No causal relationship between early motherhood and offspring adolescent offending: Empirical evidence from a genetically-informed study

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ABSTRACT

Previous studies have consistently shown that young maternal age at birth is associated with an increased risk for problematic behavior in offspring. Less is known about the mechanisms underlying this association, as it could either reflect a causal effect or a spurious relationship. This study aims to gain more insights in these underlying mechanisms by studying the relationship between early motherhood and offspring adolescent offending. The sample includes all individuals who were born in the Netherlands between 1991 and 2001 (N=2,098,815). All variables were extracted from register data of Statistics Netherlands, including police registrations to measure adolescent offending. Logistic regression analyses were used to examine the relationship between maternal age at birth and offspring adolescent offending, with and without control variables. Moreover, a children of discordant siblings model was applied to further control for unmeasured familial confounders (i.e., shared environmental and genetic confounders). In line with previous studies, the results show a significant negative relationship between early motherhood and offspring offending. However, no significant effect was found in the children of discordant siblings analysis, which suggests that this relationship is confounded by unmeasured familial factors. These results illustrate the importance of applying genetically informed research designs when studying intergenerational relationships.

1. Introduction

Young maternal age at birth (including teenage motherhood) has been consistently found to be a risk factor for problematic behavior in offspring. Various studies have shown that having a young mother is associated with criminal, antisocial, aggressive, and externalizing behaviors (e.g., Beijers, 2016; Jaffee et al., 2001; Lee et al., 2020; Nagin et al., 1997; Nagin & Tremblay, 2001; Pogarsky et al., 2003; Zonder-van-Zwijnenburg et al., 2020). Less is known, however, about the (causal) mechanisms underlying these associations. The current study aims to gain more insights in these underlying mechanisms by studying the relationship between early motherhood and offspring criminal offending during adolescence, using a genetically-informed study design which controls for unmeasured familial confounders.

Jaffee and colleagues (2001) distinguished two mechanisms that may underlie the negative relationship between maternal age at birth and poor offspring outcomes: social influence effects and social selection effects. The social influence explanation posits that early childbearing has a causal effect on offspring adversity. As young motherhood disrupts their developmental trajectories, young mothers experience more

socioeconomic deprivations and related social disadvantages, such as poverty, single motherhood, low educational attainment, and poor parenting skills (Coyne et al., 2013; Jaffee et al., 2001). As a consequence of these deprivations and disadvantages their children are at increased risk for the development of antisocial behavior.

The social selection explanation, on the other hand, posits that the association between young maternal age at birth and offspring behavior problems is spurious. Certain biopsychosocial factors (e.g., poor academic achievement, delinquency, and impoverished neighborhoods and homes), may increase some women's risk for early childbearing (Coyne et al., 2013; Jaffee et al., 2001). As parental disadvantaged backgrounds are also associated with antisocial and criminal behavior in offspring (e. g., Ellis, Beaver & Wright, 2009; Farrington, 2011), such factors may confound the relationship between young motherhood and offspring offending. According to this explanation, the young age of a mother is merely an indication of an increased risk in criminal behavior in offspring, rather than increasing this risk.

Testing these competing explanations and making causal claims about the relationship between early motherhood and offspring offending is difficult as randomized controlled trials are practically

impossible and ethically undesirable. Most previous studies only included control variables in the analyses to control for confounding by these variables. This approach, however, may lead to hidden bias as potential unmeasured confounding factors are not controlled for.

One particular source of potential hidden bias is genetic confounding (Barnes et al., 2014). In their meta-analysis of virtually all twin studies on complex human traits, Polderman and colleagues (2015) showed that all human traits are to some extent heritable and that, overall, 49 percent of the variance in human traits is attributable to genetic factors. Also meta-analyses of twin and adoption studies that focus specifically on antisocial and aggressive behavior show that a considerable proportion of variance in these behaviors can be explained through genetic influences (e.g., Ferguson, 2010; Mason & Frick, 1994; Odintsova et al., 2019; Rhee & Waldman, 2002). In addition, Rodgers and colleagues (2007) showed that early fertility among women is heritable. Since parents and children share 50 percent of their segregating genes, genetic confounding could occur when the same genetic factors are related to both antisocial behavior and early motherhood. Using genome-wide association study data, Tielbeek and colleagues (2018) showed that there indeed is a moderate negative genetic correlation (r_g=-0.64) between antisocial behavior and age at first birth.

