

Life-course fertility patterns associated with childhood externalizing and internalizing behaviors

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Abstract Childhood behavioral problems have been associated with earlier childbearing, but their life-course reproductive consequences are unknown. The present study examined whether and how behavioral problems assessed in childhood predict fertility patterns over the life course in women and men. Participants were 9,472 individuals from the British National Child Development Study (4,739 men and 4,733 women). Childhood externalizing and internalizing behaviors were rated by teachers at ages 7 and 11. Information on fertility history was derived from interviews at ages 33, 42, and 46, including date of pregnancy, whether the pregnancy was planned or non-planned, and pregnancy outcome (live birth, miscarriages/stillbirth, induced abortion). Transition to parenthood and fertility rate were assessed using survival analysis and age-stratified regression models. In both sexes, higher externalizing behavior was associated with higher rate of pregnancies, especially non-planned pregnancies in adolescence and early adulthood, but this association attenuated or even reversed later in adulthood. Internalizing behavior was associated with lower pregnancy rates, especially planned pregnancies and later in adulthood, and particularly in men. In women, higher internalizing behavior was also associated with earlier transition to parenthood. Externalizing behavior in women predicted higher risk of miscarriages and induced abortions, while internalizing behavior predicted lower risk for these outcomes. These findings

suggest that childhood behavioral problems have long-term associations with fertility behavior over the life course, including earlier transition to parenthood, lower probability of normative family formation later in adulthood, and higher risk of adverse pregnancy outcomes.

Keywords Externalizing · Family · Fertility · Internalizing · Pregnancy · Reproduction

Introduction

Behavioral problems represent some of the most salient characteristics in children and adolescents, as these behaviors are closely linked to social adjustment and have long-term influences on the transition to adulthood [1, 3]. Behavioral problems assessed in childhood or adolescence predict elevated mortality risk [1], risky health behaviors [3, 4], physical injuries [5, 6], psychiatric disorders [7–9], criminal behavior [10], and low socioeconomic achievement [11], among other adult outcomes. These longitudinal associations underscore the importance of considering the wide-ranging and far-reaching consequences of childhood behavioral problems.

Despite the breadth of outcomes investigated to date, there is a lack of studies examining how childhood behavioral problems are related to fertility behavior over the life course¹. This is a crucial omission, because having children is a central aspect in entering adulthood for the majority of people. Early childbearing in adolescence is

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¹ Following demographic research literature, the term fertility here refers to production of offspring, not to physical/physiological capability of having offspring. The terms fertility and fecundity are used in exactly opposite ways in demographic vs. biomedical literatures.

considered a major social issue, because teenage parenthood is often related to adverse outcomes for parents and offspring alike [12, 13]. The association between childhood maladjustment and teenage parenthood has therefore been investigated in several studies [14, 15]. However, children born to adolescents and young adults represent only a small proportion of children born to a given birth cohort. The narrow focus on early childbearing thus offers only a limited picture of the overall impact of childhood behavioral problems on life-course fertility patterns.

Individual differences in behavioral problems can be captured by two higher order factors of *externalizing* and *internalizing* behaviors [16]. Externalizing behaviors encompass under-controlled emotional expressions and “explosive” behavior, including impulsivity, aggressiveness, and hyperactivity. Internalizing behaviors are expressed as emotional problems, such as depressiveness and anxiousness, and as withdrawal and wariness in situations that are easily perceived as threatening. Adolescent delinquency, conduct problems, and antisocial behavior have been associated with more frequent sexual activity [17, 18] and early transition to parenthood [19, 20]. Externalizing behaviors might therefore lead to higher fertility, especially via early parenthood. Traits related to internalizing behaviors, on the other hand, have been associated with delayed transition to marriage and parenthood [21, 22]. The social anxiousness associated with internalizing behaviors hinders the formation of new friendships and romantic relationships [23]. Social anxiety also correlates with lower relationship satisfaction in established marriages [24], which may further delay the transition to parenthood [25]. Thus, it can be hypothesized that internalizing behaviors are associated with postponed and lower fertility, as individuals with high childhood internalizing behaviors are slower to make the normative transition to marriage and parenthood [21, 22].

