



Educational Attainment and Pregnancy Outcomes: A Danish Register-Based Study of the Influence of Childhood Social Disadvantage on Later Socioeconomic Disparities in Induced Abortion, Spontaneous Abortion, Stillbirth and Preterm Delivery

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Abstract

Objectives Socioeconomic disparities in pregnancy outcomes have been found across times and places, but there is a lack of studies investigating the underlying causes. The present study investigated the influence of child protective services in the pregnant woman's family of origin as a proxy of childhood social disadvantage. **Methods** The study population comprised all registered pregnancies in Denmark during the period from 2000 to 2009 that resulted in an induced abortion, spontaneous abortion, stillbirth or live birth (N = 786,054). Linear regression was used to analyze the associations between educational attainment and pregnancy outcomes in models with and without adjustment for age, parental educational attainment and child protective services in the family of origin. Further, it was tested whether child protective services in the pregnant woman's family of origin modified the associations between educational attainment and pregnancy outcomes. **Results** Women with low educational attainment had a higher risk of induced abortion, stillbirth and preterm delivery and a lower risk of spontaneous abortion. These associations were to some extent explained by child protective services in the family of origin. Further, child protective services in the pregnant woman's family of origin modified the association between educational attainment and risk of preterm delivery. Thus, women with high educational attainment were not found to differ in risk of preterm delivery according to child protective services in the family of origin. **Conclusions for Practice** Information on childhood social disadvantage may enrich our understanding of the socioeconomic disparities in pregnancy outcomes

Keywords Educational attainment · Childhood social disadvantage · Abortion · Stillbirth · Preterm delivery

Significance

What is already known on this subject? Educational attainment is associated with adverse pregnancy outcomes.

What this study adds? Educational attainment is associated with several adverse pregnancy outcomes, but childhood social disadvantage modifies the association between educational attainment and risk of preterm delivery. Thus,

childhood social disadvantage is associated with a higher risk of preterm delivery among women with low educational attainment, whereas there is little difference in risk according to childhood social disadvantage among women with high educational attainment.

Introduction

Social inequalities in pregnancy outcomes have been found across times and places (Kramer et al. 2000; Mortensen et al. 2011). Although the associations between socioeconomic position (SEP) and pregnancy outcomes vary according to time period and country, as well as according to measures of SEP and pregnancy outcomes, it has generally been found that SEP is inversely associated with adverse pregnancy outcomes—i.e., the higher SEP, the

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lower risk of adverse pregnancy outcomes (Kramer et al. 2000; Mortensen et al. 2011; Poulsen et al. 2015; Väisänen 2015; Zeitlin et al. 2016).

Despite the strong evidence for socioeconomic disparities in pregnancy outcomes, there is a lack of studies investigating the underlying causes for these. With a view to life course epidemiological theories, one obvious starting point for such studies could be to investigate the influences of risk factors in the pregnant women's childhoods—such as the influence of childhood social disadvantage. The possible influence of childhood social disadvantage on later socioeconomic disparities in pregnancy outcomes might be explained by several biological and behavioral factors: For example, childhood social disadvantage influences individuals' early growth and development, which is associated with both educational attainment and pregnancy outcomes. Likewise, some of the well-established socially patterned risk factors for adverse pregnancy outcomes, such as cytomegalovirus infections and smoking, are influenced by social circumstances in early life (Gilman et al. 2008; Mortensen et al. 2012).

