	3.4	4.9	2.8
Maternal	<Gymnasium	39.8	44.6	50.1	62.1	45.0	39.8	44.6	50.1	62.1	45.0
Education (%)	Gymnasium	19.6	17.2	14.3	11.8	17.2	19.6	17.2	14.3	11.8	17.2
	Any Tertiary	40.6	38.1	35.5	25.9	37.7	40.6	38.1	35.5	25.9	37.7
	Missing	0.0	0.1	0.1	0.3	0.1	0.0	0.1	0.1	0.3	0.1
Paternal	<Gymnasium	57.1	58.6	60.1	67.0	58.9	57.1	58.6	60.1	67.0	58.9
Education (%)	Gymnasium	12.3	12.0	11.7	10.7	11.9	12.3	12.0	11.7	10.7	11.9
	Any Tertiary	30.4	29.2	28.1	22.0	28.9	30.4	29.2	28.1	22.0	28.9
	Missing	0.3	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3
Childhood SES	Unskilled	14.5	13.3	14.6	20.6	14.5	14.5	13.3	14.6	20.6	14.5
(%)	Skilled	23.8	23.0	23.0	23.5	23.3	23.8	23.0	23.0	23.5	23.3
	Farmer/Self-employed	3.1	4.0	5.8	8.3	4.2	3.1	4.0	5.8	8.3	4.2
	Non-manual	53.9	56.5	53.4	41.3	53.9	53.9	56.5	53.4	41.3	53.9
	Other/Missing	4.9	3.3	3.2	6.3	4.1	4.9	3.3	3.2	6.3	4.1
Person-months	%	37.5	38.5	17.1	6.9	100.0	37.4	38.5	17.1	6.9	100.0
Hospitalizations	N	4,432	5,724	2,541	1,184	13,881	1,459	1,700	802	436	4,397
Hospitalizations	Rate (10^{-6})	2.1	2.6	2.6	3.0	2.5	0.7	0.8	0.8	1.1	0.8
Rate (10^{-6})	Male	2.1	2.6	2.4	2.8	2.4	0.7	0.8	0.8	1.1	0.8
by Sex	Female	2.1	2.7	2.9	3.3	2.5	0.7	0.8	0.8	1.2	0.8
Rate (10^{-6})	2	2.0	2.5	–	–	2.2	0.6	0.7	–	–	0.7
by Family Size	3	2.1	2.7	2.4	–	2.4	0.7	0.8	0.7	–	0.7
	4+	2.8	3.4	3.1	3.0	3.1	1.1	1.0	1.1	1.1	1.1

Table 2
Descriptive Statistics for Analytical Sample Used in Fixed Effects Models: Birth Order and Hospitalization for Alcohol Abuse or Narcotics Abuse Before the Age of 20 for Swedish Men and Women Born 1987–1994.