Assuming that limited long-term planning accounts for the association between behavioral problems and early childbearing, behavioral problems can be hypothesized to influence planned and non-planned pregnancies differently. The impulsive and under-controlled tendencies associated with externalizing behaviors can be hypothesized to increase the probability of non-planned pregnancies, especially in adolescence and young adulthood. With respect to later life-course patterns, behavioral problems may impede normative family formation in adulthood. In this case one would expect behavioral problems to be associated with lower rates of planned pregnancies, especially after young adulthood. Thus, the effects of behavioral problems may change with age in two directions. On one hand, behavioral problems may affect only early fertility via risky sexual behavior and lack of long-term planning in adolescence, but then become less predictive

with age as individuals adopt more responsible adult social roles [26]. On the other hand, the effects of behavioral problems can surface more prominently only later in adulthood when having children becomes a normative phase in life, because the adverse developmental trajectories associated with childhood behavioral problems may hinder such normative life transitions [21, 22]. This latter perspective has received little attention in previous research literature.

Finally, behavioral problems may be associated with adverse pregnancy outcomes, including the risk of miscarriage and the probability of having an induced abortion. The role of childhood behavioral problems in pregnancy outcomes has not been studied before, so there are no previous data to formulate specific hypotheses. Behavioral problems, externalizing behaviors in particular, have been associated with poorer health and health behaviors, such as smoking and heavy alcohol use [1–3]. These health-behavior correlates of externalizing behaviors increase the risk of miscarriages [27], so it can be hypothesized that externalizing behaviors are also associated with increased risk of miscarriages in women. Based on the hypothesis that externalizing behavior increases the probability of non-planned pregnancies (discussed above), one would also expect externalizing behaviors to increase the risk of abortions because these pregnancies have a higher risk of ending in an induced abortion. The associations between internalizing behaviors and risky health behaviors are less consistent. While internalizing behaviors may predispose to some unhealthy behaviors, such as alcohol abuse [28], other studies have reported protective associations for internalizing behaviors in predicting adverse health behaviors [4] and outcomes, such as accidents [6]. These protective associations may reflect the behaviorally and cognitively cautious dispositions associated with internalizing behaviors. Thus, no specific hypotheses can be derived for internalizing behaviors and pregnancy outcomes based on earlier research.

Present study

The present study explores the life-course fertility patterns associated with childhood externalizing and internalizing behaviors. Longitudinal data from the nationally representative British National Child Development Study [29] address three specific research questions of (1) whether the associations between childhood behavioral problems and life-course fertility rates remain constant or change with age, (2) whether behavioral problems are differently related to planned vs. non-planned pregnancies, and (3) whether childhood behavioral problems are associated with the risk of miscarriage or induced abortion.

Materials and methods

Participants

The National Child Development Study, also known as the 1958 British Birth Cohort study [29, 30] has followed a nationally representative sample ($n = 17,415$ at baseline) of individuals born in England, Wales, and Scotland during 1 week in March 1958 [31]. Data have been collected in follow-up phases at ages 7, 11, 16, 23, 33, 42, and 46. Written informed consent was obtained from the parents for childhood measurements and ethical approval for the study was obtained from the South East Multi-Center Research Ethics Committee. The participants of the present study included 9,472 individuals (4,739 men and 4,733 women) for whom data on teacher-rated childhood behavioral problems at ages 7 and 11, family covariates at age 11, and adult fertility at age 33 were available. At age 42, data on adult fertility were available for 8,668 participants, and at age 46 for 7,042 participants. Supplementary Figure S1 shows a flowchart illustrating the sample selection process, and Supplementary Table S1 shows the descriptive statistics of the study covariates.

Measures

Childhood externalizing and internalizing behaviors

At age 7 and 11 the participant's behavioral problems were rated by their teachers using the standardized Bristol Social Adjustment Guide (BSAG) [32, 33]. The instrument comprises of 146 individual items that assess children's problematic behaviors and maladjustment. The items are grouped into ten subscales, six subscales measuring externalizing behavior (hostility toward children, hostility toward adults, inconsequential behavior, restlessness, anxiety for acceptance by children, and anxiety for acceptance) and four measuring internalizing behavior (depression, withdrawal, unforthcomingness, and dismissing adult values). Some of the subscale names may be misleading in light of their item content. For eg., the externalizing subscale "anxiety for acceptance by children" might give the impression of internalizing behavior but the subscale comprises of items such as "inclined to fool around", "damages public property", "misbehaves when teacher is out of the room", and "foolish pranks when with a gang". The two-factor structure of the ten subscales has been previously demonstrated in the present cohort [6], and the predictive validity of the scales has been demonstrated in studies of premature mortality [1], adult psychiatric illnesses [7, 8], physical injuries [6], and low socioeconomic status [11]. Internal consistency coefficients (Cronbach's alpha) were 0.72 and 0.74 at ages 7 and 11 for externalizing and 0.70 and 0.68 for internalizing behaviors. To measure the more stable individual differences in

these behaviors, mean scores calculated over the two measurements at age 7 and 11 were used in the analyses. The scales were corrected for skewness (logarithmic transformation for externalizing and square root transformation for internalizing) and standardized (mean = 0, SD = 1) to facilitate the interpretation of regression coefficients.