Children of discordant siblings/twins designs are a type of family-based quasi-experimental research designs that offer a solution to control for genetic confounding, as well as for confounding by other familial factors (D'Onofrio et al., 2013). In these genetically-informed designs, pairs of siblings are selected who are discordant on the predictor variable (e.g., a sister who first gave birth at age 18 and her sister who first became a mother at age 24) and consequently a comparison is made between the behavior of their children (i.e., cousins). By comparing within pairs of relatives, everything that is shared between these relatives is automatically controlled for. This includes shared environmental factors but also genetic factors since cousins share on average 12.5 percent of their segregating genes, while their parents share 50 percent of their genetic makeup (respectively, 25% and 100% in case of children of monozygotic twins).

A couple of studies have applied children of discordant siblings (or twins) designs to examine the effects of early motherhood on offspring behavior. In line with the social selection explanation, studies among American samples found that children of teenage mothers did not have lower test scores (Geronimus, Korenman & Hillemeier, 1994; Turley, 2003) or more behavioral problems (Turley, 2003) than their cousins born to older mothers. Harden and colleagues (2007), on the other hand, found more support for the social influence explanation. In their Australian children of twin study, teenage motherhood was still significantly related to offspring behavioral problems, substance use, and internalizing problems after making a comparison within families.

To the author's knowledge only one other study has applied a children of siblings/twins design to examine the relationship between early maternal age at childbirth and offspring criminal behavior. Using longitudinal data from Swedish national registries, Coyne and colleagues (2013) found a negative relationship in a sample of over 1 million offspring. In line with the social influence explanation, similar negative associations were found when offspring of differentially exposed full sisters, dizygotic twins, and monozygotic twins were compared.

The current study examines the relationship between early motherhood and offspring adolescent offending in the Netherlands. A children of siblings design is applied to control for unmeasured familial confounders, including genetic factors. The research questions are: To what extent is early motherhood associated with offspring adolescent offending? And to what extent can this relationship be explained by measured and unmeasured confounders?

2. Methods

2.1. Data

In order to examine the relationship between young motherhood and offspring offending, register data from Statistics Netherlands was used. Statistics Netherlands provides data on all Dutch citizens from several official sources, which can be linked through an anonymized identification number. In the sample of the current study, all individuals who were born in the Netherlands between 1991 and 2001 were selected. More recent birth cohorts were excluded from the sample as the dependent variable is offending during adolescence (i.e., between age 12 and 18) and police data was only available up to 2019. Persons who were born before 1991 were excluded as not all control variables could be measured for these older birth cohorts. Moreover, individuals who died or emigrated before age 18 were excluded from the sample because the criminal offending of these individuals could not be measured during their entire adolescence. Finally, also all cases were excluded in which one or both parents could not be identified from the Personal Records Database (in Dutch: BasisRegistratie Personen; BRP) since no information on the parental variables was available for these individuals. The analytic sample included 2,098,815 individuals.

2.2. Measurements

The dependent variable of the analyses is adolescent offending and was measured using police data, in which all suspects of crimes in the Netherlands, between 1996 and 2019, were registered. Suspects were only registered in these data when there was a reasonable suspicion of guilt. Based on these police data, a binary variable was constructed which indicates whether sample members had been the suspect of at least one crime between age 12 and the year of their 18th birthday. Suspects of crime younger than age 12 are not registered, since this is the age of legal responsibility in the Netherlands.

The independent variable of interest in this study is the mother's age at birth of sample members. This continuous variable was constructed by calculating the period between the date of birth of the sample member and his or her mother, as registered in the BRP.

Moreover, several control variables were included in the analyses. Paternal age at birth was calculated in the same way as maternal age at birth. The BRP also included information on the sex (0=female; 1=male) and year of birth of sample members (range: 1991-2001), as well as on the country of birth of both parents (0=the Netherlands; 1=another country). A variable indicating the household size (i.e., the sample member and its full siblings) was calculated based on the data on parent-child relationships from the BRP. Moreover, data on household incomes was provided by Statistics Netherlands, mainly from the Tax Administration. The percentile rank within the distribution of all households incomes in the Nehterlands, in the year of the sample members' twelfth birthday, was used to indicate the household income of sample members. The highest completed educational level of the father and mother of sample members was also included in the analyses. Following the standard classification of Statistics Netherlands (2020) these variables were divided in three categories: low (i.e., primary and lower secondary education), medium (i.e., higher secondary education) and high (i.e., tertiary education). Next, the employment status of both parents of sample members was measured in the year of the sample members' twelfth birthday.[1] It was calculated how many percent of the months

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[1] Ideally, the variables on household income and parental employment status would reflect the socio-economic status of sample members across their entire youth (i.e., from birth to their twelfth birthday). However, as data on household income and parental employment were only available from, respectively, 2003 and 1999 onwards, these were only measured in the year of sample members' twelfth birthday.

between January and December the father and mothers were employed, studying, pensioned, receiving social benefits, or without an official income (i.e., 'other'). Finally, based on the dates of death in the BRP, two control variables were used to indicate whether the father and mother of sample members had died prior to age 12 of the sample members.