		Alcohol Abuse					Narcotics Abuse				
		Birth Order					Birth Order				
		1	2	3	4+	Total	1	2	3	4+	Total
N		6,628	8,273	3,848	1,997	20,746	1,970	2,471	1,170	720	6,331
%		32.0	39.9	18.6	9.6	100.0	31.12	39.03	18.48	11.37	100.0
Male	%	50.4	51.0	49.1	48.7	50.2	50.7	51.5	53.3	48.5	51.3
Maternal Age	Mean	24.6	26.9	28.9	31.3	27.0	23.9	26.4	28.3	31.1	26.5
Paternal Age	Mean	27.5	29.7	31.5	33.4	29.7	27.1	29.5	31.0	32.8	29.4
Birth Year	Mean	1989.2	1991.0	1991.3	1991.5	1990.5	1989.2	1991.0	1991.2	1991.4	1990.5
Sibling Group Size	Mean	2.8	2.9	3.7	5.3	3.2	2.8	3.0	3.9	5.4	3.4
Maternal	<Gymnasium	47.7	49.7	56.0	67.8	52.0	50.7	52.9	60.0	70.4	55.5
Education (%)	Gymnasium	17.7	16.7	14.6	11.7	16.2	16.9	15.8	12.9	9.2	14.8
	Any Tertiary	34.6	33.5	29.3	20.5	31.8	32.5	31.3	27.1	20.4	29.7
	Missing	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Paternal	<Gymnasium	62.6	63.2	65.9	73.4	64.5	68.3	67.8	68.9	74.3	68.9
Education (%)	Gymnasium	11.8	11.4	10.8	9.5	11.3	11.1	11.1	10.8	9.2	10.8
	Any Tertiary	25.3	24.9	22.9	17.0	23.9	19.8	20.7	19.9	16.3	19.8
	Missing	0.3	0.4	0.4	0.2	0.4	0.8	0.5	0.4	0.3	0.5
Childhood SES	Unskilled	18.4	18.7	21.5	25.5	19.8	22.6	23.2	26.0	29.0	24.2
(%)	Skilled	25.9	26.2	26.6	26.0	26.2	27.5	27.3	28.2	26.1	27.4
	Farmer/Self-employed	2.8	3.2	4.6	6.3	3.6	2.7	2.8	4.1	5.1	3.3
	Non-manual	48.9	47.7	42.8	35.0	46.0	40.7	40.0	34.0	29.2	37.9
	Other/Missing	4.0	4.2	4.4	7.3	4.5	6.5	6.7	7.7	10.6	7.3
Person-months	%	32.3	39.4	18.6	9.7	100.0	31.3	38.7	18.5	11.4	100.0
Hospitalizations	N	2,656	4,276	1,677	818	9,427	824	1,225	516	314	2,879
Hospitalizations	Rate (10^{-5})	5.8	7.7	6.4	6.0	6.7	6.0	7.3	6.4	6.3	6.6
Rate (10^{-5})	Male	5.8	7.7	5.9	5.6	6.6	5.8	7.3	6.1	6.0	6.5
by Sex	Female	5.8	7.7	6.9	6.4	6.8	6.2	7.2	6.7	6.6	6.7
Rate (10^{-5})	2	6.4	8.8	–	–	7.6	6.4	8.6	–	–	7.5
by Family Size	3	5.2	7.4	6.7	–	6.6	5.7	7.1	7.0	–	6.7
	4+	5.4	6.2	6.1	6.0	6.0	5.6	5.3	5.9	6.3	5.8

for men. As a robustness check we have also conducted additional analyses where we do not exclude individuals who were hospitalized before age 20 in the analyses of hospitalization after age 20. Those results were almost exactly the same as the results presented above. Furthermore, since age 20 might seem an arbitrary point at which to divide the analyses, we have also run analyses to study

Table 3
Descriptive Statistics for Full Cohort Analytical Sample Used in Models without Fixed Effects: Birth Order and Hospitalization for Alcohol Abuse or Narcotics Abuse After the Age of 20 for Swedish Men and Women Born 1987–1993.