Fertility history

At ages 33, 42, and 46 the participants were asked about all the pregnancies they had had (women) or had fathered (men) since the last interview, regardless of the pregnancy outcome and whether or not they were currently living with the partner with whom the pregnancy started. Fertility history, including years and outcomes (0 live birth, 1 miscarriage/stillbirth, 2 induced abortion) of the pregnancies was compiled from these data. At age 33 (but not at age 42 or 46), the participants also reported for each pregnancy whether the pregnancy was planned or not by answering the question "Were you planning to have a baby around this time?" (0 No/Not sure, 1 Yes).

Participant's family background

Four family measures were included as additional covariates, all reported by the parents when the participants were 11 years old: *father's occupational class* (based on Registrar General's occupational class categorization; 1 unskilled or no father, 2 semi-skilled, 3 skilled manual, 4 skilled non-manual, 5 managerial, 6 professional; treated as an ordinal variable), *family size* (number of individuals living in the household; treated as a continuous variable), and *parental figures in the household* (0 natural parent, 1 other parental figure, 2 no parental figure in the household; coded with one set of dummy variables for the father and another set for the mother figure). These variables were used as time-independent covariates in survival analysis, so that within a participant the covariate values did not change across repeated person observations.

Data analysis

Timing of pregnancies was examined with discrete-time survival analysis [34, 35]. The data were stacked so that each person-year nested within a participant was treated as an observation. Participants contributed person-year observations up to the age they participated in the study but not beyond. Separate models were used to predict (1) all pregnancies, (2) planned pregnancies (censoring all non-planned pregnancies), and (3) non-planned pregnancies (censoring all planned pregnancies). Each pregnancy was modeled as a separate "spell", so that the participant was first followed for the first pregnancy, and after this for the second pregnancy, and so on up to the tenth pregnancy [35]. For each pregnancy,

time was clocked in years with interaction effects between the spell indicator and the linear and quadratic effects of time (i.e., years after the last pregnancy). This allowed each pregnancy to have a separate hazard function that could change nonlinearly over time, which takes into account the changing probability of pregnancies by the number of earlier pregnancies. In the single-spell survival analysis predicting parenthood, participants were followed up to the first pregnancy or the end of follow-up period after which they were censored from the sample (no repeated events, time modeled with linear and quadratic terms of age).

Statistical estimates were expressed as odds ratios between hazard functions (conditional probability of pregnancy at a given year for a randomly selected participant who has not reported pregnancy in that spell before that year) associated with one unit difference in the independent variable. Thus, these odds ratios are the equivalents of hazard ratios in continuous-time survival analysis models. In all models, externalizing and internalizing behaviors were mutually adjusted (i.e., both scales included in the same model at the same time), and all models were adjusted for the four family background covariates introduced above (the unadjusted models produced almost exactly the same estimates, so only adjusted models are presented here). Given the specific hypotheses concerning age-dependent associations, interaction effects between age and behavioral problems were tested in all models. Separate models were fitted for women and men.

In addition to survival analysis, logistic and linear regression analyses were used to predict (1) the probability of parenthood and (2) total number of children assessed at different ages. Only live births were included in these analyses. While survival analysis provides estimates of the propensity of having children *at a given age* throughout the life course, the regression models provide additional information on having children *by a given age*. These models were fitted in participants who were censored after the age of 40 (4,285 men and 4,382 women). Finally, the association between behavioral problems and pregnancy outcomes was assessed with multinomial logistic regression with live birth as the reference category, and miscarriage/stillbirth and induced abortion as the outcomes of interest. In these analyses, each pregnancy was treated as an observation (8,065 pregnancies in men and 9,672 pregnancies in women), and robust estimator taking into account the non-independence of the observations was used to estimate the standard errors correctly.