This study investigates the influence of child protective services (CPS) in the family of origin. Broadly comparable CPS exist in most countries to protect children in need. An international comparison of CPS has been provided elsewhere (Gilbert 2012). In Denmark, CPS include both placements outside the home with or without the parents' consent and preventive measures such as financial support for boarding schools, out-of-home and in-home supportive measures for the child and/or the family. Thus, there is a substantial variation in the types and severity of problems, which lead to CPS. It is known that children in families receiving CPS have poor educational and labor market outcomes later in life and there is also strong evidence that CPS are associated with later criminal convictions, homelessness, drug abuse and early death (Brøndum 2018; Statistics Denmark 2018). Little is known about their reproductive outcomes (Hansen 2015; Ubbesen 2013). However, CPS in the family of origin provide a proxy measure of the type of childhood social disadvantage sometimes implicitly or explicitly evoked in discussions of the origin of socioeconomic disparities in pregnancy outcomes. Our hypothesis is that this proxy measure of childhood social disadvantage will explain parts of the associations between educational attainment and adverse pregnancy outcomes and that it might also modify the associations between educational attainment and adverse pregnancy outcomes. Thus, the aim of the study is to investigate the influence of childhood social disadvantage (measured by CPS in the family of origin) on the associations of educational attainment with induced abortion, spontaneous abortion, stillbirth and preterm delivery.

Methods

Study Population

We conducted a national register-based study of all registered pregnancies during the period from 2000 to 2009 that resulted in either an induced abortion, spontaneous abortion, stillbirth or live birth. In Denmark, birth data are compiled in the Danish Medical Birth Registry, which contains linked data from national databanks including the National Patient Register and the Civil Registration System. Data regarding educational attainment and CPS in the family of origin were extracted from other national registers administered by Statistics Denmark and linked to the birth data.

The statistical analyses were based on three different study populations. Study population 1 comprised all pregnancies at risk for induced abortion or spontaneous abortion. This population included all registered pregnancies that resulted in an induced abortion, spontaneous abortion, stillbirth or live birth during the period from 2000 to 2009 ($N = 900,043$). To investigate the influence of childhood social disadvantage on the associations between educational attainment and pregnancy outcomes, we excluded pregnancies for which it was not possible to establish a link between the pregnant woman and her mother ($N = 101,000$). Furthermore, we excluded pregnancies with missing information on CPS in the family of origin or educational attainment ($N = 12,989$). After these exclusions, study population 1 comprised 786,054 pregnancies. Study population 2 comprised all pregnancies at risk for stillbirth. Among the pregnancies in study population 1, we therefore excluded all induced abortions and spontaneous abortions ($N = 213,569$). Thus, study population 2 comprised 572,485 pregnancies. Study population 3 comprised all pregnancies at risk for preterm delivery, i.e. all pregnancies that resulted in live births. Among the pregnancies in study population 2, we therefore excluded all stillbirths ($N = 2,639$). Furthermore, we excluded pregnancies with missing information on gestational age and/or birth weight ($N = 3,192$) and pregnancies with implausible combinations of gestational age and birth weight ($N = 1,336$). After these exclusions, study population 3 comprised 565,318 pregnancies. The three study populations are illustrated in Fig. 1.

Variables

The exposures of interest were educational attainment and CPS in the family of origin. Educational attainment was indicated by the highest completed education in 2010,