		Alcohol Abuse					Narcotics Abuse				
		Birth Order					Birth Order				
		1	2	3	4+	Total	1	2	3	4+	Total
N		250,014	249,268	111,290	44,148	654,720	250,014	249,268	111,290	44,148	654,720
%		38.2	38.1	17.0	6.7	100.0	38.2	38.1	17.0	6.7	100.0
Male	%	51.7	51.8	51.5	51.6	51.7	51.7	51.8	51.5	51.6	51.7
Maternal Age	Mean	25.4	28.2	30.6	32.6	27.8	25.4	28.2	30.6	32.6	27.8
Paternal Age	Mean	28.1	30.7	32.8	34.3	30.3	28.1	30.7	32.8	34.3	30.3
Birth Year	Mean	1990.0	1990.1	1990.2	1990.3	1990.1	1990.0	1990.1	1990.2	1990.3	1990.1
Sibling Group Size	Mean	2.5	2.6	3.4	4.9	2.9	2.5	2.6	3.4	4.9	2.9
Maternal	<Gymnasium	40.6	45.3	50.5	62.1	45.5	40.6	45.3	50.5	62.1	45.5
Education	Gymnasium	19.3	16.7	13.9	11.7	16.9	19.3	16.7	13.9	11.7	16.9
(%)	Any Tertiary	40.0	37.9	35.5	26.0	37.5	40.0	37.9	35.5	26.0	37.5
	Missing	0.0	0.1	0.1	0.2	0.1	0.0	0.1	0.1	0.2	0.1
Paternal	<Gymnasium	57.7	58.9	60.1	66.8	59.2	57.7	58.9	60.1	66.8	59.2
Education	Gymnasium	12.1	11.9	11.6	10.7	11.8	12.1	11.9	11.6	10.7	11.8
(%)	Any Tertiary	29.9	29.0	28.1	22.2	28.7	29.9	29.0	28.1	22.2	28.7
	Missing	0.3	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3
Childhood	Unskilled	14.2	13.0	14.4	20.2	14.2	14.2	13.0	14.4	20.2	14.2
SES	Skilled	23.8	22.9	22.9	23.3	23.3	23.8	22.9	22.9	23.3	23.3
(%)	Farmer/Self-employed	3.2	4.2	6.0	8.8	4.4	3.2	4.2	6.0	8.8	4.4
	Non-manual	54.7	57.2	54.0	42.0	54.7	54.7	57.2	54.0	42.0	54.7
	Other/Missing	4.2	2.7	2.7	5.7	3.5	4.2	2.7	2.7	5.7	3.5
Person-months	%	39.3	37.7	16.7	6.3	100.0	39.2	37.7	16.7	6.3	100.0
Hospitalizations	N	1583	1778	789	357	4507	1163	1197	562	282	3204
Hospitalizations	Rate (10^{-6})	4.9	5.7	5.7	6.8	5.4	3.6	3.8	4.0	5.4	3.9
Rate (10^{-6})	Male	5.5	6.4	6.3	7.8	6.1	4.7	5.0	5.0	7.1	5.0
By Sex	Female	4.1	4.9	5.1	5.8	4.7	2.3	2.5	3.0	3.5	2.6
Rate (10^{-6})	2	52.2	58.4	–	–	54.4	50.1	50.6	–	–	50.3
By Family Size	3	45.3	49.7	42.4	–	46.8	46.0	50.3	35.1	–	46.0
	4+	42.0	41.6	40.1	43.7	41.7	48.3	42.1	36.4	42.8	41.9

Table 4
Descriptive Statistics for Analytical Sample Used in Fixed Effects Models: Birth Order and Hospitalization for Alcohol Abuse or Narcotics Abuse After the Age of 20 for Swedish Men and Women Born 1987–1993.