Results

Of all the pregnancies reported at age 33, the proportion of non-planned pregnancies was 29 % in men and 31 % in women (Supplementary Table S1), and this proportion was considerably higher before age 25 than after (Supplementary

Figure S2). Higher levels of childhood externalizing behavior were associated with higher pregnancy rates in adolescence but this effect attenuated with age (Table 1). Externalizing behavior predicted both planned and non-planned pregnancies, although the associations were stronger for the latter. Childhood internalizing behavior was associated with lower total pregnancy rate in men throughout the life course, and predicted lower probability of having planned pregnancies later in adulthood but was not associated with non-planned pregnancies. In women, the association between internalizing behavior and lower pregnancy rate emerged only later in adulthood. In a logistic regression model predicting the planning status of pregnancies across all pregnancies by age 33 (treating each pregnancy as an observation), higher externalizing behavior was associated with higher odds of having non-planned pregnancies in men (OR = 1.20, CI = 1.11–1.29, $p < 0.001$) and in women (OR = 1.23, CI = 1.16–1.31, $p < 0.001$), with OR = 1.22 (CI = 1.16, 1.28, $p < 0.001$) in combined sample of women and men ($p = 0.43$ for sex difference). Childhood internalizing behavior had a similar, but weaker, association in women (OR = 1.07, CI = 1.00–1.14, $p = 0.06$) but less so in men (OR = 1.04, CI = 0.96–1.12, $p = 0.39$), with OR = 1.05 (CI = 1.01, 1.11 $p = 0.043$) in combined sample of women and men ($p = 0.37$ for sex difference).

Figure 1 illustrates the age-dependent associations presented in Table 1 by plotting the model-predicted odds ratios of childhood externalizing and internalizing behaviors by age. For externalizing behavior, the positive associations for total and non-planned pregnancies attenuated or disappeared completely with age. For planned pregnancies, the association changed from a positive to a negative association after age 30 in both sexes. Internalizing behavior was also associated with lower probability of having planned pregnancies after age 25 in men and women. In women, higher internalizing behavior was also associated with higher rate of planned and non-planned pregnancies before age 20, although this association was not observed when the age interaction was assessed with longer age period spanning up to age 46 (total pregnancies).

The logistic regression models predicting the cumulative probability of parenthood by age are shown in Fig. 2, and the corresponding results of linear regression models for cumulative number of children by age are shown in Fig. 3. Childhood externalizing behavior was associated with higher odds of parenthood at younger ages but this association disappeared by age 40. However, due to higher fertility rates at early age, externalizing behavior was associated with higher number of children at age 40 in men ($B = 0.05$, CI = 0.00–0.09, $\beta = 0.03$, $p = 0.05$) and in women ($B = 0.06$, CI = 0.02–0.11, $\beta = 0.04$, $p = 0.009$), with $B = 0.05$ (CI = 0.02–0.09 $p = 0.001$) in combined sample of women and men ($p = 0.52$ for sex difference). The association between childhood internalizing behavior and lower fertility

Table 1 Interaction effects between childhood behavioral problems and age in predicting the probability of pregnancies over the life course

	All pregnancies ^a	Planned pregnancies ^b	Non-planned pregnancies ^b
Men (n = 4,739)			
Externalizing:Main effect	1.14 (1.09–1.19)***	1.19 (1.08–1.30)***	1.43 (1.26–1.26)**
Externalizing:Age interaction	0.97 (0.96–0.99)***	0.94 (0.90–0.97)***	0.93 (0.88–0.97)**
Internalizing:Main effect	0.94 (0.91–0.96)***	1.02 (0.93–1.12)	0.97 (0.92–1.03)
Internalizing:Age interaction		0.96 (0.93–1.00)*	
Women (n = 4,733)			
Externalizing:Main effect	1.16 (1.12–1.21)***	1.16 (1.08–1.24)***	1.32 (1.21–1.43)***
Externalizing:Age interaction	0.97 (0.95–0.98)***	0.94 (0.92–0.97)***	0.96 (0.92–1.00)*
Internalizing:Main effect	1.03 (0.93–1.12)	1.08 (1.00–1.15)*	1.11 (1.02–1.21)*
Internalizing:Age interaction	0.98 (0.97–1.00)*	0.95 (0.93–0.98)***	0.96 (0.92–1.00)*

Values are odds ratios (and 95 % confidence intervals) of multi-splend, discrete-time survival analysis. All coefficients are calculated for standardized scales of externalizing and internalizing behaviors (SD = 1). The main effect gives the effect size at age 15 (age centered at age 15). The interaction effect is the product between age and behavioral problem scale, and gives the proportional change in the main effect associated with a 5 years increase in age. Only statistically significant interaction effects are included. The results are illustrated in Fig. 1