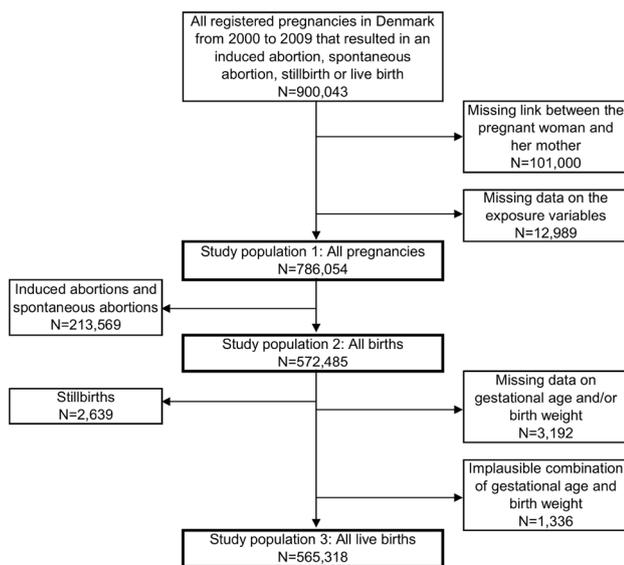


Fig. 1 Flowchart showing the selection of the study population

which was categorized into four categories: Low (primary education, upper secondary education), medium–low (vocational education and training, short cycle higher education), medium–high (vocational bachelors educations, bachelor’s programs) and high (master’s programs, PhD programs). CPS in the family of origin were indicated by whether at least one of the pregnant woman’s maternal siblings (including the pregnant woman herself) was registered with a relief measure by the age of 22 years. As mentioned, CPS include both placements outside the home with or without the parents’ consent and preventive measures such as financial support for boarding schools, out-of-home and in-home supportive measures for the child and/or the family. However, the national registers do not contain information on the various indications of which CPS are used. For documentation, please refer to Statistics Denmark (2017).

The outcomes of interest were induced abortion, spontaneous abortion, stillbirth and preterm delivery. All outcomes were defined according to common obstetric definitions. In Denmark, the current gestational age limit between spontaneous abortions and stillbirths is set at 22 weeks of gestation. However, until 2004 the threshold was set at 28 weeks of gestation. All pregnancies during the period from 2000 to 2003, for which a spontaneous abortion was registered after 22 weeks of gestation, were therefore recoded as stillbirths ($N = 317$). Preterm deliveries were defined as deliveries that occurred before 37 completed weeks of gestation. Gestational age was determined on the basis of recall of last menstruation or ultrasound. Implausible values were excluded from study population 3 ($N = 1,336$) using the methods described by Alexander et al. (1996).

Statistical Methods

The associations of educational attainment with induced abortion, spontaneous abortion, stillbirth and preterm delivery were analyzed by means of binomial regression, i.e. by means of a generalized linear model for a binomial distribution outcome with an identity link function. The associations were analyzed using two statistical models: An unadjusted model and a model adjusted for age, parental educational attainment and CPS in the family of origin. To test for effect measure modification, we added an interaction term between educational attainment and CPS in the family of origin to all statistical models. Results were presented by absolute risk differences and 95% confidence intervals.

As a sensitivity analysis, we investigated the potential influence of clustering of pregnancy outcomes within women using generalized estimating equations with robust standard errors.

All code is available from the corresponding author on request.

Ethics Statement

According to Danish law, no ethics approval is needed for register-based studies. The present study is covered by permissions from the Danish Data Protection Agency to the authors.

Results

Characteristics of the three study populations, as well as characteristics of the excluded pregnancies with missing information on variables, are shown in Table 1. The excluded pregnancies differ considerably from the included pregnancies in all three study populations. Thus, there seems to be a considerably higher prevalence of pregnancies belonging to women with low educational attainment and CPS in the family of origin among the excluded pregnancies.

In study population 1, there were 128,525 induced abortions (16.4%) and 85,044 spontaneous abortions (10.8%) among the 786,054 pregnancies. In study population 2, there were 2639 stillbirths (0.5%) among the 572,485 births. In study population 3, there were 37,978 preterm deliveries (6.7%) among the 565,318 live births. The prevalence of the four pregnancy outcomes per 1000 pregnancies/births/live births according to educational attainment and CPS in the family of origin is shown in Table 2 (see Online Resource 1 for the prevalence of the four pregnancy outcomes per 1000 pregnancies/births/live births among the excluded pregnancies with missing information on variables).