		Alcohol Abuse					Narcotics Abuse				
		Birth Order					Birth Order				
		1	2	3	4+	Total	1	2	3	4+	Total
N		1,944	2,406	1,156	602	6,108	1,235	1,519	718	408	3,880
%		31.8	39.4	18.9	9.9	100.0	31.8	39.2	18.5	10.5	100.0
Male	%	56.7	55.8	55.7	52.0	52.2	60.6	59.7	54.9	56.9	58.8
Maternal Age	Mean	24.6	26.7	28.7	31.3	26.9	24.0	26.3	28.3	31.2	26.4
Paternal Age	Mean	27.4	29.4	31.2	33.5	29.5	27.0	29.2	30.7	32.8	29.1
Birth Year	Mean	1988.6	1990.0	1990.6	1990.7	1989.7	1988.5	1990.0	1990.4	1990.6	1989.7
Sibling Group Size	Mean	2.7	3.0	3.8	5.4	3.3	2.8	3.0	3.8	5.4	3.3
Maternal	<Gymnasium	48.4	51.4	56.3	69.6	53.2	53.5	55.9	61.7	73.0	58.0
Education (%)	Gymnasium	16.3	15.8	14.4	12.8	15.4	16.2	15.5	12.7	8.8	14.5
	Any Tertiary	35.2	32.8	29.2	17.6	31.4	30.1	28.5	25.5	17.9	27.4
	Missing	0.1	0.1	0.1	0.0	0.1	0.2	0.1	0.1	0.3	0.2
Paternal	<Gymnasium	64.7	65.6	67.3	76.4	66.7	68.7	68.4	70.8	72.3	69.4
Education (%)	Gymnasium	11.2	11.3	11.0	9.8	11.1	11.6	11.1	9.3	10.3	10.8
	Any Tertiary	24.0	22.7	21.4	12.8	21.9	19.1	20.1	19.2	16.9	19.3
	Missing	0.2	0.3	0.4	1.0	0.4	0.6	0.5	0.7	0.5	0.5
Childhood SES	Unskilled	15.3	17.3	20.5	28.4	18.4	19.5	20.2	23.0	25.7	21.1
(%)	Skilled	27.9	27.6	27.5	24.9	27.4	30.1	29.8	31.5	25.5	29.7
	Farmer/Self-employed	3.5	4.1	5.3	6.6	4.4	2.8	3.2	3.2	6.6	3.5
	Non-manual	50.4	48.3	43.3	31.6	46.4	42.1	41.6	37.2	31.6	39.9
	Other/Missing	3.0	2.8	3.4	8.5	3.5	5.4	5.2	5.2	10.5	5.8
Person-months	%	39.5	36.8	16.0	7.8	100.0	39.5	36.0	16.0	8.5	100.0
Hospitalizations	N	1,174	1,132	404	209	2,919	783	709	236	149	1,877
Hospitalizations	Rate (10^{-5})	48.1	49.9	41.0	43.7	48.1	48.4	48.1	35.9	42.8	45.8
Rate (10^{-5})	Male	51.3	53.8	43.2	48.3	50.7	57.7	55.9	43.3	51.2	54.3
By Sex	Female	44.2	45.1	38.4	38.4	43.1	36.3	36.5	27.4	30.7	34.3
Rate (10^{-5})	2	52.2	58.4	–	–	54.4	50.1	50.6	–	–	50.3
By Family Size	3	45.3	49.7	42.4	–	46.8	46.0	50.3	35.1	–	46.0
	4+	42.0	41.6	40.1	43.7	41.7	48.3	42.1	36.4	42.8	41.9

first hospitalization related to alcohol and other substance use at any age up to the end of the study window, which is the end of 2013, the last point for which we have data on hospitalizations. Those results show a relationship with birth order that is closely comparable to the pattern and magnitude presented in our results for hospitalization before age 20. We have also run additional sensi-

Table 5
Results: Relationship Between Birth Order and Hospitalization for Alcohol Use and Narcotics Use for Swedish Men and Women Before and After the Age of 20, Born 1987–1994.

			Model 1			Model 2		
			Between-family			Fixed Effects		
	Variable	Category	HR	95% CI		HR	95% CI	
Under 20	Birth Order	1	1.00			1.00		
Alcohol		2	1.43	1.37,	1.49	1.47	1.35,	1.60
		3	1.49	1.40,	1.59	1.65	1.41,	1.94
		4+	1.59	1.46,	1.74	1.91	1.50,	2.43
	N		774,630			20,746		
	Hospitalizations		13,881			9,427		
Under 20	Birth Order	1	1.00			1.00		
Narcotics		2	1.42	1.32,	1.53	1.34	1.15,	1.56
		3	1.71	1.53,	1.91	1.66	1.26,	2.19
		4+	2.11	1.81,	2.45	2.21	1.46,	3.34
	N		774,630			6,331		
	Hospitalizations		4,397			2,879		
20 or Over	Birth Order	1	1.00			1.00		
Alcohol		2	1.36	1.27,	1.47	1.21	0.99,	1.49
		3	1.43	1.28,	1.59	1.15	0.79,	1.69
		4+	1.62	1.39,	1.90	1.30	0.73,	2.32
	N		654,720			6,108		
	Hospitalizations		4,507			2,919		
20 or Over	Birth Order	1	1.00			1.00		
Narcotics		2	1.37	1.26,	1.50	1.30	1.00,	1.70
		3	1.63	1.43,	1.85	1.24	0.74,	2.05
		4+	2.12	1.77,	2.54	1.66	0.76,	3.62
	N		654,720			3,880		
	Hospitalizations		3,204			1,877		

Note: Model 1 is a standard Cox model on the full population from birth cohorts 1987–1994, and includes covariates for maternal and paternal age at the time of birth, birth year, and sibling group size. Model 2 is a sibling fixed effect model based on the sibling groups with variance on the outcome variable, and includes covariates for maternal and paternal age, and birth year. Abbreviations: CI, confidence interval; HR, hazard ratio.