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

^a Follow-up up to age 46

^b Follow-up up to age 33

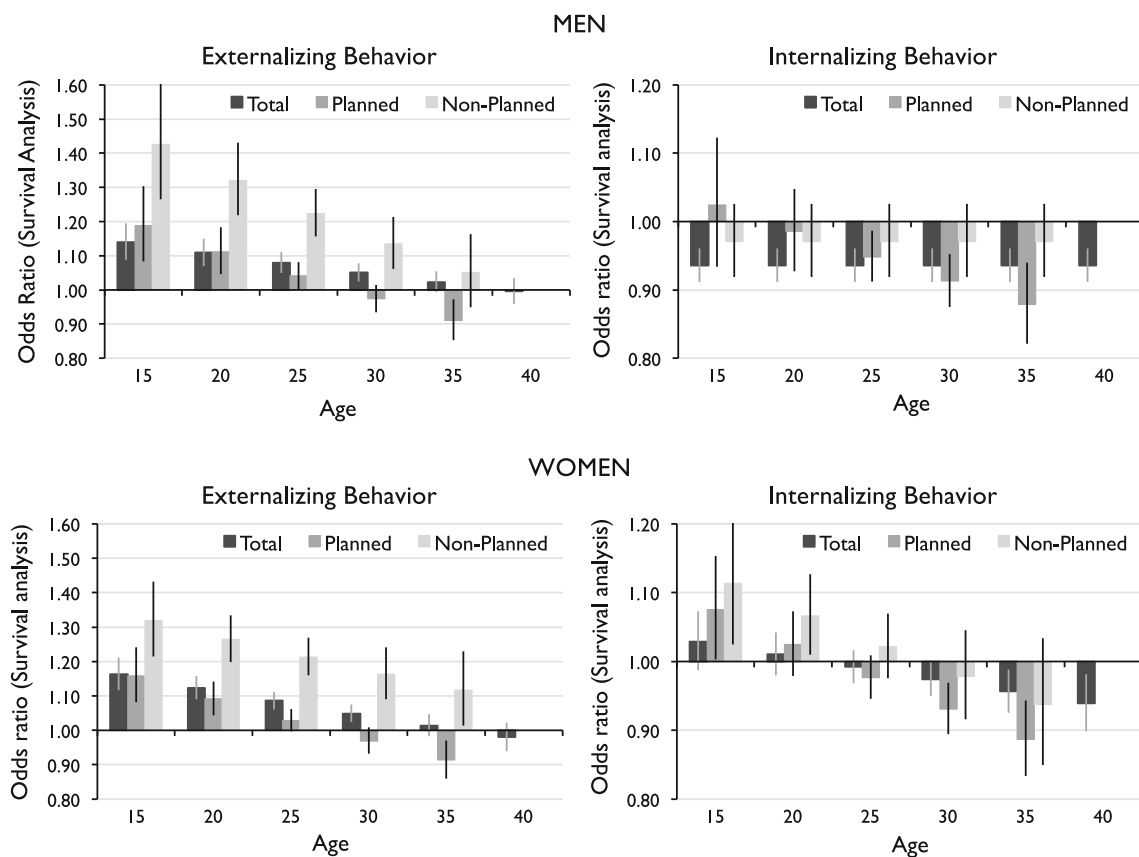


Fig. 1 Associations between childhood behavioral problems and pregnancy rates. Bars are odds ratios associated with one standard deviation difference in externalizing and internalizing behaviors (see

Table 1), error bars are 95 % confidence intervals. Odds ratios for planned and non-planned pregnancies are not plotted for age 40. N = 4,739 and 4,733 women

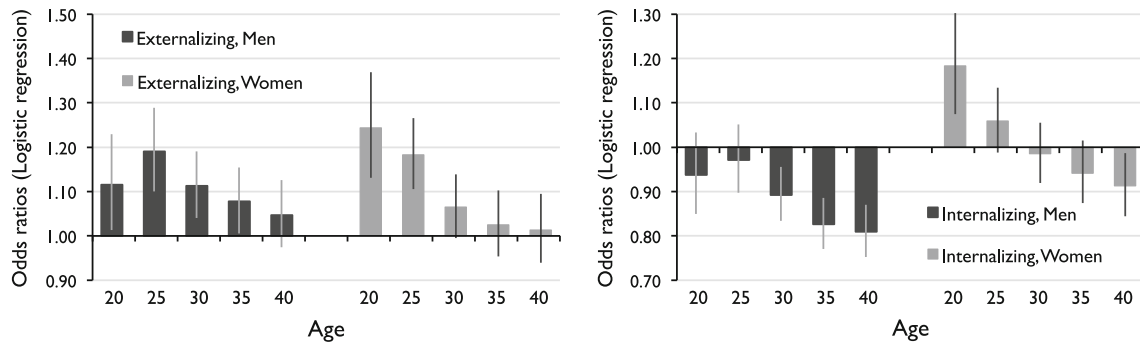


Fig. 2 Predicting parenthood by childhood behavioral problems at different ages, adjusted for family background covariates. Bars are odds ratios associated with one standard deviation difference in

externalizing and internalizing behaviors, error bars are 95 % confidence intervals. *N* = 4,285 men and 4,382 women