2.3. Analyses

Three types of analyses were conducted in this study. First, the bivariate association between maternal age at birth and offspring adolescent offending was estimated in a bivariate logistic regression model. Second, all measured control variables were added to the logistic regression model in order to examine to what extent this association could be explained by measured confounders. All 2,098,815 sample members were included to these first two regression analyses. Multiple imputation was used to handle missing values in the variables on the educational levels of the father (n=1,045,985; 49.8%) and the mother (n=945,820; 45.1%) as well as on the household income (n=81,962; 3.9%). For all other variables in the analyses, the information was complete.

Third, a children of discordant siblings model was estimated in order to further control for unmeasured familial confounders (i.e., genetic and shared environmental factors). The kinship data in the BRP was used to identify the maternal grandparents of all sample members and, consequently, it was possible to determine which mothers were full sisters of each other and, consequently, which sample members were maternal cousins. This resulted in 236,663 pairs of cousins who were differently exposed to maternal age at birth. A conditional logistic regression analysis was applied to examine the association between maternal age at birth and adolescent offending, within each pair of cousins. As conditional logistic regression analysis also requires variation on the dependent variable within each pair, the final analytic sample only consists of the 40,366 pairs of cousins (i.e., N=80,732) who were also discordant for adolescent offending.[2]

3. Results

The descriptive statistics of the variables used in the analyses (see Table 1) show that 11.21 percent of the sample members offended during adolescence. The variables indicating the average age of their mothers and fathers at birth were both normally distributed. Mothers were on average considerably younger (30.27 years) than fathers (33.00 years) when sample members were born. Moreover, slightly more sample members were male (51.22%) than female (48.78%). Year of birth was uniformly distributed with 1996 as the average year of birth. Parents were born abroad in about 15 percent of the cases and the majority of parents remained married during childhood (76.6%). Fathers were most often highly educated (40.5%), while mothers most often had a medium educational level (41.4%). Moreover, both fathers (85.32%) and mothers (69.19%) were most often employed. Most families of sample members consisted out of two or three siblings with an average of 2.56 siblings. Finally, the household income was left-skewed: families of sample members were on average in the 67th income percentile, while the median income percentile was 72.

Table 2 shows the results of the logistic regression analyses. The bivariate relationship between the mother's age at birth and offspring adolescent offending in the total population is shown in Model 1. A significantly negative association was found (B=-0.066; p<.001). The odds ratio (OR) of 0.936 indicates that a one year increase in maternal age at birth is associated with a 6.4 percent decrease in the odds of

Table 1
Descriptive statistics

	Mean / %	Std. dev.	Median	N
Dependent variable				
Adolescent offending	11.21%			2,098,815
Independent variables				
Age of mother at birth	30.27	4.52	30.33	2,098,815
Control variables				
Age father at birth	33.00	5.25	32.59	2,098,815
Sex (1=male)	51.22%			2,098,815
Year of birth	1996.05	3.18	1996	2,098,815
Father born abroad	15.64%			2,098,815
Mother born abroad	15.49%			2,098,815
Marital status parents				2,098,815
Never married	10.2%			
Married	76.6%			
Divorced	13.2%			
Educational level father				1,045,985
Low	22.0%			
Medium	37.5%			
High	40.5%			
Educational level mother				945,820
Low	27.5%			
Medium	41.4%			
High	31.2%			
Employment status father				2,098,815
Employed	85.32%			
Social support	7.79%			
Pension	0.51%			
Study	0.05%			
Other	5.29%			
Father deceased	1.04%			2,098,815
Employment status mother				2,098,815
Employed	69.19%			
Social support	9.52%			
Pension	0.58%			
Study	0.50%			
Other	19.66%			
Mother deceased	0.55%			2,098,815
Family size	2.56	1.20	2	2,098,815
Household income (1-100)	67.42	24.05	72	2,016,853

offspring offending.