Strong correlations were observed between educational attainment, parental educational attainment and CPS in the

Table 1 Characteristics of the three study populations, including characteristics of the excluded pregnancies with missing information on variables

| | Study population 1: all pregnancies (N = 786,054) | | Study population 2: all births (N = 572,485) | | Study population 3: all live births (N = 565,318) | | Excluded pregnancies (N = 12,989) | |
|--|---|--------|--|--------|---|--------|-----------------------------------|--------|
| | N | (%) | N | (%) | N | (%) | N | (%) |
| Educational attainment^a | | | | | | | | |
| 1 (low) | 202,918 | (25.8) | 122,260 | (21.4) | 120,422 | (21.3) | 3572 | (40.0) |
| 2 | 296,245 | (37.7) | 222,411 | (38.9) | 219,666 | (38.9) | 2717 | (30.5) |
| 3 | 180,280 | (22.9) | 143,067 | (25.0) | 141,461 | (25.0) | 1381 | (15.5) |
| 4 (high) | 106,611 | (13.6) | 84,747 | (14.8) | 83,749 | (14.8) | 1250 | (14.0) |
| Missing | | | | | | | 4069 | – |
| Age (year) | | | | | | | | |
| <25 | 131,358 | (16.7) | 69,232 | (12.1) | 68,283 | (12.1) | 2890 | (22.3) |
| 25–29 | 241,822 | (30.8) | 193,946 | (33.9) | 191,713 | (33.9) | 3309 | (25.6) |
| 30–34 | 261,654 | (33.3) | 210,329 | (36.7) | 207,753 | (36.7) | 3488 | (27.0) |
| 35–39 | 123,455 | (15.7) | 85,649 | (15.0) | 84,459 | (14.9) | 2300 | (17.8) |
| ≥40 | 27,756 | (3.5) | 13,329 | (2.3) | 13,110 | (2.3) | 954 | (7.4) |
| Missing | 9 | – | | | | | 48 | – |
| Parental educational attainment^a | | | | | | | | |
| 1 (low) | 184,978 | (23.4) | 128,939 | (22.5) | 127,147 | (22.5) | 1550 | (49.7) |
| 2 | 398,858 | (50.7) | 292,105 | (51.0) | 288,468 | (51.0) | 1138 | (36.5) |
| 3 | 145,166 | (18.5) | 108,280 | (18.9) | 107,049 | (18.9) | 254 | (8.1) |
| 4 (high) | 57,952 | (7.4) | 43,161 | (7.5) | 42,654 | (7.6) | 176 | (5.6) |
| Missing | | | | | | | 9871 | – |
| Child protective services in the family of origin | | | | | | | | |
| Yes | 100,301 | (12.8) | 61,211 | (10.7) | 60,280 | (10.7) | 2982 | (23.0) |
| No | 685,753 | (87.2) | 511,274 | (89.3) | 505,038 | (89.3) | 10,007 | (77.0) |

^aEducational attainment is categorized as ‘low’ (primary education, upper secondary education), ‘medium–low’ (vocational education and training, short cycle higher education), ‘medium–high’ (vocational bachelors educations, bachelor’s programs), and ‘high’ (master’s programs, PhD programs)

Table 2 Prevalence of induced abortion (IAB), spontaneous abortion (SAB), stillbirth and preterm delivery per 1000 pregnancies/births/live births according to educational attainment and child protective services in the family of origin

| | Study population 1 (N = 786,054) | | Study population 2 (N = 572,485) | Study population 3 (N = 565,318) |
|--|----------------------------------|-------|----------------------------------|----------------------------------|
| | IAB | SAB | Stillbirth | Preterm delivery |
| Educational attainment^a | | | | |
| 1 (low) | 293.1 | 104.4 | 5.9 | 74.9 |
| 2 | 141.9 | 107.3 | 4.8 | 70.6 |
| 3 | 97.2 | 109.2 | 4.1 | 61.2 |
| 4 (high) | 89.0 | 116.1 | 3.2 | 57.2 |
| Child protective services in the family of origin | | | | |
| Yes | 284.7 | 105.1 | 6.1 | 79.7 |
| No | 145.8 | 108.7 | 4.4 | 65.7 |

^aEducational attainment is categorized as ‘low’ (primary education, upper secondary education), ‘medium–low’ (vocational education and training, short cycle higher education), ‘medium–high’ (vocational bachelors educations, bachelor’s programs), and ‘high’ (master’s programs, PhD programs)

family of origin: Educational attainment and parental educational attainment: 0.37; educational attainment and CPS in the family of origin: –0.47; and parental educational attainment and CPS in the family of origin: –0.29 (polychoric correlation coefficients, all p-values < 0.001).