Table 6
Results: Relationship Between Birth Order and Hospitalization for Alcohol or Narcotics Use for Swedish Men and Women Born 1987–1994, by the Size of the Sibling Group.

			Sibling Group Size								
			2			3			4+		
			HR	95% CI		HR	95% CI		HR	95% CI	
Under 20	Birth Order	1	1.00			1.00			1.00		
Alcohol		2	1.59	1.35,	1.87	1.57	1.36,	1.82	1.31	1.10,	1.56
		3				1.84	1.40,	2.40	1.52	1.17,	1.97
		4+							1.66	1.17,	2.36
	N		6616			7431			6699		
	Hospitalizations		3368			3317			2742		
Under 20	Birth Order	1	1.00			1.00			1.00		
Narcotics		2	1.41	1.05,	1.89	1.45	1.11,	1.90	1.10	0.82,	1.49
		3				1.93	1.18,	3.16	1.58	1.02,	2.44
		4+							1.99	1.11,	3.57
	N		1923			2081			2327		
	Hospitalizations		985			953			941		
20 or Over	Birth Order	1	1.00			1.00			1.00		
Alcohol		2	1.12	0.73,	1.72	1.07	0.76,	1.50	1.19	0.81,	1.76
		3				0.88	0.46,	1.68	1.35	0.74,	2.48
		4+							1.77	0.78,	4.00
	N		1860			2244			2004		
	Hospitalizations		987			1065			867		
20 or Over	Birth Order	1	1.00			1.00			1.00		
Narcotics		2	1.38	0.79,	2.41	1.21	0.76,	1.93	1.04	0.65,	1.68
		3				1.08	0.44,	2.62	1.18	0.54,	2.58
		4+							1.67	0.55,	5.04
	N		1157			1338			1385		
	Hospitalizations		613			651			613		

Note: These analyses use sibling fixed effect models and includes covariates for maternal

tivity analyses where we control for birth weight, and those results are very consistent with the main results presented above.

4. Discussion

Using high quality Swedish population register data and a within-family sibling comparison model that minimises residual confounding from measured and unmeasured factors shared by siblings, this study has found that later born children are more likely to be hospitalized for alcohol and narcotics use both before and after the age of 20 than their first born sibling. These birth order effects are substantial in size, and much larger than the estimated sex differences for the risk of hospitalization related to alcohol and drug use before age 20, or previous estimates for socioeconomic status differences in alcohol and drug abuse (Hanson and Chen, 2007). We find that the relationship between birth order and hospitalization

for alcohol and narcotics use is stronger before the age of 20 than it is after the age of 20, and that is particularly true for alcohol use. This is plausible given that the strength of parental influence on children typically diminishes as individuals grow older and leave the family home. In Sweden the mean age for leaving the family home is around age 20 (Leopold, 2012). Furthermore, one of the mechanisms that we have considered for the birth order-alcohol abuse relationship is that older siblings may be behavioural models for their young sibling or provide alcohol to them before they have the legal age to purchase it themselves. If this mechanism does play a role, we would expect the birth order effect on alcohol consumption to weaken after the age at which an individual can legally purchase alcohol, which is age 20 in Sweden (Systembolaget, 2001).