In Model 2, various demographic and socioeconomic characteristics were included into the model as control variables. The strength of the association between maternal age at birth and offspring offending decreased by 64 percent, but the regression coefficient was still significant and negative (B=-0.024; p<.001). This indicates that a large part of this relationship can be explained by these measured confounders. Moreover, this model shows that the relationship between offspring offending and paternal age at birth is much weaker (B=-0.002; p<.001). Most other control variables were also significantly related to offspring offending. Male sample members and those from older birth cohorts were more likely to offend than women and sample members from more recent birth cohorts. Moreover, sample members with parents who were born abroad, low educated, unemployed or deceased were at increased risk of offending. Finally, the household income was negatively related to adolescent offending, while a positive association with family size was found.

In the next step of the analysis, a children of discordant sibling model was used to control for unmeasured familial confounders. Model 3 shows the results of this conditional logistic regression analysis. The regression coefficient of maternal age at birth decreased by an additional 30 percent in this model and is not significant anymore (B=-0.004; p=0.288). The regression coefficients of all control variables, except for sex and year of birth, also decreased in size and/or became insignificant.

4. Conclusion

The relationship between maternal age at birth and offspring

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[2] The other 196.297 pairs of cousins either both offended during adolescence or both abstained from adolescent offending. Although these are perfectly valid observations, they would not contribute to the estimation and are therefore not included in the effective sample size of the estimation.

Table 2

Logistic regression analyses (Model 1 and 2) and conditional logistic regression analysis (Model 3) on offspring adolescent offending.

	Total population Model 1		Model 2		Children of discordant siblings Model 3	
	B (s.e.)	OR	B (s.e.)	OR	B (s.e.)	OR
Age of mother at birth	-0.066 (0.000)	0.936***	-0.024 (0.001)	0.976***	-0.004 (0.003)	0.996
Control variables						
Sex (1=male)			1.195 (0.005)	3.304***	1.270 (0.175)	3.559***
Year of birth			-0.096 (0.001)	0.908***	-0.114 (0.004)	0.892***
Age father at birth			-0.002 (0.001)	0.998***	-0.004 (0.002)	0.996
Father born abroad			0.299 (0.008)	1.348***	0.201 (0.038)	1.223***
Mother born abroad			0.090 (0.008)	1.094***	-0.000 (0.075)	1.000
Marital status parents						
Never married			0.704 (0.007)	2.023***	0.364 (0.030)	1.434***
Married			Ref.		Ref.	
Divorced			0.546 (0.007)	1.726***	0.394 (0.026)	1.482***
Educational level father						
Low			Ref.		Ref.	
Medium			-0.252 (0.008)	0.774***	-0.218 (0.024)	0.804***
High			-0.533 (0.000)	0.582***	-0.477 (0.034)	0.621***
Educational level mother						
Low			Ref.		Ref.	
Medium			-0.261 (0.008)	0.771***	-0.151 (0.024)	0.860***
High			-0.496 (0.013)	0.609***	-0.303 (0.033)	0.739***
Employment status father						
Employed			Ref.		Ref.	
Social support			0.341 (0.008)	1.407***	0.237 (0.033)	1.267***
Pension			0.381 (0.030)	1.464***	0.295 (0.165)	1.343
Study			-0.032 (0.123)	0.969	0.834 (0.449)	2.302
Other			-0.156 (0.011)	0.855***	0.007 (0.043)	1.008
Father deceased			0.336 (0.026)	1.399***	0.163 (0.010)	1.177
Employment status mother						
Employed			Ref.		Ref.	
Social support			0.342 (0.008)	1.408***	0.089 (0.031)	1.093**
Pension			0.032 (0.035)	1.033	0.003 (0.136)	1.003
Study			0.075 (0.039)	1.078	-0.152 (0.137)	0.859
Other			-0.221 (0.007)	0.802***	-0.218 (0.025)	0.804***
Mother deceased			0.416 (0.028)	1.516***	0.272 (0.106)	1.312*
Family size			0.055 (0.002)	1.056***	0.043 (0.009)	1.043***
Household income			-0.003 (0.000)	0.997***	-0.002 (0.001)	0.998***
N	2,098,815		2,098,815		80,732	

Note: ***p<.001; **p<.01; *p<.05

adolescent offending was examined in this study, using register data on 2,098,815 individuals born between 1991 and 2001 in the Netherlands. The bivariate analyses showed a significant negative relationship, indicating that when a mother was one year older when giving birth to her child, this child had 6.4 percent lower odds to have been a suspect of crime during adolescence. This result is in line with the vast majority of studies on this subject, which also found that early and teenage motherhood was related to offspring criminal, antisocial, and externalizing behaviors (Beijers, 2016; Jaffee et al., 2001; Lee et al., 2020; Nagin et al., 1997; Nagin & Tremblay, 2001; Pogarsky et al., 2003; Zondervan-Zwijnenburg et al., 2020).