The main analyses showed that educational attainment was inversely associated with induced abortion, stillbirth and preterm delivery—i.e., the lower educational attainment, the higher risk of these pregnancy outcomes (Table 3). Compared to women with high educational attainment, women with low educational attainment experienced 11.9 more induced abortions per 100 pregnancies, 2.0 more stillbirths per 1000 births and 1.3 more preterm deliveries per 100 live births, respectively. With regard to the association between educational attainment and spontaneous abortion, the opposite tendency was seen—i.e., the higher educational attainment, the higher risk of spontaneous abortion (Table 3). Compared to women with high educational attainment, women with low educational attainment experienced 0.4 fewer spontaneous abortions per 100 pregnancies. Further, CPS in the family of origin were found to be associated with a higher risk of all pregnancy outcomes (Table 3).

Table 3 Associations of educational attainment and child protective services in the family of origin with induced abortion (IAB), spontaneous abortion (SAB), stillbirth and preterm delivery

| | IAB | | SAB | | Stillbirth | | Preterm delivery | |
|---|--|--------------|--|--------------|--|------------|--|------------|
| | RD (95% CI) ^{a,b} per 100 pregnancies | | RD (95% CI) ^{a,b} per 100 pregnancies | | RD (95% CI) ^{a,b} per 1000 births | | RD (95% CI) ^{a,b} per 100 live births | |
| Educational attainment ^c | | | | | | | | |
| 1 (low) | 11.9 | (11.7, 12.2) | −0.4 | (−0.7, −0.2) | 2.0 | (1.4, 2.7) | 1.3 | (1.1, 1.5) |
| 2 | 3.9 | (3.7, 4.1) | −0.4 | (−0.7, −0.2) | 1.2 | (0.7, 1.7) | 1.0 | (0.8, 1.2) |
| 3 | 0.9 | (0.7, 1.1) | −0.4 | (−0.7, −0.2) | 0.6 | (0.1, 1.1) | 0.2 | (0.0, 0.4) |
| 4 (high) | 0 | (ref.) | 0 | (ref.) | 0 | (ref.) | 0 | (ref.) |
| Child protective services in the family of origin | | | | | | | | |
| Yes | 8.4 | (8.2, 8.7) | 0.4 | (0.2, 0.7) | 1.3 | (0.7, 2.0) | 1.2 | (1.0, 1.5) |
| No | 0 | (ref.) | 0 | (ref.) | 0 | (ref.) | 0 | (ref.) |

RD risk difference, CI confidence interval

^aThe likelihood ratio test of overall association is statistically significant ($p < 0.01$)

^bThe statistical analyses of the influence of educational attainment are adjusted for age, parental educational attainment and child protective services in the family of origin, whereas the statistical analyses of the influence of child protective services in the family of origin are adjusted for age and parental educational attainment

^cEducational attainment is categorized as ‘low’ (primary education, upper secondary education), ‘medium–low’ (vocational education and training, short cycle higher education), ‘medium–high’ (vocational bachelors educations, bachelor’s programs), and ‘high’ (master’s programs, PhD programs)

We have illustrated the associations between educational attainment and pregnancy outcomes, as well as the influence of CPS in the family of origin on these associations, in Fig. 2. This figure illustrates (I) the unadjusted and adjusted associations between educational attainment and pregnancy outcomes cf. Tables 2 and 3, (II) the associations between educational attainment and pregnancy outcomes among women with and without CPS in the family of origin centered such that the prevalence-weighted average of the two corresponds to the adjusted associations cf. Tables 3 and 4, and (III) the differences in risk between women with and without CPS in the family of origin at each level of educational attainment.