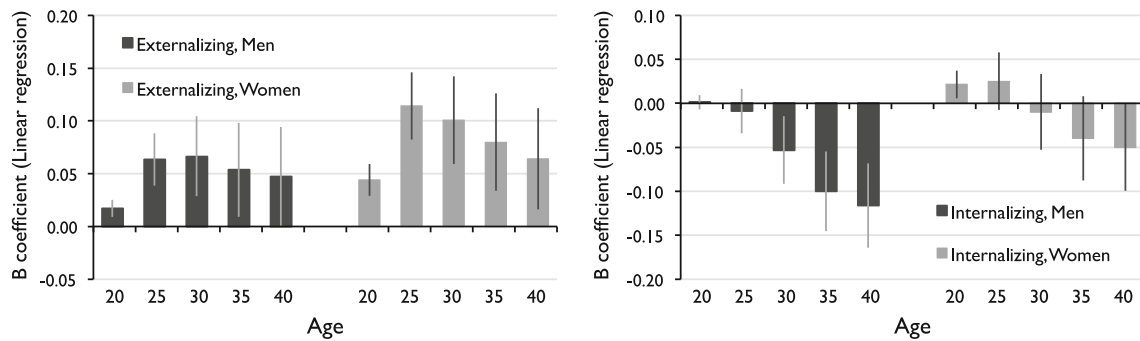


Fig. 3 Predicting the number of children by childhood behavioral problems at different ages, adjusted for family background covariates. Bars are regression coefficients associated with one standard

deviation difference in externalizing and internalizing behaviors, error bars are 95 % confidence intervals. *N* = 4,285 men and 4,382 women

rate became more apparent with age, and at age 40 internalizing behavior was associated with lower number of children particularly in men ($B = -0.12$, $CI = -0.16$ to -0.07 , $\beta = -0.08$, $p < 0.001$) but also in women ($B = -0.05$, $CI = -0.10$ to 0.00 , $\beta = -0.03$, $p = 0.05$), with $B = -0.08$ ($CI = -0.12$, -0.05 , $p < 0.001$) in combined sample of women and men ($p = 0.04$ for sex difference). The association between higher internalizing behavior and earlier transition to parenthood in women was observed in the analysis of parenthood and number of children at age 20, but these associations reversed after age 30.

The multinomial logistic regression predicting pregnancy outcomes is presented in Table 2. In women, childhood externalizing behavior predicted higher risk of miscarriages and induced abortions (compared to having a pregnancy leading to a live birth). Childhood internalizing behavior, in turn, was associated with lower risk of miscarriages and induced abortions. There were no significant associations in men.

Attrition analysis

In earlier studies of the cohort, childhood behavioral problems have been shown to predict selective attrition

Table 2 Associations between childhood behavioral problems and later pregnancy outcomes

	Miscarriage/stillbirth	Induced abortion
Men		
Externalizing behavior	0.96 (0.87–1.06)	1.08 (0.91–1.28)
Internalizing behavior	0.99 (0.89–1.10)	0.89 (0.74–1.07)
Women		
Externalizing behavior	1.12 (1.04–1.21)**	1.23 (1.09–1.39)***
Internalizing behavior	0.91 (0.85–0.98)*	0.84 (0.75–0.95)**

Values are odds ratios (and 95 % confidence intervals) with live births as the reference category. All coefficients are calculated for standardized scales of externalizing and internalizing behaviors ($SD = 1$). *N* = 8,065 pregnancies in men and 9,672 pregnancies in women

* $p < 0.05$
 ** $p < 0.01$
 *** $p < 0.001$

from the cohort [6, 30]. Supplementary Table S2 shows the effects of selective attrition on sample characteristics in the present study. Following a previous study with the present cohort [7], the potential impact of attrition was assessed by re-fitting the statistical models by applying inverse probability sampling weights, which gives more weight to

participants who would be more likely to be lost to attrition given their baseline characteristics, externalizing and internalizing behaviors in particular. The results of the weighted sensitivity analyses were essentially the same as the results without sampling weights, with most differences being slight variations in the second decimal place of logistic regression coefficients, so the weighted analyses are not presented here.