Multivariate analyses, including a children of siblings analyses, were carried out to test whether this association between early motherhood and offspring offending reflects a causal effect (i.e., social influence effects) or rather is a spurious relationship (i.e., social selection effects). The results are more in line with the latter than the former. The strength of the association between early motherhood and offspring offending decreased by 64 percent after including various demographic and familial control variables to the regression model. The results of the children of siblings model showed that another 30 percent of this association was explained by unmeasured familial factors (i.e., genetic or shared environmental factors). The relationship between early motherhood and offspring offending was also not significant anymore in this model, which indicates that offspring of young mothers were not more likely to offend in adolescence than their cousins born to older mothers. These results suggest that most previous studies, that did not control for unmeasured familial confounders, overestimated the effect of young motherhood on offspring criminal and antisocial behavior which

possibly even led to the wrong conclusions.

These results from the children of siblings model are in line with previous American studies that examined the effect of teenage motherhood on offspring test scores (Geronimus, Korenman & Hillemeier, 1994; Turley, 2003) and behavioral problems (Turley, 2003), and did not find significant effects either after applying a genetically informed study design. However, the results of this study do not align with those of Coyne and colleagues (2013), who did find a significant relationship between early motherhood and offspring offending when comparing children of Swedish siblings and twins. The difference in conclusions between this study and the study of Coyne et al. (2013) could be explained by the fact that more potential confounders on the parental level, which are not always shared between cousins, were included in the analyses of the current study (paternal age at birth, family size, household income, and the migration background, marital status, employment status and educational level of both parents) than in the study of Coyne and colleagues (paternal age at birth, parental criminal history, and the educational level of both parents). Since these measured non-shared factors explained the largest part of the relationship between maternal age at birth and offspring offending, the wrong conclusions are likely drawn when these factors are not taken into account. This illustrates the importance of not only using a genetically informed research design to control for (unmeasured) environmental and genetic factors that are shared within families, but to also include measurements of non-shared environmental confounders as covariates in the statistical analyses.

While interpreting the results of this study, it is important to keep its limitations in mind. First of all, police registrations were used to

measure offspring adolescent offending. Given that a vast and growing amount of research has demonstrated that the majority of criminal acts are not detected by law enforcement (i.e., the *dark figure* of crime), it is likely that many crimes which were not reported or for which the perpetrator was never caught, are not reflected in these data (e.g., Biderman & Reiss, 1967; Minkler et al., 2022). Consequently, a part of the sample members that was considered as non-offenders in the analyses, might in fact have committed crimes during adolescence for which they were never arrested. Replication of this study with self-reported measured of criminal offending is therefore desirable.

Second, this study only compares the offspring of full sisters, as it was impossible to distinguish monozygotic twins from dizygotic twins in the data of Statistics Netherlands. A comparison of offspring of monozygotic twins would enable to control for even more genetic confounding as monozygotic twins and their offspring share more genes (100% and 25%, respectively) than full siblings and their children (50% and 12.5%, respectively). Moreover, a comparison between results of children of dizygotic twins and children of monozygotic twins offers the opportunity to estimate the relative influence of shared environmental factors and genetic factors in explaining the association between early motherhood and offspring offending. Although this is beyond the aim of the current study, it is an interesting topic for future research.

A third limitation of the current study is that the results might not be generalizable to other countries. In the Netherlands, the prevalence of teen motherhood is, for example, relatively low compared to other countries. Statistics Netherlands (2021) showed that in 2019 only 2.5 children were born per 1,000 Dutch girls between the age of 15 and 20, which is (considerably) lower than the rate of teen motherhood in all other European Union countries except Denmark. The younger mothers in this study are therefore most often not teen mothers and relatively old compared to young mothers in other studies. As a consequence, their developmental trajectories might be less disrupted by their pregnancy and their children may be exposed to less socioeconomic deprivations and social disadvantages, compared to the youngest mothers in other countries. Moreover, the Netherlands has an extensive social welfare system, which could mitigate the negative consequences of young motherhood.

In conclusion, this study shows that a young maternal age at birth is related to offspring adolescent offending, but does not cause it. This study also illustrates the importance of controlling for unmeasured familial confounders, since the wrong conclusions would have been drawn when they were not taken into account. Therefore, future researchers are encouraged to use genetically informed research designs (see D'Onofrio et al. 2013 for an overview) when examining the consequences of early motherhood or intergenerational causes of criminal behavior.

CRediT authorship contribution statement

Steve van de Weijer: Conceptualization, Data curation, Formal analysis, Funding acquisition, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing.

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