As can be seen in Fig. 2, the associations between educational attainment and pregnancy outcomes were to some extent explained by age, parental educational attainment and CPS in the family of origin. For induced abortion and preterm delivery, statistically significant interactions between educational attainment and CPS in the family of origin were found on the additive scale. However, the interpretation of the association between educational attainment and induced abortion was not substantially affected by this effect measure modification (Fig. 2). On the other hand, the interpretation of the association between educational attainment and preterm delivery was substantially affected. Thus, CPS in the family of origin were associated with a higher risk of preterm delivery among women in the two lowest educational attainment categories, whereas there was little difference in risk according to CPS in the family of origin among women in the two highest educational attainment categories (Fig. 2).

For spontaneous abortion and stillbirth, no statistically significant interactions between educational attainment and CPS in the family of origin were found.

Sensitivity analyses showed that clustering of pregnancy outcomes within women did not influence our study results.

Discussion

Main Findings

The results showed that women with low educational attainment had a higher risk of induced abortion, stillbirth and preterm delivery and a lower risk of spontaneous abortion. The associations between educational attainment and pregnancy outcomes were to some extent explained by age, parental educational attainment and CPS in the family of origin. Further, the results showed that CPS in the family of origin modified the association between educational attainment and risk of preterm delivery. Thus, CPS in the family of origin were associated with a higher risk of preterm delivery among women in the two lowest educational categories, whereas there was little difference in risk according to CPS in the family of origin among women in the two highest categories.

We propose three explanations of the observed interaction between educational attainment and CPS in the family of origin on the risk of preterm delivery: First, educational attainment may have a causal effect that negates the influence of CPS in the family of origin on risk of preterm delivery,