The relationship between birth order and risk ratios of hospitalization are consistent across family sizes of 2, 3, and 4 or more children, and is not driven by birth order patterns in the largest sibling groups. However, we do observe that the birth order effects are slightly stronger in larger sibling groups, particularly for hospitalizations before age 20. The ability of parents to exercise social control may diminish in the largest sibling groups, and this would provide greater opportunities for siblings in large families to engage in deviant behaviours. We would expect that later borns in the largest sibling groups would have the most opportunities to engage in inappropriate alcohol or drug use behaviours since they would arrive at a point where parental capacity to monitor would be most stretched, and where they could have access to illicit materials facilitated by older siblings. Recent research on the relationship between birth order and mortality using Finnish population data has found that there are substantial differences in the association by different ethnic groups (Saarela et al., 2016). Our finding that birth order effects vary by age and by family size also suggest that the local context and environment plays an important role in moderating the effect of birth order on health and health behaviours.

Although this study is based upon high quality data and uses sophisticated methods to address our research question, it is not without limitations. By studying hospitalizations we focus upon serious cases of alcohol and substance use. It is difficult to know the extent to which our results are generalizable to birth order and other much more common, though still dangerous, patterns of alcohol consumption such as binge drinking. Nevertheless, there are also clear advantages in using objective and clear measures of alcohol and narcotic use. Another limitation of our study is that we only have a follow-up to a maximum age of 26. It is also possible that there is measurement error due misclassification of diagnosis. External reviews of the Swedish Inpatient Register suggest that 85–95% of diagnoses are valid (Ludvigsson et al., 2011), meaning that there is some degree of misclassification. Furthermore, this external review did not explicitly address alcohol and drug-related hospitalizations, so we cannot be entirely certain of the degree of misclassification of our outcome variables.

For all the advantages of sibling fixed effects models, this modelling approach also has its limitations. For one it requires a focus upon a much smaller segment of the population, meaning sibling groups that experience the outcome. However, we have shown that the pattern is typically very similar in the full population as well. A further limitation is that estimates from sibling fixed effects models can suffer from stronger bias than between-family comparisons when there are unmeasured non-shared confounders (Frisell et al., 2012). A potential source of unmeasured non-shared confounding could be parental income or socio-economic position, which typically improves with parental age. However, recent research shows mixed and complex influences of socio-economic position on adolescent alcohol use and its short- and long-term health effects (Hanson and Chen, 2007). In addition, adjustment for social factors makes little difference to the estimates for the relationship between birth order and a range of educational and health outcomes in fixed effects models (Barclay and Myrskylä, 2016). If parental socioeconomic status does influence alcohol and drug use amongst their children, it might be expected that the risk of abuse would be lower amongst those from higher socioeconomic status backgrounds. Since parental resources typically increase with age, this would mean that later borns should on average experience a higher socioeconomic status upbringing, which would mean that our estimates would be conservative.

In summary, our study finds clear support for a relationship between birth order and hospitalization for alcohol and narcotics use amongst adolescents and young adults in Sweden. Furthermore, this pattern was found in even the most typical sibling group sizes in Sweden. Given that problematic alcohol and narcotics consumption is associated with worse cognitive performance and lower educational attainment (Brown et al., 2000; King et al., 2006), it is possible that these behaviours mediate the frequently observed negative relationship between birth order and intelligence (Bjerkedal et al., 2007), and birth order and educational achievement (Black et al., 2005). Furthermore, since alcohol and narcotics use are correlated over the life course, this birth order pattern observed in adolescence and early adulthood may persist into adulthood, which has clear implications for long-term health. It is therefore plausible that patterns of consumption of alcohol and other substances may partially explain the pattern observed in previous research that later born siblings have higher mortality (Bjørngaard et al., 2013; Rostila et al., 2014; Barclay and Kolk, 2015). However, it should be noted that strong discontinuities between adolescent and adult patterns of alcohol consumption are common (Norström and Pape, 2012). For all the undeniable strengths of a register-based study, we did not have data to examine what explains the relationship between birth order and hospitalizations related to alcohol and narcotics use. Future research should seek to examine the extent to which it is attributable to a lack of parental control, the extent to which older siblings facilitate access to drugs for younger siblings, as well as whether these patterns are observed in other countries.

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Contributors

KB and MM designed the study, KB conducted the analyses, KB, MM, PT, DB and FR wrote the paper, PT prepared the data.

Conflict of interest

No conflict declared.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.drugalcdep.2016.06.029.

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