Discussion

Findings from the nationally representative 1958 British Birth Cohort study yield novel data on the association between childhood behavioral problems and life-course fertility behavior. High externalizing behavior was associated with earlier transition to parenthood and higher number of children in adulthood, but this association attenuated with age. Childhood internalizing behavior, in turn, was associated with lower fertility rates particularly in men, and this association became progressively stronger with age. In women, childhood internalizing behavior was associated with higher probability of parenthood before age 25 but after that internalizing behavior started to predict lower rather than higher fertility rate also among women. Thus, the associations of externalizing behavior were observed especially in young adulthood and for non-planned pregnancies, whereas the associations of internalizing behavior were observed later in adulthood and particularly for planned pregnancies.

Methodological considerations

The methodological strengths of the present study include a large and nationally representative sample, repeated measurement of childhood externalizing and internalizing behaviors with a standardized instrument, detailed information on the planning status of participants' children, and a long follow-up period spanning from childhood to adulthood when the cohort members had nearly reached the end of their reproductive age. Regarding limitations, selective attrition associated with childhood behavioral problems may have biased the current results [6, 30]. Applying sampling weights of attrition probability related to externalizing and internalizing scores had negligible influence on the results. Thus, the impact of attrition bias was unlikely to be substantial. Another methodological limitation was the self-reported fertility history that may not be completely accurate, especially in men. Men reported fewer pregnancies than women by age 46, and men were less likely than women to report pregnancies to end in miscarriage/stillbirth or in an induced abortion

(Supplementary Table S1). At least three factors could contribute to these differences: men may not be aware of all the pregnancies they have conceived, men may be otherwise less accurate than women in recalling their reproductive history, and men who father many children may be less likely to participate in cohort studies.

Questions regarding the planning status of pregnancies were administered only at age 33, so this analysis was more limited than the main analysis. Retrospective reports on the planning status of pregnancies are unlikely to be completely accurate, so these results need to be interpreted with appropriate caution [36]. Recall bias might have confounded the associations if childhood behavioral problems were associated with how accurately and truthfully people report their fertility history as adults. It is difficult to estimate the direction or magnitude of this potential bias. Approximately 30 % of pregnancies were reported to be non-planned. This implies that the question of planned vs. non-planned pregnancies was not highly sensitive to the respondents, as the percentage was quite substantial.

In terms of individual-level risks, the effect magnitudes of most associations were modest. For example, the difference in number of children at age 40 was approximately 0.10 between individuals with high (+1SD) vs. low (−1SD) childhood behavioral problems (i.e., standardized *B*-coefficients multiplied by two). However, more detailed calculations are needed to estimate the potential population-level implications of these associations, and how prevention efforts targeted to improve children's mental health [37] could change the risky fertility patterns associated with behavioral problems, including early and unintended pregnancies. Even modest individual-level associations between behavioral problems and fertility outcomes may have non-trivial implications to reproductive and mental health of populations.

Age-specific fertility patterns

Childhood behavioral problems were particularly prominent in predicting early pregnancies. In both men and women, high externalizing behavior was associated with higher rates of non-planned pregnancies in adolescence and young adulthood, but this association attenuated with age. The positive association is in agreement with previous studies showing that conduct problems, delinquency, and antisocial behavior predict early sexual activity [17, 18] and childbearing at younger ages [14, 20]. Externalizing behavior is related to disinhibited behavior and higher frequency of risky sexual behaviors, such as not using contraception [38]. Together these factors may contribute to higher rate of non-planned pregnancies and lack of long-term plans for family formation, especially in adolescence and young adulthood. The age-related attenuation of the

association might be related to how childbearing becomes increasing part of stable marital relationships instead of sexual activity; in social circumstances of adulthood, externalizing behavior is no longer as strong predictor of higher pregnancy rate. Future studies should examine potential interaction effects between behavioral problems, sexual activity, marital status, and marital quality to characterize the relationship contexts of the current findings in more detail.

Previous studies of personality traits related to internalizing behavior (e.g., shyness) have shown that these traits may postpone the transition to marriage and parenthood, particularly in men [21, 22]. In addition, high negative emotionality has been associated with lower fertility [39, 40] especially beyond the first child [41]. The present results are partly in agreement with these findings, as high internalizing behavior did predict lower fertility rates in men and women. However, this was not due to postponement of parenthood but rather because high internalizing behavior predicted an earlier and steeper decline in age-specific fertility rates. This shortened the length of reproductive life span. These results suggest a different life-course pattern associated with internalizing behavior than the two previous studies. However, the present findings may not be directly comparable to the previous studies of shyness [21, 22], because different facets of the internalizing spectrum (behavioral problems vs. shyness) may have different associations with fertility behavior.