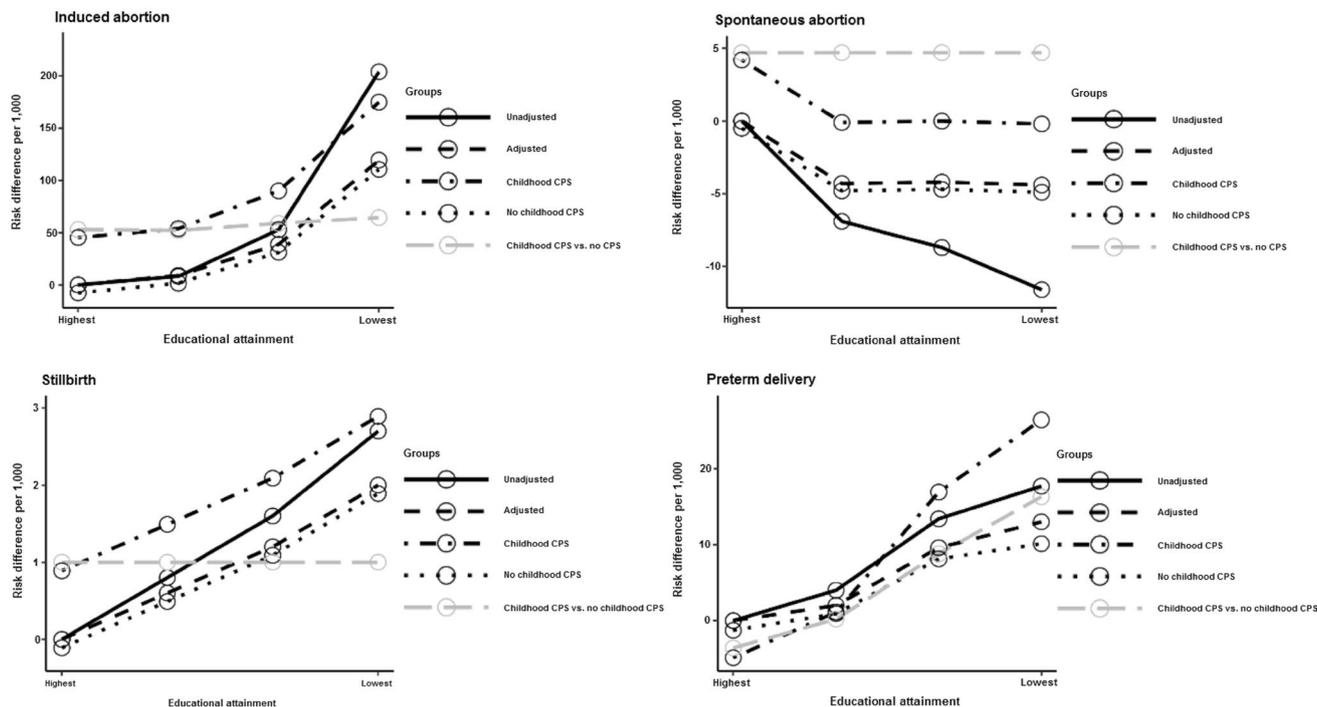


Fig. 2 Associations between educational attainment and pregnancy outcomes, including the influence of child protective services (CPS) in the family of origin on these associations. Adjusted for age, parental educational attainment and CPS in the family of origin. The associations between educational attainment and pregnancy outcomes among women with and without CPS in the family of origin are centered such that the prevalence-weighted average of the two cor-

responds to the adjusted associations. The line marked ‘Childhood CPS vs. no childhood CPS’ illustrates the differences in risk among women with and without CPS in the family of origin at each level of educational attainment—if CPS in the family of origin do not modify the associations between educational attainment and pregnancy outcomes, this line will be horizontal

Table 4 Associations of educational attainment with induced abortion and preterm delivery in the case of effect measure modification by child protective services in the family of origin

| | Child protective services in the family of origin | |
|---------------------------------|---|----------------------|
| | Yes RD (95% CI) | No RD (95% CI) |
| Induced abortion | | |
| 1 (low educational attainment) | 182.6 (178.2, 187.0) | 118.2 (115.4, 121.0) |
| 2 | 97.7 (93.2, 102.3) | 38.8 (36.7, 40.8) |
| 3 | 61.5 (54.7, 68.3) | 9.3 (7.3, 11.3) |
| 4 (high educational attainment) | 53.0 (41.1, 65.0) | 0 (ref.) |
| Preterm delivery | | |
| 1 (low educational attainment) | 27.7 (23.8, 31.5) | 11.4 (8.9, 13.9) |
| 2 | 18.2 (14.1, 22.2) | 9.4 (7.3, 11.5) |
| 3 | 2.4 (−3.4, 8.2) | 2.2 (0.1, 4.2) |
| 4 (high educational attainment) | −3.6 (−13.1, 5.8) | 0 (ref.) |

The statistical analyses are adjusted for age and parental educational attainment

Educational attainment is categorized as ‘low’ (primary education, upper secondary education), ‘medium–low’ (vocational education and training, short cycle higher education), ‘medium–high’ (vocational bachelors educations, bachelor’s programs), and ‘high’ (master’s programs, PhD programs)

p values for likelihood ratio tests of interactions between educational attainment and child protective services in the family of origin: *p*=0.017 for induced abortion, *p*=0.882 for spontaneous abortion, *p*=0.153 for stillbirth and *p*<0.001 for preterm delivery

RD risk difference, CI confidence interval

but this seems unlikely. Second, educational attainment may be a proxy for maternal characteristics that influence both educational attainment and risk of preterm delivery. These characteristics might be individual (e.g., intelligence, resilience) and/or contextual (e.g., exposure to environmental pollutants, neighborhood effects). If the characteristics are more prevalent among women with high educational attainment and are not adjusted for in the statistical analyses, this would induce interaction. Third, our proxy measure of childhood social disadvantage includes CPS for all siblings irrespective of the type of problem involved and its degree of severity—this may be thought of as mismeasurement. If women with ‘light’ exposure to childhood social disadvantage on average have higher educational attainment and lower preterm delivery rates, this would result in an interaction of the type observed. In principle, all three mechanisms might contribute, but the two latter are in our view the most important contributors. However, why the interaction is only observed for preterm delivery (and not for spontaneous abortion and stillbirth) is unclear as similar biological pathways might be involved.