The more specific associations with planned vs. non-planned pregnancies provide novel support for the hypothesis that childhood behavioral problems hinder normative family formation in adulthood. Higher externalizing behavior predicted lower rate of planned pregnancies after age 30, and an association between higher internalizing behavior and lower probability of planned pregnancies emerged around age 25. There are many plausible psychological and social mechanisms that may explain why behavioral problems are associated with lower likelihood of normative family formation in adulthood. These may be related to problems in long-term personal relationships [22], psychiatric disorders [7], poor financial situation [11], and poor physical health [4], among other manifestations of psychosocial maladjustment [1, 3]. Given that childhood behavioral problems predict adolescent and adult fertility rates very differently, the mediating mechanisms are likely to differ across life stages [42]. The present study did not yet attempt to identify the specific pathways that mediate the associations between childhood behavioral problems and later fertility outcomes, but this line of research clearly merits further attention.

It should also be noted that many of the social determinants of fertility behavior have gone through major changes in contemporary societies. In the late twentieth

century Britain, the importance of marriage declined as cohabitation became more common, divorce rates increased, many women postponed motherhood to later ages, non-marital sexual relations became socially more acceptable, and the proportion of childless individuals increased [31]. Moreover, oral contraceptives became widely available and abortion was legalized in the 1960s. These changes may have contributed to a more individualized social climate in which individual behavioral dispositions become more important predictors of fertility behavior and family formation compared to earlier times when family formation was more directed by stronger social norms. For example, in the United States, some adult personality traits (e.g., conscientiousness and openness to experience) have become more important predictors of fertility in birth cohorts born in the late twentieth century compared to those born in the early twentieth century [43]. This may reflect the individualization of fertility decisions associated with social changes in family formation.

Some of the associations between behavioral problems and lower fertility rates later in adulthood might also be explained by physiological factors related to poor reproductive health. Individuals with a history of childhood behavioral problems may have a higher risk of contracting sexually transmitted diseases [38], and some common sexually transmitted diseases (e.g., chlamydia) increase the risk of infertility by inducing pelvic inflammatory disease [44]. This could be particularly relevant risk pathway among present-day cohorts of adolescents and young adults, as the numbers of diagnosed chlamydia cases have been increasing in recent years in Britain as well as in the United States [44].

Pregnancy outcomes

Women's childhood behavioral problems were associated with adverse pregnancy outcomes later in adulthood. Externalizing behavior predicted higher probability of having an induced abortion, which is in line with the associations between externalizing behavior and risky sexual behavior [38]. Compared to planned pregnancies, non-planned pregnancies in adolescence and young adulthood are much more likely to end in an induced abortion [45]. Externalizing behavior was also related to higher risk of miscarriages. This may be due to risky health behaviors, such as smoking and alcohol use that are associated with externalizing behavior [4], as these risky behaviors increase the risk of miscarriages [27].

By contrast, higher childhood internalizing behavior in women predicted lower probability of induced abortions and lower risk of miscarriages. Individuals with high internalizing behavior tend to be risk-averse and act cautiously in many situations. For example, a previous study

using the same sample as here showed that individuals with high childhood internalizing behavior were less likely to be injured in accidents as adults [6]. Perhaps a similar wary and cautious behavioral tendency in romantic relationships and during pregnancies explains the associations with lower incidence of pregnancy risks. Moreover, women with high internalizing behavior may be less likely to become pregnant in circumstances that increase the risk of an abortion (e.g., when not having a partner). They may also have a higher threshold for seeking for an abortion even when contemplating such a decision.

Conclusions

In sum, the present findings add novel evidence to previous research literature on the life-course associations of childhood externalizing and internalizing behaviors with fertility behavior. The results demonstrate that childhood behavioral problems are associated not only with early transition to parenthood, which has been examined in many earlier studies, but also with lower probability of having children later in adulthood. The latter association suggests difficulties in normative family formation. Moreover, behavioral problems were associated with adverse pregnancy outcomes (i.e., miscarriages and induced abortions) in women, indicating a public health concern related to reproductive health of girls with early behavioral problems. Fertility, family formation, and reproductive health should be considered as relevant outcomes when evaluating the overall long-term psychological and social trajectories associated with childhood behavioral problems.

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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