Comparison with the Existing Literature

The finding of inverse associations of educational attainment with induced abortion, stillbirth and preterm delivery are consistent with previous studies (Mortensen et al. 2011; Poulsen et al. 2015; Rasch et al. 2008; Väisänen 2015; Zeitlin et al. 2016). A recent Danish study also found an inverse association between educational attainment and spontaneous abortion (Norsker et al. 2012), which is in contrast with our study results, but this study was based on a smaller and much more selected study population. There are studies that have investigated the influence of childhood social environment on pregnancy outcomes, but not in ways that are directly comparable to what we have done in the present study (Lawlor et al. 2011; Mortensen 2013). However, given the well-documented associations of childhood social disadvantage with later educational attainment and health (Gluckman et al. 2009; Hertzman 1999; Machin 2006) and the strong and consistent intergenerational associations in educational attainment and pregnancy outcomes, our findings are not surprising and in concordance with the literature (Conley et al. 2003; Currie and Moretti 2005).

Strengths and Limitations

The major strength of this study is its large study population comprising 786,054 registered pregnancies in Denmark during the period from 2000 to 2009. The use of information from national registers ensures a systematic collection of data and a limited magnitude of missing information due to the registers’ high degree of coverage. As all Danish citizens

are assigned a personal identification number, it has been possible to link the register-based information on educational attainment, CPS in the family of origin and pregnancy outcomes at the individual level.

However, some potential limitations might have influenced the study results and weakened their validity. To be included in the study population, it was required that the pregnant women could be linked to their mothers and that the registered pregnancies did not have missing information on variables. Among the 900,043 eligible pregnancies, 11.2% and 1.4% were excluded due to these two criteria. The majority of missing links between the pregnant women and their mothers were due to the fact that the pregnant women were born outside of Denmark. We have found that missing links between the pregnant women and their mothers are strongly associated with low educational attainment and CPS in the family of origin, for which reason there is basis for selection bias resulting in underestimation of the investigated associations. Further, the information on educational attainment used in this study is based on the highest completed education in 2010. Thus, the educational attainment is recorded after the registration of the pregnancy outcome. This involves a risk of reverse causation, but we believe the risk to be minor. Also, we believe that any ‘effect’ of completing an education will be minor compared to the influence of being the kind of person who at some point attains a certain educational level (Mortensen 2013). Depending on the pregnant women’s year of birth, the women will have been followed for a varying number of years, but this has probably not affected our study results in that the statistical analyses are adjusted for age. The use of CPS in the family of origin as a proxy measure of childhood social disadvantage is debatable. For example, CPS may in some cases be used for reasons that have very little to do with the family social environment (e.g., if the child has a severe developmental disorder). Putting the issue of construct validity aside, it is clear that CPS in the family of origin as a proxy measure of childhood social disadvantage are measured with considerable error.

Conclusions

In conclusion, women with low educational attainment had a higher risk of induced abortion, stillbirth and preterm delivery and a lower risk of spontaneous abortion. The associations between educational attainment and pregnancy outcomes were to some extent explained by age, parental educational attainment and CPS in the family of origin. Further, it was found that CPS in the family of origin modified the association between educational attainment and preterm delivery: CPS in the family of origin were associated with a higher risk of preterm delivery among women in the two

lowest educational categories, whereas there was little difference in risk according to CPS in the family of origin among women in the two highest categories. The findings suggest that thinking about novel social markers of risk might enrich our understanding of the socioeconomic gradient in pregnancy outcomes.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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